The influence of ethnic segregation and school mobility in primary education on high school dropout : evidence from regression discontinuity at a contextual tipping point

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The influence of ethnic segregation and school mobility in primary education on high school dropout – Evidence from regression discontinuity at a contextual tipping point[1]

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Abstract

This paper investigates the influence of ethnic composition and school mobility at the primary school-level on the propensity to drop out of high school. Using rich school and neighbourhood administrative data, we observe that (i) frequent school movers have a 2.6 times higher likelihood of early school leaving; (ii) the relationship between the share of non-western minority students (in primary school) and early school leaving is non-linear; and (iii) the influence of non-western peers on early school leaving is moderated by student's own ethnicity. Using polynomial regression and regression discontinuity methods, we observe a 'contextual tipping point' in ethnic peer composition that is linked to a discontinuous break in the predicted probability of school dropout. The conditional probability of school dropout increases by 5.4 percent points to 8.0 percent if 'school stable' native Dutch students are enrolled in primary schools that exceed the contextual tipping point of 77.7 percent non-western minority students.

Keywords: Ethnic segregation; School mobility; School dropout; Regression discontinuity; Tipping point

JEL-classification: I21, I22, J18, R20

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1. Introduction

'Few events in the adolescent life course determine subsequent social and economic opportunities more than dropping out of school' (Crowder and South, 2003, p. 660). In a developed, knowledge-driven society, high school dropout is a subject of policy and research with growing importance – c.f. the European Council's target for lowering average rate of high school dropout to below 10 percent. 'Early school leavers' can be defined as 'people aged 18 to 23 who have only lower secondary education or less and are no longer in education or training' (European Council, 2003). Lack of economic opportunities aside (Rumberger and Lamb, 2003), early school leavers are also positively associated with various delinquent behaviours (Anderson, 2012; Hirschi, 1969), teenage pregnancy (Black et al., 2008), lower life expectancy (Kindig and Cheng, 2013), and overall lower lifetime wealth, health quality, and happiness (Oreopoulos, 2007).

The determinants for high school dropout are numerous, multi-levelled, and complexly intertwined (for in-depth reviews, see De Witte et al., 2013; Murnane, 2013; Rumberger, 2011). Not to be studied in isolation, high school dropout is 'the culmination of a long-term process of academic disengagement' (Alexander et al., 1997). It is often, but not necessarily, preceded by academic underachievement and various forms of noncompliant behaviour such as truancy, absenteeism, disruptive conduct in class, and delinquency (Alexander et al., 1997; Brooks-Gunn et al., 1993; Cairns et al., 1989; De Witte and Csillag, 2012; Finn and Rock, 1997). Underlying this process of academic disengagement are socioeconomic 'risk factors' such as low income or minority status (Entwisle and Alexander, 1993). If left unmediated by external factors such as state intervention, schools largely reflect and reproduce the social inequities in society.

One growing facet of this line of research looks at the influences of ethnicity background of the student and his/her peers. Exploiting historical data and a legal-political intervention, Guryan (2004) found that desegregation policies in the 1970s have led to small decrease in the dropout rate of African American students. While in Israel, Gould and colleagues did not find statistically significant effect of immigrant peers on the dropout probability of native students, although there is immigrant peer effect on native students' matriculation test outcome (Gould et al., 2009). However, most earlier literature on school dropout ignored peer effects and was limited to examining ethnic differences in dropout behaviour (Cameron and Heckman, 2001; Cataldi and KewalRamani, 2009; Griffin, 2002; Kalmijn and Kraaykamp, 2003; Ream and Rumberger, 2008). Driscoll (1999) also found generational differences, i.e. third generation Hispanic students have higher dropout probability than those from first- and second-generation after controlling for family resources and background.

More insights on school peer effects[2] can be gained from the broader education (economics) literature. Van Ewijk and Sleegers (2010a, 2010b) conclude in their meta-analyses that both socioeconomic and ethnic peer effects matter. For school peer ethnicity, the effect tends to be mixed, conditional to the student's own ethnicity. Few studies did find significant immigrant peer effect on native students' educational outcome (Brunello and Rocco, 2012; Gould et al., 2009; Jensen and Rasmussen, 2011). Jensen and Rasmussen (2011) established that there is negative immigrant peer effect on native Danish students' test score in mathematics but not on migrant students' own results in reading and mathematics. Even so, the majority of literature concurs on the conclusion that share of peers of disadvantaged or immigrant background have a larger effect on students of the same background, and a considerably smaller, if at all, effect on the advantaged or native background students (Angrist and Lang, 2004; Geay et al., 2013; Guryan, 2004; Hanushek et al., 2009; Hoxby, 2000; Ohinata and Ours, 2011; Peetsma et al., 2006; Schneeweis, 2013; Van Ewijk and Sleegers, 2010a). For instance, Ohinata and van Ours (2011) do not find peer effects of immigrant children in class on the educational outcomes of native Dutch students but found an adverse effect on the language test scores of immigrant children themselves. For brevity of this paper, we refer for a broader discussion on peer effects to the excellent reviews by Jencks and Mayer (1990; 1989) and Sampson et al. (2002).

Moreover, various studies have confirmed the undesirable effects of frequent mobility between schools. Frequent mobility is correlated to a higher risk of dropout from high school (Astone and McLanahan, 1994; Coleman, 1988; Gasper et al., 2012; Ream and Rumberger, 2008; Rumberger and Larson, 1998) and lower educational achievement (Alexander et al., 1996; Hanushek et al., 2004; Mehana and Reynolds, 2004; Pribesh and Downey, 1999; Temple and Reynolds, 2000). Whereas school mobility is typically calculated over the course of high school attendance (e.g. Gasper et al., 2012; Rumberger and Larson, 1998), we measure school mobility during primary schooling. Doing so, we avoid the disadvantage of using the more contemporaneous measure of high school mobility given its potential endogeneity with high school dropout. As noted by Bowditch (1993), the same factors used to identify students 'at-risk' of dropping out – such as disruptive behaviour in class and truancy – can be used by schools to 'push out' students who are considered as 'troublemakers'.

The effect of changing schools can be heterogeneous, conditional on the student's personal and family characteristics. Looking at both individual student mobility and aggregated mobility Hanushek et al. (2004) observe larger negative externalities of student mobility for ethnic minority students who disproportionately change schools more often and attend schools with higher turnover than 'white' students. Similarly, socially disadvantaged students – as measured by African American minority

[2] 'Peer effect' in this paper refers to Manski's (1995, p. 129) terminology of 'contextual effect'. This effect is driven by the distribution of exogenous background characteristics such as ethnicity in the reference group, i.e. the primary school in our study. Due to the limited scope of the paper, 'ethnic peer effect' is treated as a proxy to these unobserved wider influences (see also Thrupp et al. (2002) for a discussion).

status, receipt of school meal subsidies, and mother's low level of education – were found to have a higher probability in changing schools (Alexander et al., 1996).

This paper contributes to the literature in two ways. First, we investigate ethnic heterogeneity in the propensity of school dropout in secondary education. We also examine how ethnic heterogeneity interacts with (i) the influence of primary school student mobility and (ii) the 'contextual effect' (Manski, 1995) of peer ethnicity at the primary school-level. Mainly due to data limitations, earlier literature on high school dropout has ignored the influence of primary school factors. Using administrative data linking primary school and high school records, we aim to fill this research gap.

Our second contribution involves the testing of the 'contextual tipping point' effect of non-western peer composition on the likelihood of high school dropout. 'A contextual tip occurs when a gradual change in a variable y_t causes a discontinuous jump in future values of some other variable x_t' (Lamberson and Page, 2012). In contrast, our methodology is largely inspired by the 'direct tipping point' search procedures expounded in Card et al. (2008) that have both dependent and independent variables derived from the same variable. To our best knowledge, this paper marks the first tipping point estimation in the research field of school dropout. Using high-order polynomial regression and a regression discontinuity design, we deduce and statistically test the 'contextual tipping point' of share of non-western school peers from which the propensity to dropout increases exponentially for native Dutch students. Assuming that parents and students do not observe this 'contextual tipping point' and do not self-select into schools at either side of the threshold, we alleviate the omitted variable bias and establish causality between the share of non-western peers and early school leaving.

The remainder of the paper is structured as follows. Section 2 introduces the Dutch education system and the issue of ethnic segregation in schools. Section 3 describes our specially compiled dataset from various sources including school records and neighbourhood administrative data. Section 4 estimates the relationship between school mobility, ethnic peer effect, and school dropout and explores the potential 'contextual tipping point' effect of peer ethnicity. Section 5 concludes.

2. The case of Amsterdam and its school system

Besides the availability of rich school and neighbourhood data, the city of Amsterdam provides a suitable testing ground for the association between ethnicity, school peer ethnicity, school mobility, and early school leaving. First, as a relatively new 'migrant-receiving country', there is significant difference in dropout rates between native Dutch students and those of 'non-western' migrant origin. The latter typically refers to the four largest 'non-western' ethnic groups – Aruban and Dutch Antillean, Turkish, Moroccan, and Surinamese – with ethnicity defined by the parents' country of

birth. Next, without school catchment conditions and with per capita state funding for almost all schools, there is clear parental choice-driven ethnic sorting. On the one hand, equalised state funding for private and public schools with additional weights based on students' socioeconomic and 'foreign' background have mediated the economic factor in school choice (Ladd and Fiske, 2009a). On the other hand, non-socioeconomic school segregation has been institutionally permissible and sustained as parents choose according to other considerations such as religious denomination, educational philosophy, and student ethnic composition. The latter's salience in school choice has been exacerbated by secularisation and the growing population of inhabitants with a foreign background (*allochtonen*) since the 1960s – making The Netherlands an interesting case study for ethnic segregation in schools.

Sykes and Musterd (2011) find a strong and significant effect of schools' socioeconomic composition on educational outcomes in the Netherlands, mediating to a large extent, initial residential neighbourhood effects. We expect a stronger effect for Amsterdam, an ethnically diverse city with the average primary school having more non-western minority students than native Dutch and western minority student (see *Table 1*). In 2000, one in four non-western primary school pupils are enrolled in a school where the share of non-western minority students approaches ninety percent (own calculations using Municipality of Amsterdam data).

Table 1: Relative size of ethnic groups for 2000 in row percentages

Age Group	Native Dutch	*Moroccan*	*Antillean-Aruban*	*Surinamese*	*Turkish*	*Other Non-west*	*Western*	*Total*
4-12 years Amsterdam	33.63	16.58	2.51	15.81	9.63	12.00	8.84	67357
All ages Amsterdam	55.62	7.48	1.52	9.74	4.61	7.73	13.30	731288
4-12 years Netherlands	79.00	3.03	1.09	2.65	3.46	4.35	6.43	1776269
All ages Netherlands	82.51	1.65	0.68	1.91	1.95	2.70	8.61	15863950

Source: CBS (2010)

Unlike general education systems found in the United States and the United Kingdom, high school education in the Netherlands is divided into multiple tracks (see *Figure A* in *Appendix*) with the mainstream ones divisible into: (i) the general tracks; and (ii) the vocational tracks. They are hierarchical based on student ability (proxied by test scores and teacher's recommendation) and susceptible to ethnic sorting (Kalmijn and Kraaykamp, 2003). Although we do not analyse 'downward mobility' in educational track, we account for its effects in our section on early school leaving.

3. Data and descriptive statistics

Our main data originate from a rich school administrative dataset provided by the Municipality of Amsterdam. It comprises the universe of students aged four to thirteen[3] who were enrolled in 241 primary schools in Amsterdam in 2000. For 46,652 of our observations, we have information on student demographics – gender, ethnicity, residential postcode (up to the six-position detail), educational track[4], and whether one is from a single-parent family – and school characteristics such as location and size. The detailed postcode information for both school and residence allows us to measure the student's distance to school[5]. With enrolment records, we also observe student's inter-school mobility in Amsterdam over time.

The data tracks the educational career of these students through secondary education. While the majority of the students graduate by the end of the dataset, i.e. year 2008, 8.4 percent of students end up as school dropouts. Our operational definition of a high school dropout is someone who has left the school system without obtaining a higher secondary diploma. Since we do not observe the students in our sample (i.e. those enrolled in primary school in 2000) until the age of 23 – but only until the age of 20 – the observed event of high school dropout is right-censored. We account for this in our empirical analysis using cohort dummy variables.

The data have been enriched with information from three additional sources. First, in order to avoid measurement error in high school dropout and using unique student identification numbers, we combined the dataset to a nationwide register dataset with information on school dropout (*Basis Register Onderwijs Nummer* or BRON data). As a result of both sources of administrative data, we avoid endogeneity issues arising from measurement errors.

Bivariate statistical analyses in *Table 2* show a positive association between the likelihood of high school dropout with being female, ethnicity (for those of Dutch Antillean, Aruban, or other non-western origin and those of 1st generation migrant background), single parenthood, and vocational and pre-adult education tracks. Native Dutch students have on average a lower dropout rate (7.1 percent) compared to those of foreign background – between 8.2 percent for students of Moroccan and Turkish origin to 12.7 percent for those of Dutch Antillean or Aruban origin. As expected, first-generation

[3] Despite the official primary school age from 4 to 12 years, we kept the thirteen year-olds because many (more than 8000) had passed their 13th birthday when they de-enrolled from primary school.

[4] We use the following classification: pre-vocational secondary education (VMBO) and the special education stream within it for those with learning difficulties (LWOO), general secondary education (HAVO), pre-university secondary education (VWO), prolonged general adult education (VAVO), elementary vocational training (PRO), transitory education for inter-secondary education programmes (BRUG), and vocational education (MBO). See *Figure A* in *Appendix* for a schema of the Dutch education system.

[5] Although we do not have information on the exact address of the student, the six-position postcode provides detailed information on the location of the student. This limits the measurement error in measuring distance to the school.

migrant students have a significantly higher dropout rate compared to second-generation migrant students. High school students enrolled in the vocational (MBO) track have a disproportionately high rate of dropout at 23.5 percent, while dropout only afflicts about 2.5 percent of pre-university (VWO) and general secondary (HAVO) students.

Table 2: Descriptive statistics (row percentages reported)

	Non-dropout	Dropout	Total
Native Dutch	92.86	7.14	16,144
Antillean/Aruban	87.28	12.72	967
Surinamese	89.06	10.94	7,013
Moroccan	91.79	8.21	9,012
Turkish	91.76	8.24	5,070
Other non-western	90.87	9.13	5,347
Western	91.26	8.74	3,594
VWO (pre-university)	97.62	2.38	8,665
VMBO (pre-vocational secondary)	91.86	8.14	9,372
MBO (vocational)	76.52	23.48	7,880
HAVO (general secondary)	97.42	2.58	5,154
LWOO (special needs pre-vocational)	91.82	8.18	6,984
Brug (bridge-class)	95.31	4.69	7,817
PRO (elementary vocational training)	91.00	9.00	1,200
pre-VAVO (pre-adult education)	88.30	11.70	94
Female	93.10	6.90	23,327
Male	89.94	10.06	23,839
Native Dutch	94.53	7.15	16,146
1st generation	90.16	13.38	3,930
2nd generation	91.42	8.58	27,060
Two-parent household	92.03	7.97	42,394
Single parent household	86.78	13.22	4,772
Total	91.50	8.50	47,166

Source: Municipality of Amsterdam and BRON data (2000-2008).

Second, our dataset has been enriched with data from the Ministry of Education on school type (i.e. teaching philosophy and religious denomination) and students' socio-economic and foreign background composition as measured by 2005 data on school funding weights for socially disadvantaged students[6]. The latter pertains to public funding of schools which is allocated per capita and with additional weights assigned: 0.25 for native Dutch students with both parents having a maximum of lower vocational-level education and 0.90 for first- and second-generation immigrants with at least one parent with a maximum lower vocational-level education or is unemployed, or the highest earning parent working in the manual or unskilled sector (Ladd and Fiske, 2009b)[7]. Using the

[6] We do not have school funding data for 6 percent of our observations.

[7] Schools with less than nine percent students in need of additional weighting were not provided more than per capita funding (Ladd et al., 2010). For the purpose of our paper we ignore the additional weighting for children of shipping crewmembers or caravan families. From 2006 onwards, all weights were streamlined into two

information on the student weights, we construct a new compositional school variable for the proportion of *all* students with low socioeconomic background. The variable is based on parental education (and employment status for those of migrant background). Correlation is high between the new variable and proportion of non-western students (Pearson's product moment correlation = 0.8656, p-value<0.000) but this is mitigated by our use of categorical dummy variables for the latter. Given the high correlation between socioeconomic status and 'non-western' ethnic background, including this crucial variable helps us to control for socioeconomic peer effects in order to obtain actual ethnic peer effect on the probability of school dropout.

Third, using the residential postcode, we link the data to 2004 'block'-level neighbourhood data based on the smallest six-position-postcode identifier, and 'zipcode'-level neighbourhood data based on the four-position-postcode from Statistics Netherlands (CBS)[8]. Relevant neighbourhood data include the level of urbanity, number of inhabitants, average housing price (assessed by the municipality authority for taxation purpose), mean level of income, and compositional information over ethnic group ('native Dutch', 'non-western', and 'western'), age group, welfare recipient status, and household type (single-person, household with or without children). In the Netherlands, administrative data on the highest obtained education level and occupational type of parents do not exist. We subsequently proxy household income – and to a lesser extent, parental education and occupation type – with block-level (or six-position-postcode) average individual income from wage, welfare benefit, and pension. The mean number of inhabitants per block in Amsterdam is 43 (standard deviation = 40.86) and given the spatial concentration of dwellings of similar price, characteristics, and quality, block-level variables can reasonably proxy for the corresponding household-level information[9]. We also apply neighbourhood fixed effects using four-position-postcode that is comparable to 'zipcode' neighbourhoods in the United States with an average number of inhabitants of 12,372 in Amsterdam (standard deviation = 4416.16).

School mobility within the municipality of Amsterdam is observed from the administrative data. It is deemed to have occurred when a student was not registered in the same school location within two consecutive years. From *Table 3*, most native Dutch students (around 71 percent) did not change schools at all and if they did, they did it less frequently (less than 8 percent had changed schools more than once). In contrast, just slightly more than half of the western minority students had not switched schools while the proportion of those who had switched schools more than once almost doubles that of

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categories based solely on parental education level: 1.20 for students with at least one parent possessing primary-level education only; 0.30 for students with both parents having a maximum of lower vocational-level education.

[8] Excluding missing postcode information, we do not have neighbourhood information for 2.5 percent of our sample due to new housing after 2004 and sparse neighbourhoods restricted by Statistics Netherlands (defined as having less than 10 residents per six-position-postcode area and 50 residents per four-position-postcode area).

[9] We have also included average housing value but the variable was more significant at the four-position postcode-level than block-level.

native Dutch students. This is noteworthy considering the fact that more than 90 percent of students across all ethnic backgrounds did not move into a different neighbourhood block (based on six-position postcode area) during that period – see *Table 4*. Hence we can postulate that most of the school mobility observed was due to individual- and school-related factors, and not residential neighbourhood factors.

Table 3: Mobility between primary schools[a] in column percentages

School Change	Native Dutch	Moroccan	Antillean-Aruban	Surinamese	Turkish	Other Non-west	Western	Total
0	70.95	53.31	50.09	50.63	51.30	55.57	65.32	59.93
1	21.47	32.36	30.69	31.58	34.19	31.38	24.80	27.93
2	5.45	10.36	12.73	12.20	10.88	9.35	7.06	8.67
3	1.49	2.82	4.15	3.84	2.74	2.59	1.87	2.43
4 or more	0.64	1.15	2.35	1.75	0.89	1.10	0.95	1.04
Total	17,383	9,257	1,108	7,393	5,283	5,742	3,682	49,848

Source: Municipality of Amsterdam school data (2000-2008), authors' own calculations.
[a] Those offering standard primary education and based on locational-level. We do not have data to correct for 'mobility' due to the merging, division or dissolution of schools.

Table 4: Mobility between residential postcodes[a] in column percentages

Postcode Change	Native Dutch	Moroccan	Antillean-Aruban	Surinamese	Turkish	Other Non-west	Western	Total
0	96.31	92.83	94.04	91.79	90.74	94.67	95.60	94.11
1	3.07	5.92	5.32	6.21	7.22	4.32	3.42	4.75
2 or more	0.62	1.25	0.63	2.00	1.82	1.01	0.98	1.14
Total	17,383	9,257	1,108	7,393	5,283	5,742	3,682	49,848

Source: Municipality of Amsterdam school data (2000-2008), authors' own calculations.
[a] Our dataset has approximately 12,477 six-digit postcode areas with an average of 43 inhabitants.

A school's student turnover rate corresponds to its aggregated student mobility between 2000 and 2001 over its student population. From *Table 3* we know that non-western students are more likely to change schools compared to native Dutch and western students. And due to ethnic segregation in schools, aggregated student mobility is higher for schools with more non-western students (Pearson's product moment correlation = 0.40, p-value<0.000).

4. Empirical strategy and results

Our empirical section seeks to measure the influence of school moving and ethnic school peer effects on early school leaving. In *Section 4.1*, we explore the determinants of one's likelihood to change primary schools frequently. In particular, we correlate school mobility to student's ethnicity and peer ethnicity in school. Next, we explore the detrimental influence of primary school mobility and ethnic segregation on high school dropout in *Section 4.2*. Finally in *Section 4.3*, we examine, using a regression discontinuity design, the influence of a 'contextual tipping point' in school peer composition on early school leaving.

4.1. Student mobility in primary schools

We begin by first analysing the ethnic difference in primary school mobility – coded as binary dependent variable for changing schools more than once[10] – conditional on school peer ethnicity. The probability of moving schools more than once for student *i*, $P(M_i)$ is estimated using logistic regression as a function of student (including household), primary school, and neighbourhood factors:

$$P(M_i) = \frac{1}{1 - e^{-(\alpha+\beta \boldsymbol{X}_i+\gamma E_i+\rho \boldsymbol{P}_j+\lambda Z_j+\tau T_{-ij}+\varphi E_i * Z_j+\varepsilon_i)}}$$

where α is the intercept, E_i is student *i*'s ethnicity, Z_j is the proportion of non-western students in her primary school *j*, $E_i * Z_j$ is the interaction between student ethnicity and school peer ethnicity, T_{-ij} is primary school *j*'s turnover rate excluding student *i*'s own mobility, and ε_i is the error term. The vectors, $\boldsymbol{X}_i$, $\boldsymbol{P}_j$, $\boldsymbol{N}_l$ represent the control variable vectors at the respective student (including student's household), primary school, and neighbourhood-levels.

When we control for neighbourhood fixed effects, our model estimates the conditional logit for the probability of dropping out for student *i*:

$$P(M_{il}) = \frac{1}{1 - e^{-(\alpha_l+\beta \boldsymbol{X}_{il}+\gamma E_{il}+\rho \boldsymbol{P}_{jl}+\lambda Z_{jl}+\tau T_{-ijl}+\varphi E_{il} * Z_{jl}+\varepsilon_{il})}}$$

where α_l denotes the neighbourhood-specific intercept or neighbourhood fixed effect[11], ε_{il} is the individual- and neighbourhood-specific error term. The variable and vectors – E_{il}, Z_{jl}, T_{-ijl}, $\boldsymbol{X}_{il}$, and $\boldsymbol{P}_{jl}$ – now become student (including student's household) and school covariates of within-neighbourhood variability for $P(M_{il})$. By removing the unobserved neighbourhood effects that are common to all neighbourhood residents, we reduce the potential omitted variable bias that may arise from the correlation between neighbourhood effects and our covariates. Since we are interested in the between and within school effect, we do not control for unobserved primary school fixed effects. Nevertheless, we found our results without school fixed effects to be robust.

The Amsterdam median category of 40 to 60 percent non-western students in a school is used as a benchmark to distinguish schools with 'uneven' ethnic distribution. This operationalisation of ethnic segregation commonly used in segregation studies (see Massey and Denton, 1988) reflects how even or uneven is the distribution of the minority group in a school when compared to the larger areal unit, i.e. the city of Amsterdam. Besides the individual and aggregated school mobility and ethnicity variables reported in *Table 5*, we have controlled for student demographics (gender, age cohort, single-parent household, block-level average income, distance between school and residence) and primary

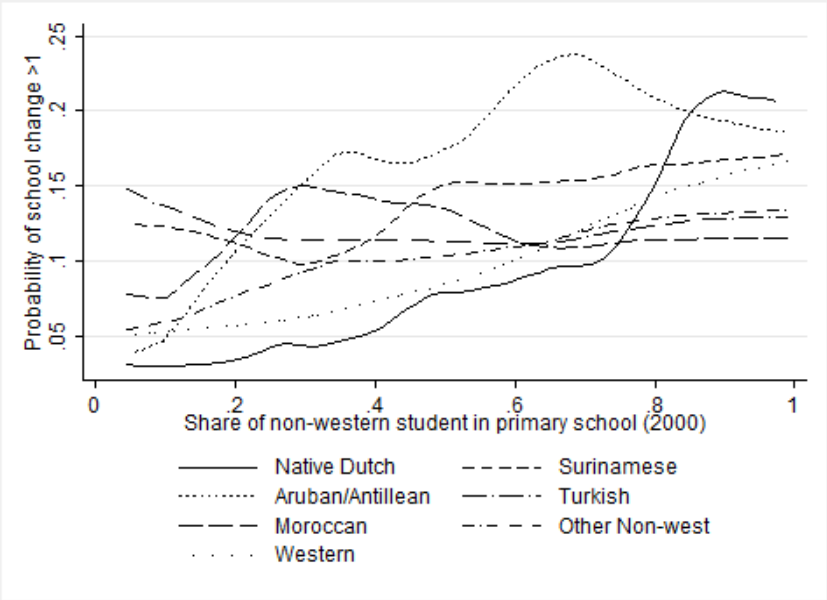
[10] We choose to restrict our definition of 'movers' to those who have changed schools more than once to isolate the 'at-risk' frequent movers (see Temple and Reynolds, 2000). We assume circumstantial or non-systematic mobility behaviour of students who have only changed schools once, which comprise of approximately a third of non-western minority students and a fifth of native Dutch students (see Table 3).

[11] Demeaned or 'within transformation' fixed effect estimation suppresses the estimation of neighbourhood-specific intercept α_l.

school characteristics (size, educational philosophy or denomination, ethnic composition, share of students with low socioeconomic background). When four-position-postcode neighbourhood fixed effects were not applied, the following neighbourhood variables were included: average housing value, number of inhabitants, and percentages for non-western residents, households with children, welfare recipients, and elderly residents above age 65.

By including the interaction between student ethnicity and school peer ethnicity, E_i*Z_j, the ethnic difference in likelihood of school mobility is now conditional on school peer ethnicity. To illustrate this interaction effect, we plot the local polynomial graph of the predicted probability of changing schools more than once (based on *Model 1* in *Table 5*) by ethnicity, on the percentage of non-western students in *Figure 1* while holding the other variables at the respective ethnic group's mean values. Note that the variability exhibited by the Aruban or Dutch Antillean group is due to the small number of observations (863 out of our sample of 41,688 students) hence we should interpret their estimated coefficients and predicted probability with caution.

Figure 1: Local polynomial smooth plot for probability of changing schools by ethnicity



Source: Authors' own calculations with combined data from the Municipality of Amsterdam (2000-2008), BRON (2004-2008), MINOCW (2005), and CBS (2004).

The likelihood of frequent school mobility for native Dutch students is much lower than other ethnic groups at low proportions of non-western students but increases exponentially, surpassing that of other ethnic groups if their primary school (in the year 2000) had more than 80 percent non-western students. Their conditional likelihood of changing schools doubles when enrolled in a school with more than 80 percent non-western students, while the reverse is true for students of non-western background as their respective conditional odds decrease by 53 to 73 percent (see *Table 5*). With respect to schools with the median ethnic composition, students of non-western (except Dutch

Antillean and Aruban) background are between 1.4 to 2.5 times more likely to change primary schools compared to native Dutch students. Surinamese and Turkish minority students are also much more likely – 1.8 and 3.6 times respectively – to change schools when they are enrolled in schools with less than 20 percent non-western students (compared to when they are in schools with 40 to 60 percent non-western minority). Being of second-generation migrant background (as opposed to first-generation) also has an independent negative influence on school mobility since it reduces the likelihood by 18 percent. There appears to be no significant difference between students of western and native Dutch backgrounds in terms of school mobility behaviour. As expected, since moving residences across postcodes within the city is infrequent, the results are consistent even after controlling for zipcode-level neighbourhood fixed effect. School mobility appears to be due to individual- and school-related factors that are unrelated to residential neighbourhood. We have also tested for three-way interaction effects between ethnicity, second-generation status and peer ethnicity on school mobility but they were found to be insignificant.

Table 5: Logistic regression estimates for primary school mobility

School mobility (1 = moved schools more than once)	Model 1		Model 2	
	Odds ratio	Standard Error	Odds ratio	Standard Error
Individual attributes				
Ethnicity (ref: Native Dutch)				
Surinamese	**2.462**	**0.318**	**2.396**	**0.327**
Antillean/Aruban	**1.972**	**0.567**	1.866	0.607
Turkish	**1.723**	**0.319**	**1.628**	**0.276**
Moroccan	**2.007**	**0.486**	**1.957**	**0.284**
Other non-western	**1.400**	**0.212**	**1.410**	**0.224**
Western	1.221	0.278	1.229	0.245
Second generation	**0.813**	**0.046**	**0.819**	**0.044**
Primary school attributes				
% non-western (ref: 40-60%)				
0-20% non-western	**0.350**	**0.049**	**0.360**	**0.049**
20-40% non-western	**0.535**	**0.083**	**0.561**	**0.066**
60-80% non-western	**1.394**	**0.226**	**1.406**	**0.177**
80-100% non-western	**3.286**	**0.509**	**3.238**	**0.488**
School turnover rate	**1.016**	**0.007**	**1.013**	**0.003**
Ethnicity*Peer Ethnicity				
Surinamese*0-20% non-west	**1.890**	**0.456**	**1.847**	**0.423**
Surinamese*20-40% non-west	1.024	0.210	1.005	0.188
Surinamese*60-80% non-west	0.733	0.147	0.741	0.125
Surinamese*80-100% non-west	**0.356**	**0.062**	**0.379**	**0.067**
Antillean/Aruban*0-20% non-west	0.727	0.486	0.761	0.515
Antillean/Aruban*20-40% non-west	**2.728**	**1.040**	**2.739**	**1.126**
Antillean/Aruban*60-80% non-west	2.076	0.793	**2.335**	**0.891**
Antillean/Aruban*80-100% non-west	**0.462**	**0.150**	0.524	0.191
Turkish*0-20% non-west	**3.690**	**1.425**	**3.582**	**1.302**
Turkish*20-40% non-west	1.490	0.406	1.516	0.370
Turkish*60-80% non-west	0.693	0.149	0.719	0.149
Turkish*80-100% non-west	**0.354**	**0.081**	**0.361**	**0.074**
Moroccan*0-20% non-west	1.340	0.520	1.288	0.440
Moroccan*20-40% non-west	**1.951**	**0.631**	**1.877**	**0.364**
Moroccan*60-80% non-west	0.613	0.169	**0.603**	**0.107**
Moroccan*80-100% non-west	**0.268**	**0.071**	**0.264**	**0.048**
Other non-west*0-20% non-west	1.384	0.336	1.399	0.363
Other non-west*20-40% non-west	**1.876**	**0.461**	**1.791**	**0.369**
Other non-west*60-80% non-west	0.964	0.238	0.926	0.186
Other non-west*80-100% non-west	**0.468**	**0.098**	**0.474**	**0.095**
Western*0-20% non-west	1.588	0.444	1.594	0.403
Western*20-40% non-west	1.452	0.397	1.354	0.335
Western*60-80% non-west	1.164	0.351	1.153	0.296
Western*80-100% non-west	0.676	0.207	0.658	0.174
Fixed effects	Cohort		Cohort, Neighbourhood	
McFadden's pseudo R^2	0.069		0.057	
Number of observations	41688		42394	

Note: Bolded estimates indicate statistical significance at the five percent level. Without neighbourhood fixed effects, standard errors are clustered at the school-level. To avoid endogeneity, 'school turnover rate' here excludes observation's own school change.

4.2. Determinants of high school dropout

While the previous section contends the determinants of one's likelihood to change schools frequently, this section explores the detrimental influence of school mobility that is moderated by ethnicity and peer ethnicity. A clear and univocal output indicator is early school leaving. To examine the relationship between ethnicity, school mobility, and early school leaving, we estimate the probability model of high school dropout, $P(Y_i)$ for student i in high school j who was (in the year 2000) enrolled in primary school k and residing in neighbourhood l using binary logistic regression:

$$P(Y_i) = \frac{1}{1 - e^{-(\alpha+\beta \boldsymbol{X}_i+\gamma E_i+\mu M_i+\rho \boldsymbol{P}_j+\lambda Z_j+\tau T_{-ij}+\eta \boldsymbol{H}_k+\nu \boldsymbol{N}_l+\tau E_i*M_i+\varphi E_i*Z_j+\omega E_i*M_i*Z_j+\varepsilon_i)}}$$

where E_i is student i's ethnicity, M_i is her school mobility, Z_j is the proportion of non-western students in her primary school j, and T_{-ij} is primary school j's turnover rate excluding student i's own mobility. Two-way and three-way interaction between ethnicity, school mobility, and peer ethnicity are denoted by the terms E_i*M_i, E_i*Z_j, and $E_i*M_i*Z_j$. The vectors, $\boldsymbol{X}_i$, $\boldsymbol{P}_j$, $\boldsymbol{H}_k$, $\boldsymbol{N}_l$ represent the control variable vectors at the respective student- (including student's household), primary school-, high school-, and neighbourhood-levels. The control variables include: (1) individual covariates: gender, single-parent household, block-level average income, distance to primary school, and high school educational track; (2) primary school covariates: size, educational type, and share of students with low socioeconomic status; (3) high school covariates: size and share of students with migrant background; and (4) neighbourhood covariates: average housing value and share of non-western residents, households with children, welfare recipients, and elderly residents above age 65. Finally, the intercept, α and error term ε_i complete the equation.

Comparing *Model 1* and *Model 2* in *Table 6*, we see that school mobility has a very strong, positive influence on the likelihood of high school dropout after controlling for student demographics, primary and high school characteristics, and neighbourhood attributes. All things equal, the odds of dropping out of high school for a student who has changed primary schools more than once is approximately 2.6 times the odds of one who was relatively 'school-stable'. Before controlling for interactions between ethnicity, peer ethnicity, and school mobility, students of Moroccan or Turkish background were found to be less likely to drop out of high school when compared to native Dutch students. The predicted conditional odds of high school dropout decrease by 35 percent for students of Moroccan and Turkish background when compared to native Dutch students.

Table 6: Logistic regression for high school dropout

School dropout	Model 1		Model 2		Model 3		Model 4	
	Odds Ratio	Std. Error	Odds Ratio	Std. Error	Odds Ratio	Std. Error	Odds Ratio	Std. Error
Individual attributes								
Ethnicity								
(ref: Native Dutch)								
Surinamese	0.948	0.083	0.870	0.077	0.905	0.091	0.860	0.171
Antillean/Aruban	**1.371**	**0.149**	**1.237**	**0.132**	1.209	0.156	1.319	0.592
Turkish	**0.669**	**0.064**	**0.652**	**0.062**	**0.716**	**0.071**	0.757	0.138
Moroccan	**0.671**	**0.069**	**0.651**	**0.065**	**0.689**	**0.078**	0.559	0.168
Other non-western	1.043	0.099	0.997	0.096	1.084	0.118	1.220	0.247
Western	**1.254**	**0.127**	1.207	0.123	1.212	0.139	1.456	0.346
Second generation	0.964	0.065	0.976	0.067	0.970	0.066	0.972	0.067
Moved schools >1			**2.642**	**0.139**	**3.225**	**0.326**	**2.596**	**0.676**
Primary school attributes								
% non-western								
(ref: 40-60%)								
0-40% non-western					0.971	0.079	1.038	0.139
60-80% non-western					**0.857**	**0.065**	**0.689**	**0.109**
80-100% non-western					0.908	0.090	**1.738**	**0.334**
School turnover rate					1.000	0.003	1.000	0.003
Ethnicity*School Mover								
Surinamese*Mover					0.842	0.119	1.584	0.704
Antillean/Aruban*Mover					1.014	0.247	0.825	0.581
Turkish*Mover					**0.636**	**0.118**	1.278	0.457
Moroccan*Mover					0.793	0.137	2.085	0.934
Other non-west*Mover					**0.647**	**0.118**	0.734	0.36
Western*Mover					0.976	0.222	0.949	0.564
3-way interaction	No		No		No		Yes	
Fixed effects	Cohort, Track		Cohort, Track		Cohort, Track		Cohort, Track	
McFadden's pseudo R^2	0.141		0.157		0.157		0.161	
Number of observations	41743		41743		41295		41295	

Note: Bolded estimates indicate statistical significance at the five percent level with standard errors clustered at the primary school-level. Three-way interaction involves ethnicity, school mobility, and school peers' ethnicity. Control variables include: (1) individual covariates: gender, single-parent household, block-level average income, distance to primary school, and high school educational track; (2) primary school covariates: size, educational type, and share of students with low socioeconomic status; (3) high school covariates: size and share of students with migrant background ; and (4) neighbourhood covariates: average housing value and share of non-western residents, households with children, welfare recipients, and elderly residents above age 65.

However, once the two- and three-way interaction terms were included (see *Model 3* and *Model 4*), the ethnic difference in the propensity to drop out of high school becomes conditional to primary school ethnic composition and school mobility. In schools with a median non-western composition of 40 to 60 percent (our reference category), there is no statistically significant difference between native Dutch students and those of a foreign background, regardless of their school mobility. In contrast, for a native Dutch student who is 'school stable', being in the school with more than 80 percent non-western students (instead of an ethnically mixed school) increases the odds of dropout by a factor of 1.7. The three-way interaction terms between ethnicity, peer ethnicity, and school mobility were individually statistically insignificant at the five percent level (except for 'frequent movers' of Moroccan background in schools with 60 to 80 percent non-western students) although collectively they are statistically significant (Wald $\chi 2 = 50.291$, p-value < 0.000)[12].

Based on our last model, we estimate the predicted probabilities of high school dropout for the different ethnic, peer ethnic composition, and school mobility groups in *Table 7* while holding the other variables at their respective subgroup (conditional on ethnicity, peer ethnicity, and school mobility) mean values. For a relatively rare event of high school dropout, these within-group marginal effects could be more intuitive to interpret than the multiplicative effects from the previous table (Buis, 2010).

Table 7: Predicted probabilities of high school dropout

	School change once or less				School change more than once			
	Percentage non-western residents in primary school							
Ethnicity	0-40%	40-60%	60-80%	>80%	0-40%	40-60%	60-80%	>80%
Native Dutch	0.032	0.039	0.037	0.111	0.165	0.143	0.220	0.186
Surinamese	0.031	0.044	0.045	0.068	0.111	0.181	0.201	0.167
Aruban/Antillean	0.042	0.070	0.045	0.096	0.174	0.215	0.187	0.274
Turkish	0.021	0.042	0.043	0.045	0.162	0.153	0.128	0.067
Morocco	0.045	0.030	0.043	0.041	0.148	0.207	0.091	0.118
Other non-western	0.040	0.050	0.041	0.052	0.082	0.143	0.118	0.147
Western	0.038	0.057	0.049	0.043	0.205	0.204	0.129	0.155

Note: Results based on model with three-way interaction between ethnicity, peer ethnicity and school mobility.

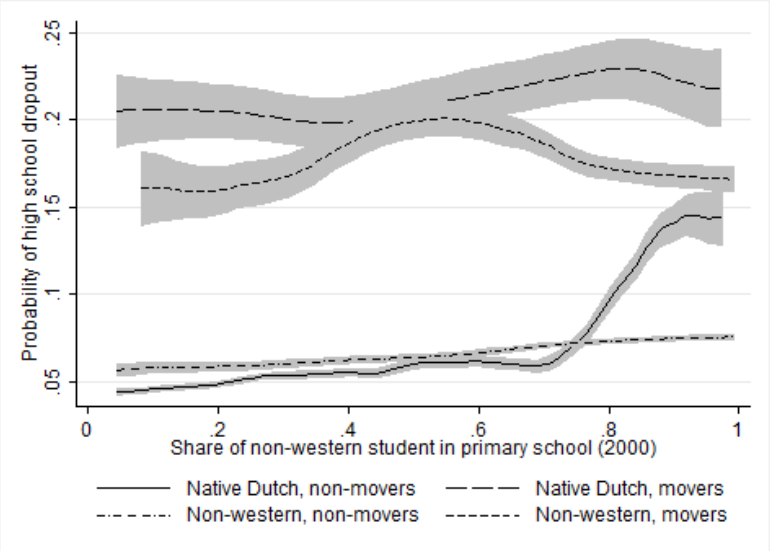
The interaction effect between school mobility, ethnicity and peer ethnicity is clear. The likelihood of high school dropout for Native Dutch students is highest for frequent school movers with above median proportion of non-western students. Almost one fifth of these Native Dutch students are predicted to drop out of high school. Meanwhile the probability of early school leaving for 'school

[12] There are only slight differences in the results when three-way interaction terms were included – full empirical results can be obtained upon request. We have additionally controlled for neighbourhood fixed effects (which did not alter the results substantially) and tested for three-way interaction between second-generation status, ethnicity, and peer ethnicity, and four-way interaction between second-generation status, ethnicity, peer ethnicity and school change. These interaction results were not robust (with oversized logit coefficients) due to sparse cells.

stable' students of Turkish and Moroccan background is predicted to be between 2 and 4.5 percent, substantially below the unconditional sample average dropout rate of 7.6 percent. Surinamese 'school stable' students have slightly higher predicted probabilities between 3.1 and 6.8 percent. Due to the small sample size of students with Aruban or Dutch Antillean background, their relevant probabilities should be interpreted with caution.

Being in a 'black school' is most adversely associated with native Dutch 'school-stable' students compared to students of other ethnicity (except those of Dutch Antillean and Aruban background). So much so, for primary schools with more than 80 percent non-western students, even 'mover' students of Turkish background have lower predicted probability of dropout than 'non-mover' Native Dutch students. The local polynomial smooth plot in *Figure 2* depicts how the predicted probability of dropout (calculated in *Table* 7 based on *Model 4*) for 'school-stable' native Dutch students increases exponentially after a certain share of non-western peers. This surpasses the predicted dropout probability of 'school stable' non-western minority students which varies slightly across school ethnic composition. Besides the potential bias of specific native Dutch students self-selecting themselves into 'black schools', it is plausible that members of the ethnic majority group do not adapt well when they are in role of the minority. Nonetheless, due to omitted variable biases, such as self-selection and from the lack of parental background information, we cannot establish the causal effects of our explanatory variables on early school leaving. Hence, in the following subsection, we attempt to establish causal effect of peer ethnicity by deducing a 'contextual tipping point' and estimating its potential discontinuous effect on the probability of school dropout.

Figure 2: Local polynomial smooth plot for probability of high school dropout



Source: Authors' own calculations with combined data from the Municipality of Amsterdam (2000-2008), BRON (2004-2008), MINOCW (2005), and CBS (2004). 'Movers' refer to those who have changed schools more than once. The shaded grey area corresponds to the 95 percent confidence interval with standard errors clustered at the primary school-level.

4.3. Causal evidence by a contextual tipping point

Visual inspection of *Figure 2* suggests a potential 'contextual tipping point' effect of share of non-western peers on the dropout probability of non-mover native Dutch students. This group makes up approximately a third of our sample, i.e. the largest subgroup. Besides the evidently different dynamics affecting 'movers' and 'non-movers', focusing on 'non-movers' permits us to reduce the effect of 'at-risk' students. In this section, we use high-order polynomial regression and a regression discontinuity design to deduce and statistically test the 'contextual tipping point' effect of non-western student composition on Dutch 'non-mover' students.

Selection of the tipping point

To appropriately fit a global polynomial model, we select only native Dutch 'non-movers' who were enrolled in primary schools with a majority of non-western students in year 2000, $Z_j > 0.5$. From there, two random samples for mutually independent tipping point search procedure and hypothesis test are created (c.f. "fixed point" search procedure employed in Card et al., 2008). We first fit the deviation of the conditional predicted probability of school dropout (from our last model) from the sample mean, $\widehat{P(Y_i)} - \bar{x}_{P(Y)}$, to a quartic polynomial in share of non-western students in primary school, Z_j with ε_i representing the error term[13]:

$$\widehat{P(Y_i)} - \bar{x}_{P(Y)} = \sum_{p=0}^{4} \lambda_p {Z_j}^p + \varepsilon_i$$

Based on visual inspection and our analyses so far, we expect the predicted probability of dropout to be lower than the sample average at low percentages of non-western peers until it reaches the tipping point, after which, the positive slope becomes disproportionately steep. If the equation has at least one real root, we expect the function to cross the average dropout probability from below, i.e. with a positive slope, at one of the roots. The regression coefficients are used to calculate the roots of the polynomial equation and we choose the root (x = 0.76013) which provides the most positive slope as a potential 'contextual tipping point'. We refine the search procedure by estimating a cubic polynomial using a smaller sample within 10 percentage points from the previously identified root and selecting the polynomial root with the most positive slope – share of non-western students equals 0.77688 – as the final 'contextual tipping point'.

[13] Adapting the polynomial regression model by Card et al. (2008) with both dependent and independent variables derived from one *continuous* variable, we use the predicted probability of our *binary* event (school dropout) from our last regression model, $\widehat{P(Y_i)}$ as the dependent variable. Since the logit estimation of the binary event with polynomials and control variables did not converge, this alternative using predicted values allows for the probability of dropout to be conditional to other explanatory variables and for the global, quartic polynomial fit on share of non-western students.

The regression discontinuity design

For the random sample of the students not selected for the tipping point procedure, we estimate the local difference in conditional predicted probability of school dropout at 'contextual tipping point' and test the potential discontinuity effect with regression discontinuity method based on the empirical specification below:

$$P(Y_i) = \frac{1}{1 - e^{-(\alpha+\beta \boldsymbol{X}_i+\rho \boldsymbol{P}_j+\pi(Z_j-Z_{tip})+d\mathbf{1}[Z_j>0]+\tau T_{-ij}+\eta \boldsymbol{H}_k+\nu \boldsymbol{N}_l+\varepsilon_i)}}$$

where, as before, α is the intercept, T_{-ij} is primary school j's turnover rate excluding student i's own mobility, ε_i is error term while the vectors, $\boldsymbol{X}_i$, $\boldsymbol{P}_j$, $\boldsymbol{H}_k$, $\boldsymbol{N}_l$ represent the control variable vectors at the respective student- (including student's household), primary school-, high school-, and neighbourhood-levels. The new variable, $d\mathbf{1}[Z_j > 0]$ is an indicator variable taking the value one if the proportion of non-western students is larger than the 'tipping point' share, Z_{tip}, and zero otherwise. The proportion of non-western students in primary school is then measured as the deviation from this tipping point, $(Z_j - Z_{tip})$.

Results

Among 'non-mover' native Dutch students, the conditional probability of school dropout for one enrolled in primary schools beyond the 'contextual tipping point' of 77.7 percent is 8.4 times (derived from $e^{2.127}$) the odds of another enrolled in a primary school with proportionally less non-western students (see *Table 8*). This difference in conditional probability is statistically significant, suggesting discontinuity in the effect of non-western peers on early school leaving, as is evident in *Figure 3*. The mean conditional difference in predicted probability of school dropout between students on different sides of the tipping point is 5.4 percent. The discontinuity point is robust to using only local observations, i.e. those located at 10 percentage-points before and after the 'contextual tipping point' as seen in the last model of *Table 8*. For sensitivity analysis, we have also smoothed the probability of school dropout as a polynomial function of $(Z_j - Z_{tip})$ and found the discontinuity indicator to be statistically significant at the five percent level (with third-order polynomials) and at the ten percent level (with second- and fourth-order polynomials). For ease of exposition here, we choose the linear function on share of non-western students minus the 'contextual tipping point' value.

If the 'contextual tipping point' identified from our data is not observed by parents, we can assume that it is exogenous and provides support for the causal effect of peer ethnicity in primary school on early school leaving for these 'non-mover' native Dutch students. For the small number of observations located just before and after the 'contextual tipping point' (N = 141), there is statistically

significant discontinuity effect[14]. Those who are within 10 percentage points beyond the 'contextual tipping point' have on average 5.9 percent higher conditional predicted probability of school dropout than those who are within 10 percentage points before the threshold. Despite having trimmed 80 percent of the outermost data points, the size of peer ethnicity effect is now only slightly larger than the effect estimated using the test sample (N = 726) of native Dutch 'non-movers' in schools with a majority of non-western peers.

As an additional robustness check, we have explored the possibility that the relationship between peer ethnicity and early school leaving is driven by school quality by looking into education inspectorate assessments in 2012[15]. Only 4 out of the 56 schools with more than 77 percent non-western students in our sample have been evaluated as a 'weak school' based on the school's educational performance, learning process and financial management (Inspectie van het Onderwijs, 2009). None were evaluated as 'very weak schools'. Unsurprisingly, controlling for school quality did not affect our results[16].

Table 8: Logit estimates of the 'contextual tipping point' effect

School Dropout	(1)	(2)	(3)	(4)	(5)
Beyond tipping point (> 0.77668)	**2.13**	4.91	**2.64**	2.46	**3.95**
	(0.74)	(4.62)	(1.34)	(1.45)	(1.35)
Linear in share of non-western peers minus CTP	y				y
Quadratic in share of non-western peers minus CTP		y			
Cubic in share of non-western peers minus CTP			y		
Quartic in share of non-western peers minus CTP				y	
Threshold sample: 67%-87% non-western peers					y
Demographic/School/Neighbourhood controls	y	y	y	y	y
McFadden's pseudo R-square	0.261	0.270	0.275	0.275	0.424
Number of observations	726	726	726	726	141

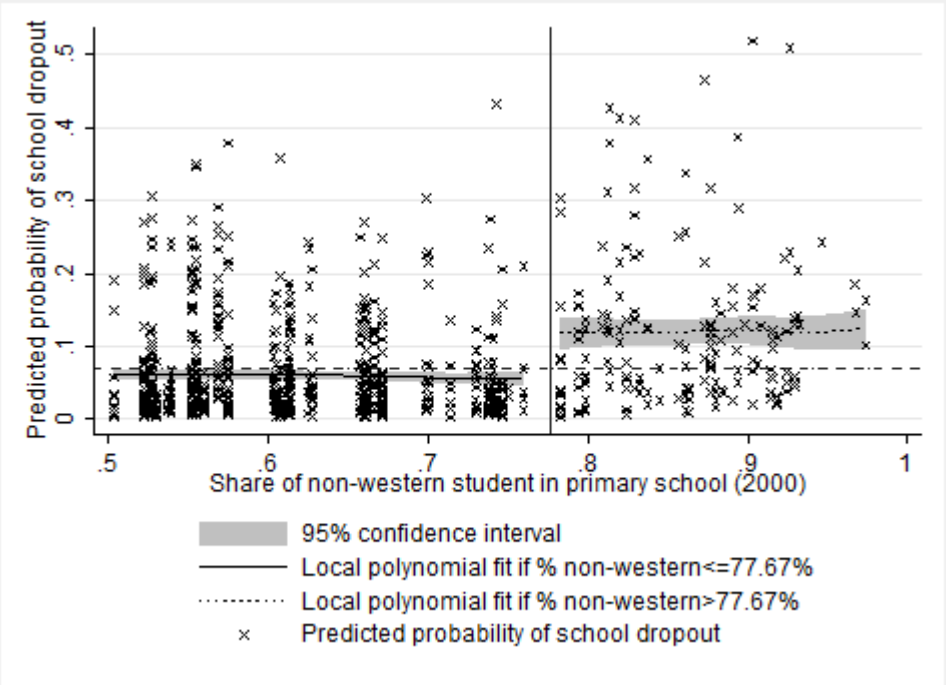
Note: Logit coefficients reported with school-clustered standard errors in brackets. Bold estimates indicate statistical significance at five percent level. Sample only includes the remaining one-third of Dutch non-movers not used in the tipping point search procedure. Control variables include: (i) individual covariates: gender, single-parent household, block-level average income, distance to primary school, and high school educational track; (ii) primary school covariates: size, educational type, and share of students with low socioeconomic status; (iii) high school covariates: size and share of students with migrant background ; and (ib) neighbourhood covariates: average housing value and share of non-western residents, households with children, welfare recipients, and elderly residents above age 65.

[14] We have further tested the sensitivity of this interval width since there could still be significant differences between students within this 67 percent to 87 percent non-western school peer sample that could affect dropout probability, hence violating our regression discontinuity assumptions (Van der Klaauw, 2008, c.f. 2002). While the results remain statistically significant, the logit coefficients in the smaller sample interval are oversized indicating sparse data points (e.g only 61 observations between 68 to 86 percent non-western students).

[15] Data can be assess via the education inspectorate website, http://www.onderwijsinspectie.nl. Unfortunately we do not have earlier inspectorate assessments. We would assume that the school quality did not differ significantly over the years.

[16] Results with school quality control are available upon request.

Figure 3: Predicted probability of dropout for 'non-mover' native Dutch students



Source: Authors' own calculations with combined data from the Municipality of Amsterdam (2000-2008), BRON (2004-2008), MINOCW (2005), and CBS (2004). The discontinuity point of high school dropout probability at 77.7 percent of non-western student in primary school is found to be statistically significant at the one percent level (p-value=0.004) with standard errors clustered at the school-level. The dash horizontal line represents the sample mean dropout rate.

5. Conclusion and discussion

This paper examined the effect of ethnic segregation and school mobility in primary education on high school dropout. Our rich administrative data – with various control variables on the student, household, school, and neighbourhood-levels – and with links between primary school information and high school outcomes reduces the problem of endogeneity caused by measurement error, simultaneity, and omitted variable bias. We have taken a step further in this paper to estimate a 'contextual tipping point' effect of non-western peers on 'school stable' native Dutch students in order to verify potential causality between ethnic peer effects and school dropout.

The first main lesson from our study is that there are long-term effects of primary school conditions and student behaviour – in this case, on high school dropout as the outcome. Our results reveal that frequent school movers during primary schooling have a 2.6 times higher likelihood of dropping out from high school after controlling for various individual, school, and neighbourhood characteristics.

The second lesson is that, depending on the student's own ethnicity and mobility status, there is some influence of non-western peers on early school leaving. Diverging from findings of the insignificant

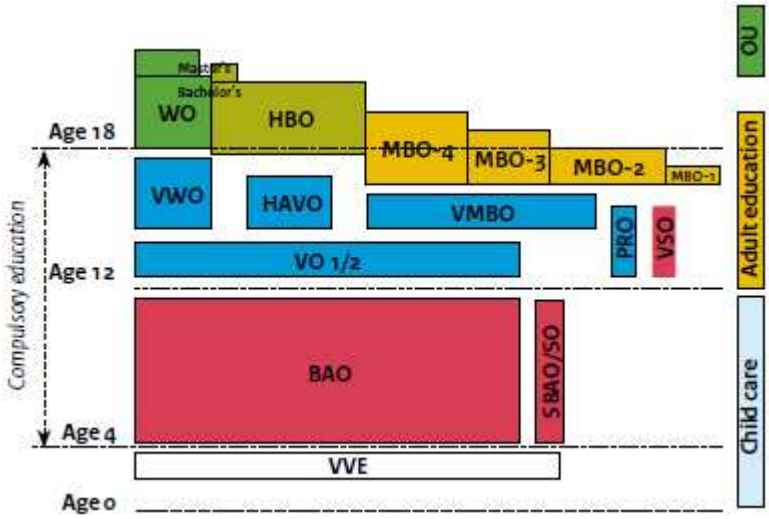
effect of migrant student peers on native ethnic students (e.g. Ohinata and Ours, 2011 for the Netherlands), we find that native Dutch 'non-mover' students in primary schools with more than 80 percent non-western students (instead of an ethnically mixed school) have 1.7 times higher odds of dropout. This could, among others, be due to definitional difference on the concept of 'peers' as we measure ethnic composition at the school-level, and the fact that we have controlled for school mobility. The latter isolates the potentially 'at-risk' students who experience different underlying forces in their school behaviour and outcomes.

We extended our analysis for the native Dutch 'non-mover' subgroup by extracting two independent samples: (1) to identify a 'contextual tipping point' of the share of non-western peers using a polynomial regression and (2) to test the tipping point effect using a regression discontinuity method. The conditional predicted probability of school dropout increases by 5.4 percent points to 8.0 percent if students are enrolled in primary schools with more than 77.7 percent non-western minority students. This peer effect on school dropout is statistically significant and is assumed to be causal since parents and students do not observe this 'contextual tipping point' and do not self-select into schools at either side of the threshold within a narrow interval.

Yet, we refrain from extrapolating the '77.7 percent' contextual tipping point to the rest of The Netherlands since our sample is limited to the ethnically diverse municipality of Amsterdam. The complex interrelationship between ethnic peer effect, student ethnicity, school mobility, and early school leaving as uncovered in this paper mandates further research with a richer set of control variables and a wider sample to account for city and country effects. Further quantitative research could include more detailed information on parental background and individual student ability, which are lacking in the current study. Qualitative research could also enrich this research niche by looking at the processes underlying these peer contextual effects.

APPENDIX

Figure A: Dutch education system



Note: BAO = mainstream primary education, BBL = block or day release in vocational education, BOL = full-time vocational programmes, HAVO = general secondary education, HBO = professional higher education, MBO = vocational education, OU = Open University, PRO = elementary vocational training, SBAO = special primary education, SO = special education, VMBO = pre-vocational secondary education, VO = secondary education, VSO = secondary special education, VVE = early childhood education, VWO = pre-university education, WO = academic higher education.
Source: Ministerie van Onderwijs Cultuur en Wetenschap (2012)

BIBLIOGRAPHY

Alexander, K.L., Entwisle, D.R., Dauber, S.L., 1996. Children in motion: School transfers and elementary school performance. The Journal of Educational Research 90, 3–12.

Alexander, K.L., Entwisle, D.R., Horsey, C.S., 1997. From first grade forward: Early foundations of high school dropout. Sociology of education 87–107.

Anderson, D.M., 2012. In school and out of trouble? The minimum dropout age and juvenile crime. Review of Economics and Statistics.

Angrist, J., Lang, K., 2004. Does school integration generate peer effects? Evidence from Boston's Metco Program. American Economic Review 94, 1613–1634.

Astone, N.M., McLanahan, S.S., 1994. Family structure, residential mobility, and school dropout: A research note. Demography 31, 575–584.

Black, S.E., Devereux, P.J., Salvanes, K.G., 2008. Staying in the Classroom and out of the maternity ward? The effect of compulsory schooling laws on teenage births*. The Economic Journal 118, 1025–1054.

Bowditch, C., 1993. Getting rid of troublemakers: High school disciplinary procedures and the production of dropouts. Social Problems 493–509.

Brooks-Gunn, J., Guo, G., Furstenberg, F., 1993. Who drops out of and who continues beyond high school? A 20-year follow-up of black urban youth. Journal of Research on Adolescence 3, 271–294.

Brunello, G., Rocco, L., 2012. The effect of immigration on the school performance of natives: Cross country evidence using PISA test scores. Economics of Education Review.

Buis, M.L., 2010. Stata tip 87: Interpretation of interactions in non-linear models. The Stata Journal 10, 305–308.

Cairns, R.B., Cairns, B.D., Neckerman, H.J., 1989. Early School Dropout: Configurations and Determinants. Child Development 60, 1437–1452.

Cameron, S.V., Heckman, J.J., 2001. The dynamics of educational attainment for black, hispanic, and white males. Journal of political Economy 109, 455–499.

Card, D., Mas, A., Rothstein, J., 2008. Tipping and the Dynamics of Segregation. The Quarterly Journal of Economics 123, 177–218.

Cataldi, E.F., KewalRamani, A., 2009. High School Dropout and Completion Rates in the United States: 2007 Compendium Report (No. NCES 2009-064). National Center for Education Statistics, Washington, DC.

Centraal Bureau voor de Statistiek, 2010. Statline: Bevolking Kerncijfers [WWW Document]. URL http://statline.cbs.nl/

Coleman, J.S., 1988. Social capital in the creation of human capital. American journal of sociology S95–S120.

Crowder, K., South, S.J., 2003. Neighborhood distress and school dropout: the variable significance of community context. Social Science Research 32, 659–698.

De Witte, K., Cabus, S., Thyssen, G., Groot, W., van den Brink, H.M., 2013. A Critical Review of the Literature on School Dropout. Educational Research Review.

De Witte, K., Csillag, M., 2012. Does anybody notice? On the impact of improved truancy reporting on school dropout. Education Economics 1–20.

Driscoll, A.K., 1999. Risk of high school dropout among immigrant and native Hispanic youth. International Migration Review 857–875.

Entwisle, D.R., Alexander, K.L., 1993. Entry Into School: The Beginning School Transition and Educational Stratification in the United States. Annual Review of Sociology 19, 401–423.

European Council, 2003. Council Conclusions of 5 May 2003 on Reference Levels of European Average Performance in Education and Training (Benchmarks). Official Journal of the European Union C 134/03.
Finn, J.D., Rock, D.A., 1997. Academic success among students at risk for school failure. Journal of applied psychology 82, 221.
Gasper, J., DeLuca, S., Estacion, A., 2012. Switching Schools Revisiting the Relationship Between School Mobility and High School Dropout. American Educational Research Journal 49, 487–519.
Geay, C., McNally, S., Telhaj, S., 2013. Non-native speakers of English in the classroom: what are the effects on pupil performance? The Economic Journal.
Gould, E.D., Lavy, V., Daniele Paserman, M., 2009. Does Immigration Affect the Long-Term Educational Outcomes of Natives? Quasi-Experimental Evidence*. The Economic Journal 119, 1243–1269.
Griffin, B.W., 2002. Academic disidentification, race, and high school dropouts. The High School Journal 85, 71–81.
Guryan, J., 2004. Desegregation and black dropout rates. American Economic Review 94, 919–943.
Hanushek, E.A., Kain, J.F., Rivkin, S.G., 2004. Disruption versus Tiebout improvement: The costs and benefits of switching schools. Journal of Public Economics 88, 1721–1746.
Hanushek, E.A., Kain, J.F., Rivkin, S.G., 2009. New Evidence about Brown v. Board of Education: The Complex Effects of School Racial Composition on Achievement. Journal of Labor Economics 27, 349–383.
Hirschi, T., 1969. Causes of delinquency. University of California Press, Berkeley, C.A.
Hoxby, C., 2000. Peer effects in the classroom: Learning from gender and race variation. National Bureau of Economic Research (NBER) Working Paper Series.
Inspectie van het Onderwijs, 2009. Toezichtkader PO/VO 2009. Inspectie van het Onderwijs, Utrecht.
Jencks, C., Mayer, S.E., 1990. The Social Consequences of Growing Up in a Poor Neighborhood, in: Lynn, L.E., McGeary, M.G.H. (Eds.), Inner-city Poverty in the United States. National Academy Press, Washington D. C., pp. 111–186.
Jensen, P., Rasmussen, A.W., 2011. The effect of immigrant concentration in schools on native and immigrant children's reading and math skills. Economics of Education Review 30, 1503–1515.
Kalmijn, M., Kraaykamp, G., 2003. Dropout and Downward Mobility in the Educational Career: An Event-History Anaylsis of Ethnic Schooling Differences in the Netherlands. Educational Research and Evaluation 9, 265–287.
Kindig, D.A., Cheng, E.R., 2013. Even As Mortality Fell In Most US Counties, Female Mortality Nonetheless Rose In 42.8 Percent Of Counties From 1992 To 2006. Health Affairs 32, 451–458.
Ladd, H.F., Fiske, E.B., 2009a. The Dutch Experience with Weighted Student Funding: Some Lessons for the U.S. Duke Sanford School of Public Policy Working Paper Series.
Ladd, H.F., Fiske, E.B., 2009b. Weighted Student Funding for Primary Schools: An Analysis of the Dutch Experience. Duke Sanford School of Public Policy Working Paper Series.
Ladd, H.F., Fiske, E.B., Ruijs, N., 2010. Migrant Education in the Netherlands: Segregation and the Role of Weighted Student Funding. Presented at the Migration, A World in Motion: A Multinational Conference on Migration and Migration Policy, Maastricht.
Lamberson, P.J., Page, S.E., 2012. Tipping Points. Santa Fe Institute Working Paper.
Manski, C.F., 1995. Identification Problems in the Social Sciences. Harvard University Press, Cambridge, MA.

Massey, D.S., Denton, N.A., 1988. The Dimensions of Residential Segregation. Social Forces 67, 281–315.
Mayer, S., Jencks, C., 1989. Growing up in poor neighborhoods: How much does it matter? Science 243, 1441–1445.
Mehana, M., Reynolds, A.J., 2004. School mobility and achievement: A meta-analysis. Children and Youth Services Review 26, 93–119.
Ministerie van Onderwijs Cultuur en Wetenschap, 2012. Key Figures 2007-2011. Education, Culture and Science. Ministerie van Onderwijs Cultuur en Wetenschap, Den Haag.
Murnane, R.J., 2013. U.S. High School Graduation Rates: Patterns and Explanations. National Bureau of Economic Research (NBER) Working Paper Series.
Ohinata, A., Ours, J.C., 2011. How immigrant children affect the academic achievement of native Dutch children. IZA Discussion Paper Series.
Oreopoulos, P., 2007. Do dropouts drop out too soon? Wealth, health and happiness from compulsory schooling. Journal of public Economics 91, 2213–2229.
Peetsma, T., van der Veen, I., Koopman, P., van Schooten, E., 2006. Class composition influences on pupils' cognitive development 1. School effectiveness and school improvement 17, 275–302.
Pribesh, S., Downey, D.B., 1999. Why are residential and school moves associated with poor school performance? Demography 36, 521–534.
Ream, R.K., Rumberger, R.W., 2008. Student Engagement, Peer Social Capital, and School Dropout Among Mexican American and Non-Latino White Students. Sociology of Education 81, 109–139.
Rumberger, R.W., 2011. Dropping out: Why students drop out of high school and what can be done about it. Harvard University Press, Cambridge, MA.
Rumberger, R.W., Lamb, S.P., 2003. The early employment and further education experiences of high school dropouts: A comparative study of the United States and Australia. Economics of Education Review 22, 353–366.
Rumberger, R.W., Larson, K.A., 1998. Student mobility and the increased risk of high school dropout. American Journal of Education 1–35.
Sampson, R.J., Morenoff, J.D., Gannon-Rowley, T., 2002. Assessing "Neighborhood Effects": Social Processes and New Directions in Research. Annual Review of Sociology 28, 443–478.
Schneeweis, N., 2013. Immigrant concentration in schools: Consequences for native and migrant students. IZA Discussion Paper Series.
Sykes, B., Musterd, S., 2011. Examining Neighbourhood and School Effects Simultaneously What Does the Dutch Evidence Show? Urban Studies 48, 1307–1331.
Temple, J.A., Reynolds, A.J., 2000. School mobility and achievement: Longitudinal findings from an urban cohort. Journal of School Psychology 37, 355–377.
Thrupp, M., Lauder, H., Robinson, T., 2002. School composition and peer effects. International Journal of Educational Research 37, 483–504.
Van der Klaauw, W., 2002. Estimating the Effect of Financial Aid Offers on College Enrollment: A Regression–Discontinuity Approach*. International Economic Review 43, 1249–1287.
Van der Klaauw, W., 2008. Regression–discontinuity analysis: a survey of recent developments in economics. Labour 22, 219–245.
Van Ewijk, R., Sleegers, P., 2010a. Peer ethnicity and achievement: A meta-analysis into the compositional effect. School Effectiveness and School Improvement 21, 237–265.
Van Ewijk, R., Sleegers, P., 2010b. The effect of peer socioeconomic status on student achievement: A meta-analysis. Educational Research Review 5, 134–150.

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