

Peer Influence and Segregation in Education and Employment

Gilat Levy and Ronny Razin, LSE

A preliminary version

Abstract: In this paper we examine how individuals beliefs are affected by their school peers' beliefs. We introduce a new model of peer influence which is based on group members exchanging their posterior beliefs. Specifically, we focus on beliefs of private school graduates on the ability of state school graduates. We incorporate this into a dynamic model of parental school choice (state versus private) and labour market decisions (whether to hire a state or a private school graduate). We show under what conditions peer influence is strong enough to outweigh true learning and thus lead to segregation in education and employment. On the other hand, we show that segregation can fail when parents are concerned about strong peer influence.

1 Introduction

There is a large literature focusing on whether and how peer pressure or peer influence are important determinants of individuals' behaviour. Papers study a wide variety of applications including addictive behaviour among teenagers, productivity among firm workers, or academic achievements in schools and universities.¹ A central issue in the empirical literature is whether these effects have long lasting consequences, so that behaviour in schools for example might be correlated with earning data many years later.

In this paper we suggest another dynamic avenue for peer influence: it can affect behaviour or success later on in life, not through its effect on present behaviour, but through the *propagation of beliefs* which affect future decisions. Specifically, in our model, peer influence will affect the beliefs of those attending a private school about the ability of those graduating from a state school. It will then affect the decision of employers who have attended a private school whether to employ workers who have graduated from a state school. We incorporate a new model of peer influence and its effect on beliefs, and characterize necessary and sufficient conditions for long term segregation in education and employment.

In the UK, while private school graduates are only 7% of the population, the Social Mobility and Poverty Commission report has recently identified that they constitute 71%

¹See Duncan et al (2005) for a study of peer effects in drug use, Sacerdote (2001) for analysis of peer effects on students' academic and social behaviour, Hoxby (2000), Angrist and Lang (2004) and Burke and Sass (2013) for such analysis in schools. Sacerdote (2011) is an excellent survey of the literature.

of senior judges, 62% of senior armed forces officers, 55% of top civil servants, 36% of the Cabinet and 43% of newspaper columnists. The same commission identified (after tracking 20,000 university graduates) that private school male graduates are up to 10 per cent more likely to land top jobs than those who have the same grades from the same university but went to a state school. A higher share of private school graduates is admitted to top universities such as Oxford and Cambridge despite recent data showing that state school graduates perform better at university everything else equal.²

On the face of it, state school graduates are discriminated against. Among the reasons for such discrimination (such as favouritism of individuals with similar characteristics in the workplace)³, is the possibility that many employers believe that state schools graduates are not as able as their private school counterparts. According to research done by the Fabian Society in 2010, the Conservative party’s “broken Britain” rhetoric has fuelled middle-class anxieties about state schools.⁴ In a 2013 YouGov survey, almost 21% have answered yes (and that this is an important factor) to the question: “Pupils at private schools are generally brighter than pupils at state schools”. Many believe that state schools are worse due to a plethora of reasons, some more justified than others (larger classes, less resources and worse teachers, even though there is more regulation on teachers’ qualification at the state sector and the state school year is on average 4 weeks longer).⁵ Some believe that private schools have a better socio-economic mix of peers, which would influence their own children’s attainment. On the other hand, a recent study of Abdulkadiroglu, Angrist and Pathak (2014) shows that the beliefs of parents

²The Higher Education Funding Council (Hefce) tracked 130,000 students beginning degrees in 2007, looking at schooling, background and ethnicity. It found on some measures state pupils were significantly more likely to get a 2:1 than their private school peers. Of those students who achieved the same grades at high school (ABB at A-level), some 69% of students from private (independent) schools went on to gain 2:1 or above at university compared with about 77% of students educated at state schools. And at three Bs, 61% of independent students pupils got a 2:1 or above compared with 70% of state school students.

³See Simon and Warner (1992). Granovetter (1974) observes that about half of all jobs are allocated through social network connections rather than formal channels such as classified ads. Marmaros and Sacerdote (2002) show how Dartmouth College seniors use social networks to obtain their first jobs.

⁴“The Conservatives have massively exaggerated the problems in state schools, linking poor families with educational failure and anti-social behaviour.” <http://www.theguardian.com/education/2010/sep/08/broken-britain-rhetoric-fuels-fear>

⁵Others also believe that poorer children, who are typically priced out of private schools, are simply less smart (<http://www.scotsman.com/news/uk/working-classes-are-less-intelligent-says-evolution-expert-1-1169317>). Moreover, recent 2012 UK Government reforms of secondary schools have abolished “meaningless dumb exams” with tougher ones (<http://www.dailymail.co.uk/news/article-2203826/Michael-Gove-New-rigorous-exams-abolish-GCSEs.html>). Naturally, a belief that high school grades are meaningless will induce employers to look at more subjective measures on which beliefs may differ.

about schools exhibit an “elitist illusion”. Specifically, they show that the presence of pupils with high achievements or the school’s racial mix have no effect on other pupils’ attainment.⁶

There is also a wide divergence in beliefs about state schools. The YouGov survey shows big differences between different regions, different political affiliations and socioeconomic status, in their response to questions about state school quality. For example, when asked: “From what you know, do state secondary schools generally give talented children a good education and allow them to achieve their full potential?”, 64% of labour supporters replied yes compared to only 54% conservatives. In London the yes reply was given by 47% while in the North and Scotland 59%, despite school graduates in inner London gaining on average better grades.⁷ Among state school parents 58% replied yes compared to only 48% of private school parents. Similar differences occur for the same question regarding primary schools. In the US surveys show at least 10 percentage point differences between state school parents and others for similar questions.⁸

To consider the above issue, we analyze a non-overlapping generations model with infinite periods and three stages at each period. In the first stage, individuals attend school (state or private) and their initial beliefs (inherited from their parents) together with peer influence affect their beliefs upon graduation. We focus on the beliefs of private school graduates on those that graduate from state schools, and assume that these are lower than the true ability of such graduates.⁹ Upon graduation, individuals enter the employment market, some become employers while others are employees. Employers decide whether to hire an assigned employee, given his school education and their beliefs. Those who employ state school graduates will observe some information about their true ability and will update their beliefs. The individuals then become parents and transmit their beliefs to their offsprings. Finally, parents decide on their offsprings’ education path (state or private), given their own beliefs, the schooling decisions of other parents and peer influence, using “partial empathy”. The private school admits a fixed share of the population with the highest willingness to pay for the school.

Note that a school fulfills two roles in the model. First, it creates an observable signal about one’s ability. Second, it allows individuals to interact and be influenced by others’ beliefs. Thus, the relative benefit of sending one’s offspring to a private school is poten-

⁶Their study contrasts exam-based selection in state schools to those without any such selection mechanisms.

⁷<http://www.ofsted.gov.uk/news/ofsted-too-many-of-englands-poorest-children-continue-be-let-down-education-system>

⁸See <http://pdkintl.org/programs-resources/poll/> for the Annual PDK/Gallup Poll of the Public’s Attitudes Toward the Public Schools.

⁹Our model is one-sided for simplicity.

tially two-fold. The first benefit is an increased probability of employment (as employers who went to a private school might hire her with a higher probability). This benefit arises for all parents, disregarding their beliefs, as even if they know the truth they can benefit from others discriminating. The second potential benefit depends on the parents' beliefs and arises when her child becomes an employer herself. Peer influence implies that the beliefs of the offspring change, which represents a loss to the parent. Specifically, parents with favourable beliefs towards state school graduates might be concerned about peer influence in the private school; a strong peer influence effect may lead their offspring to excessively forgo hiring when she becomes an employer.

Our model of peer influence is a model of group communication, in which individuals communicate their beliefs (posteriors) to each other.¹⁰ Applied to the current set up, it is characterized by a polarization property: Once beliefs are strong enough against state school graduates, all will become more extreme and will have even stronger beliefs (and the other way around).¹¹ There is therefore a tension in the model between learning the true information (from hiring a state school graduate), and peer influence which might push in the opposite direction. We characterise a simple necessary and sufficient condition for long-term segregation between schools and in the employment market. The condition is a function of the accuracy of learning from true observations, the initial range of beliefs in the private school, and the strength of peer influence.

Our condition identifies environments in which peer influence can outweigh true learning and enable individuals to form extreme beliefs against state school graduates. This, in the long run, will lead them to not employing such graduates and hence to long-term segregation.¹² But peer influence has its limits too. In particular, there may be misalignment between the parents' relative benefit from private schools (or their willingness to pay) and their beliefs. If parents may worry about too strong peer influence, they may have low willingness to pay for the private school. In their stead, offspring of parents with strong favourable beliefs on state school graduates may attend the private school (as they can enjoy better employment opportunities without worrying about peer influence given their strong beliefs). Beliefs against state school graduates will then deteriorate and segregation will break up.

¹⁰We describe the general framework in Levy and Razin (2014). The model is based on a result first introduced in Sobel (2014), Proposition 5.

¹¹Such polarization accords with both experiments of group decision making as well as recent theoretical models of groupthink. See for example Glazer and Sunstein (2009) and experiments referenced there. For another model of groupthink, see Benabou (2013).

¹²Segregation is wrong in our model but individuals may end up with the wrong beliefs. This arises not because they stop "experimenting", but because their peers' beliefs are pessimistic enough and thus peer influence outweighs any positive learning. In that sense we differ from Piketty (1995) or Fudenberg and Levine (1993) where agents maintain wrong beliefs as they do not experiment.

The model delivers two immediate implications. One implication -from the point of view of the private schools themselves- is that to survive in the long term, such schools should not necessarily screen according to fees (that is, accept the parents with the highest willingness to pay for the school). Instead, to maximize long term survival, it should also consider screening according to beliefs to create the right mixture of beliefs in the school. This accords with a common practice of many schools in the UK which hold interviews, not only to the children, but also to their parents.

Another implication -from the point of view of society in general- is that policies of integration are efficient. It would benefit workers from the state schools who do not find sufficient employment, and private school employers who forgo hiring opportunities. While private school graduates enjoy better positions in the employment market, they also pay private school fees which extract their willingness to pay. But their willingness to pay is, in part, based on wrong beliefs and is thus not recuperated later on in the market. Note also that the data in the UK supports the observation that private schools are not beneficial to those who attend them on average: The report by the Social Market Foundation calculated that the higher educational achievement and university degrees accrued by private school pupils translated to £193,000 in higher earnings between the ages of 26 and 42. After adjusting for family background and social circumstances, which also affect employment prospects, the private school pay advantage was £57,000. However, ten years' worth of average private school fees in 1980 would be around £56,000 in today's prices, roughly equal to the subsequent boost in earnings.¹³ Finally, as segregation in the model has substantial effects, policies which will prevent it would be efficient in a utilitarian sense even if state school graduates would indeed have lower ability (as long as it is not too low).

Our paper is related to several strands of the literature. First, it is related to the literatures of segregation and discrimination. Several models of discrimination in the labour market assume that individuals have some (sometimes wrong) beliefs which allows them to discriminate.¹⁴ We explore then under what environments such wrong beliefs are feasible when it is actually possible to learn some information about the truth (when for example hiring a state school graduate).¹⁵ In the literature on segregation, Benabou (1993) shows how stratification inefficiently arises due to complementarities in education

¹³<http://www.theguardian.com/education/2014/jul/03/subsidy-independent-school-fees>

¹⁴See Black (1995), and Lang, Manove and Dickens (2005)

¹⁵For a survey on models of statistical discrimination see Fang and Moro (2011). Coate and Loury (1993) show how discrimination or segregation arises without negative beliefs, but due to self fulfilling asymmetric equilibria, following Arrow (1973), and as in Eeckhout (2006), Moro and Norman (2004), and Chaundhuri and Sethi (2008). Peski and Szentes (2013) analyze "spontaneous" discrimination which arises from repeated game considerations.

whereas Benabou (1996) allows for endogenous community formation. In the context of social learning in networks, Calvo-Armengol and Jackson (2004) consider how better information and status create segregation in employment. In the context of schools, Epple and Romano (2008) also use complementarities in education and income to derive segregation between state and private schools.

To the large literature on peer effects or peer pressure mentioned above we add the study of dynamic effects of peer influence of beliefs.¹⁶ Peer effect is also endogenous in the sense that parents decide with whom their offsprings will interact with (endogenous peer effect groups are observed experimentally in Carrell et al 2013). Our model is also related then to the literature on cultural transmission. Such literature concerns transmission of preferences by means of both inheritance and socialization (Bisin and Verdier 2001). In our model, similarly to Bisin and Verdier (2001), parents transmit beliefs to their children but also make a decision about their socialization process which influences these beliefs.

The remainder of the paper is as follows. The next Section presents the model. Section 3 characterizes the relative benefit function from private versus state school education. We also define there long-term segregation. In Section 4 we present our main result, a simple necessary and sufficient condition for long-term segregation. Section 5 discusses various policy implications and other possible applications of our model.

2 The model

We assume a continuum of dynasties, each indexed by $i \in [0, 1]$. Each dynasty consists of one individual at any period $t \in \{0, 1, \dots, \infty\}$, and at the end of the period is replaced by one offspring. Each dynasty holds a belief about the ability of state school graduates, which changes with time and within periods. At any period t , individuals participate in three stages:

Stage 1: Schooling. Pupils start school with the beliefs of their parent. Pupils interact with peers in schools and update their beliefs accordingly.

Stage 2: Labour market. In this stage individuals become employees or employers and are matched. Beliefs are updated given the experiences in the labour market.

Stage 3: Parental school choice. In this stage individuals become parents and have one offspring each. Depending on their beliefs, they choose to send their offsprings to private or state schools in the next period and transmit their beliefs to their offsprings.

There are two kinds of schools, state and private. We assume that whatever the school an individual goes to, his ability is equal to 1 (the analysis can be generalized to different abilities). There is, however, heterogeneity in the beliefs that dynasties hold about the

¹⁶See Mobius and Rosenblat (2014) for a survey of social learning. We survey the literature that is more relevant to our model of group communication in Levy and Razin (2014).

ability of state school graduates. We assume that each dynasty, in time t , knows that the ability of private school graduates is 1 but holds a belief that the ability of graduates of state schools is 1 with probability q_i^t and 0 otherwise.

Our starting point is a population with a continuum of individuals, which constitutes a full support distribution of beliefs $f^0(q)$ on $(0,1]$.¹⁷

School and peer influence: Pupils start school with their parents' beliefs but are influenced by their peers. We assume for simplicity that in the state school all learn the truth about themselves and so all state school graduates learn the true ability of all individuals in society, which is 1.¹⁸

In a private school the individual will randomly interact and exchange information with n other individuals. Let \mathbf{q}^t be a vector of length n of beliefs q_j^t of individuals who attend the private school. If the offspring from dynasty i is matched with these individuals, then his belief when graduating, $q_{i,g}^t$, is

$$q_{i,g}^t = \chi(\mathbf{q}^t, q_i^t) = \frac{q_i \prod_{j=1,\dots,n} q_j}{q_i \prod_{j=1,\dots,n} q_j + (1 - q_i) \prod_{j=1,\dots,n} (1 - q_j)}.$$

Note that beliefs upon graduation increase in the parent's beliefs and those of the others in the school.

We view peer influence as communication in a group. The functional form for the peer influence is easily microfounded via a simple model of communication in a group, with the following assumptions. Suppose that individuals start with a common uniform prior about a state of the world and then are exposed to some, potentially different, information sources, and form their own posteriors. Assume further that individuals believe that the sources of information they are exposed to are conditionally independent from the others' sources. If individuals communicate their posteriors to others, Bayesian updating takes the functional form above. This result is proven in Sobel (2014) and generalised in Levy and Razin (2014).¹⁹

Moreover, it is easy to show the following useful observations:

Lemma 1: *(i) Persuasion: If one individual has extreme beliefs ($q_j = 1$ or 0) then*

¹⁷We allow for the possibility that at period 0, there is an atom at 1.

¹⁸In a more general model, any two groups or schools if segregated for long enough, will become quite confident in their beliefs. If one group is asymmetrically more confident than the other (which is quite likely), a similar analysis will arise.

¹⁹Suppose then n individuals interact and observe each others' posteriors, $h_i(\omega)$, where $\cap_{i \in n} \text{Supp}(h_i(\omega)) \neq \emptyset$. Suppose also that they know that they share a common prior $h(\omega)$ and that they believe that their signals structures are independent from each other (conditional on the state of the

he convinces all others (that is, $\chi(q, q_i) = 1$ or 0 respectively for all other i whom he interacts with). (ii) *Monotonicity*: A player with $q_i > (<) \frac{1}{2}$ increases (decreases) the beliefs of others. (iii) *Polarization*: If $q_1, q_2, \dots, q_n > (<) \frac{1}{2}$, then for all i , $\chi(\mathbf{q}, q_i) > \max (< \min) q_i$ (a first order stochastic shift).

The features above are attractive when considering peer influence. Persuasion implies that an individual with strong convictions is likely to completely sway others by his beliefs. Monotonicity is also quite intuitive, whereby individuals influence others in the direction of their beliefs. Finally, a recent literature has focused on how polarization arises in group deliberation.²⁰ In our model individuals who all share the same direction of beliefs (above or below a half) will become more extreme in that direction.

The labour market: School graduates at time t make up the entire employment market. We assume that any individual (disregarding their education path) becomes an employer with probability γ and an employee with probability $1 - \gamma$. Employers and employees are then matched randomly. To fix ideas, let $\gamma < \frac{1}{2}$, so an employer is matched for sure with an employee, while an employee is matched with probability $\frac{\gamma}{1-\gamma} < 1$.

We assume that an employee always prefers to work, while the employer has to decide whether to employ the individual he is matched with, conditional on both the wage rate and his beliefs about the ability of the employee. Specifically, the gain from employing is the ability of the employee.²¹ The cost is a wage w paid to the employee, drawn independently for each match according to a uniform distribution on $[0, 1]$.²² This implies that a state school graduate employer, or a private school employer who is matched with a private school graduate, will employ anyone, as $w \leq 1$ for any w . On the other hand, a private school graduate employer from dynasty i will employ a state school graduate employee at time t only if $w < q_{i,g}^t$, which arises with probability $q_{i,g}^t$.

We assume that following the employment phase, the private-school employer who had employed a state school graduate, receives a signal about his ability. The signal indicates that the ability of the employee is 1 with precision $p \in (0.5, 1)$. The private employer world). In that case, as we show in Levy and Razin (2014), their (common) posterior becomes:

$$\eta(\omega) \propto \frac{\prod_{i \in n} h_i(\omega)}{h(\omega)^{n-1}}.$$

The proof is simple and shows that for any beliefs of an individual about the signal structure of the others, he will update to this formula. Applied to our binary model, the peer influence function is generated when all individuals believe that they have a common prior at a half.

²⁰See for example Glaeser and Sunstein (2009).

²¹The production function could potentially incorporate the ability of the employer as well. For simplicity we assume this away.

²²The uniform distribution over w is not important for our qualitative results.

updates then his beliefs to $q_{i,e}^t$, which is given by,²³

$$q_{i,e}^t = \begin{cases} \frac{q_{i,g}^t p}{q_{i,g}^t p + (1 - q_{i,g}^t)(1 - p)} & \text{if employed a state school graduate} \\ q_{i,g}^t & \text{otherwise} \end{cases}$$

For simplicity we assume that learning only arises for employers (while private school employees do not learn about the ability of state school graduates they are employed by). Recall that state school graduates, employees and employers, all have beliefs $q_{i,g}^t = 1$ and hence their dynasty will not update its beliefs anymore.

REMARK 1 (THE EMPLOYMENT MARKET): One can endogenise wages by modeling a more elaborate labour market. Instead, in this paper we focus on frictions in the labour market (the possibility of being unemployed) as the key disadvantage of state vs. private school graduates. Our results would hold more generally as long as the labour market offers some advantage to private school employees, and some disadvantage to private school employers (who miss opportunities to employ). This arises in many models of job market discrimination.²⁴ In addition, one could add other advantages to graduates from private schools, such as a higher probability of becoming an employer, and this would not affect our results.

Belief transmission and school choice: Parents transmit their beliefs to their children and decide which school to send them to. Thus, $q_i^{t+1} = q_{i,e}^t$. We model the schooling decision in the following way. Let Δ_i^t be the benefit from attending a private school vis a vis a state school, as perceived by a parent from dynasty i with beliefs $q_{i,e}^t$ (we compute this later). We assume that at any time t , the private school admits a share ρ of individuals with the largest Δ_i^t , conditional on $\Delta_i^t > 0$ (an IR constraint). Thus, the school admits all those with the largest willingness to pay, subject to the school's capacity constraint. We discuss later other school admission policies and their impact on segregation.

Equilibria: In equilibrium, at each period t , the decisions of employers are optimal given their beliefs (as described above), and parents correctly compute Δ_i^t to optimally choose a school, given the current distributions of beliefs, the equilibrium decisions of other parents, and future behaviour of employers.

²³For example, assume that the employer believes that if the ability is 1 then he receives the signal $s = 1$ for sure and if the ability is 0 he receives the signal $s = 1$ with probability $\alpha \in (0, 1)$, and that he receives $s = 0$ otherwise. Then, $p = \frac{1}{1+\alpha}$ is the percision of the signal $s = 1$. Given that the true ability is 1 he will receive $s = 1$ and the updating above represents his posterior beliefs.

²⁴See for example Black (1995), Lang, Manove and Dickens (2005).

3 Private school versus state school

In this Section we characterize the relative benefit from educating an offspring in a private versus a state school. We then use this to define equilibrium long-term segregation.

3.1 The relative benefit function

We now compute Δ_i^t , the benefit from attending a private school vis a vis a state school, as perceived by a parent with beliefs $q_{i,e}^t$. This illustrates the trade-off arising in the employment and schooling “markets”, and specifically the role played by the different beliefs in this trade-off.

Note that with probability $\gamma\rho$ an individual becomes an employer and is matched with a private school graduate. In this case no matter what is her own education path, she would employ the graduate and pay w . Also, with probability $\gamma(1 - \rho)$, an individual becomes an employee, and is matched with a state school employer who does not discriminate. These two events do not depend then on the individual’s education path.

There are therefore two events in which the education path is relevant. First, with probability $(1 - \gamma)\frac{\gamma}{1-\gamma}\rho = \gamma\rho$ the individual becomes an employee and finds a match with a private-school graduate employer. In this case, she is employed for sure if she herself went to a private school (and receives an expected wage of a half), but if she went to a state school she will only be employed with some probability. Specifically, she is employed by an individual from dynasty j only if $w < q_{j,g}^{t+1}$. Thus, given some distribution of employers from dynasties j with beliefs $q_{j,g}^{t+1}$, the relative benefit for attending a private school in this case is:

$$\begin{aligned} \frac{1}{2} - \bar{w}^{t+1} &\geq 0 \\ \bar{w}^{t+1} &\equiv E_{q_{j,g}^{t+1}}(E(w|w < q_{j,g}^{t+1})) \end{aligned}$$

The second case in which a benefit or a loss from attending a private school arises, is where an individual becomes an employer, finds a match, and encounters an employee from a state school (which happens with probability $\gamma(1 - \rho)$). If she went to the state school herself, she would employ him for sure, gaining -in the eyes of her parent- expected productivity of $q_{i,e}^t$ while paying in expectations $\frac{1}{2}$. On the other hand, if she were to attend a private school, she would employ with an expected probability of $q_{i,g}^{t+1}$ (which takes into account expected peer influence). She would then pay in expectation $E(w|w < q_{i,g}^{t+1})$, and gain productivity of $q_{i,e}^t$. Thus we have that in this event the gain/loss from attending a private school, is:

$$\hat{\Delta}_i^t \equiv \pi_i^t - (q_{i,e}^t - \frac{1}{2}) \tag{1}$$

where π_i^t is the expected gain, in the eyes of the parent, from the offspring being a private

school employer, which is:

$$\pi_i^t \equiv E_{\chi(\mathbf{q}^{t+1}, q_{i,e}^t)}(\chi(\mathbf{q}^{t+1}, q_{i,e}^t)q_{i,e}^t - E(w|w < \chi(\mathbf{q}^{t+1}, q_{i,e}^t)))$$

Putting these two together, we have that for a parent with partial empathy and a belief $q_{i,e}^t$, the benefit from a private school vis a vis state school is:

$$\Delta_i^t = \gamma((1 - \rho)(\pi_i^t - (q_{i,e}^t - \frac{1}{2})) + \rho(\frac{1}{2} - \bar{w}^{t+1})) \quad (2)$$

Note that the second term, which is a gain, does not depend on the parent's beliefs. It only depends on others' beliefs and how they discriminate. The first term on the other hand, depends on the parent's beliefs, and in two ways. First, the eventual beliefs of the offspring, following peer influence, are a function of the parent's beliefs. Second, the parent assesses the value from employing according to her beliefs ("partial empathy"). For example, if the beliefs of the parent are relatively high, attending the private school might represent a larger loss as peer influence might substantially decrease the offspring's beliefs. On the other hand, if the beliefs of the parent are very low, the induced behaviour of his offspring if he goes to the state school must be worse than that induced by the private school, implying a positive first term. The potential trade-off between the first and second term, and how the first term is affected by parents' beliefs and peer influence, will constitute the key insight of the paper.

3.2 Segregation: a definition

We now use the relative benefit function to define what we mean by long term segregation. What we want to rule out, is a private school that survives just because individuals are indifferent between joining the school or not. Segregation is meaningful only if the beliefs in the private school, in the long term, are different from one (the beliefs induced by the state school).

Let Δ_s^t be the relative benefit of sending an offspring to the private school versus the state school when the parent has the true beliefs, one (that is, when in this dynasty an agent had previously attended a state school himself). Note that for such dynasty, $\hat{\Delta}_s^t = 0$. That is, the relative benefit conditional on becoming an employer is zero. This arises as $\chi(\mathbf{q}^{t+1}, 1) = 1$ for any \mathbf{q}^{t+1} and thus no matter which school the offspring goes to, his beliefs will remain at one. On the other hand, if the beliefs in the private school are different from one, then the relative benefit conditional on being an employee, $\rho(\frac{1}{2} - \bar{w}^{t+1})$, is strictly positive. Thus, whenever there is long term segregation, it has to be that $\Delta_s^t > 0$. We then have the following definition:

Definition 1: *Long-term segregation exists if there is a $\delta > 0$ such that $\lim_{t \rightarrow \infty} \Delta_s^t > \delta$.*

In the next Section we provide our main result characterizing the environments for which long-term segregation arises. These would depend on the accuracy of learning, the initial intake of beliefs in the private school, and the strength of peer influence.

4 Peer influence and long-term segregation

We now analyse under what conditions long term segregation will hold. Note that to sustain segregation, beliefs at any point in time have to be sufficiently pessimistic. To see why, suppose for example that at some point in time, all those that attend the private school have beliefs above a half. Thus, the beliefs in the private school can only increase. Peer influence, by Lemma 1, will induce a first order stochastic shift in beliefs. In addition, labour market experience will only exacerbate this.

Long term segregation can also fail when the pool of beliefs is “contaminated”. Suppose that at some point in time there are private school dynasties i with $\Delta_i^t < \Delta_s^t$, i.e., their relative benefit from attending the private school is lower than that of a state school dynasty. As a result of such misalignment between beliefs and the willingness to pay for the private school, there might be an influx of children into the private school with very extreme beliefs. These new entrants will affect the beliefs of others within the school and possibly cause an irreversible shift of beliefs in the school.

Our main result below characterizes initial conditions such that long term segregation will be sustained. We show that the requirements above are strongly related: when beliefs remain pessimistic for all such private school dynasties i , then also the benefits of private schools are aligned with beliefs, i.e., $\Delta_i^t > \Delta_s^t$ for all t . Moreover, this also holds the other way around: if the beliefs of even a small measure of dynasties i become sufficiently optimistic, then eventually there would be a time t where $\Delta_i^t < \Delta_s^t$ and segregation will break up.

Proposition 1: *Assume that the initial distribution of beliefs of individuals in the private school is $[0, \bar{q}]$ such that $\rho = F^0(\bar{q})$. (i) long term segregation arises if and only if*

$$\left[\frac{\bar{q}}{1-\bar{q}}\right]^{n-1} \leq \frac{1-p}{p},$$

(ii) when it arises, the set of dynasties in the private school is constant and beliefs converge to a degenerate distribution on 0.

The result provides a well-defined and simple condition for the existence of long term segregation. It depends negatively on the precision of information in the labour market, p , negatively on the upper bound of beliefs in the private school \bar{q} and positively on the intensity of peer influence in the school, n .

The condition is calculated for dynasties at the upper bound of the beliefs in the private school. It insures that those dynasties, following peer influence and labour market experience, will end up with lower beliefs than they started with.

At the same time this also implies that these dynasties still want to send their children to private schools more than state school parents do. Specifically, we show that when beliefs of all dynasties i in the private school are all below a half, then $\Delta_i^t > \Delta_s^t$. Thus, the set of dynasties whose children attend the school at any period are those with initial beliefs below $\bar{q} < \frac{1}{2}$, and their beliefs converge to 0.

The above condition is also necessary for long term segregation to arise. To see why, note that if it is not satisfied, then there would be a small share of individuals (those with the highest beliefs) for whom peer influence with like-minded dynasties, along with labour market experience, will further increase their beliefs. In the proof we show that as some of these dynasties' beliefs keep on increasing and get closer to one, their relative benefit from the private school will become lower compared with the relative benefit of state school parents. The reason is that under the supposed segregation, beliefs of most in the private school must converge to zero. Hence for this small measure of dynasties whose beliefs keep increasing, peer influence in the private school means a large swing in beliefs (and thus suboptimal labour market behaviour). This however is not a concern for state school parents whose beliefs are strong enough so that their offsprings are not influenced in the private school. Therefore, given this misalignment of beliefs and willingness to pay, some state school parents send their offsprings to the private school and a process of contamination of beliefs starts, resulting in no segregation in the long run.

The formal proof is relegated to the appendix and we next discuss the implications of the above result.

REMARK 3: Note that we are focusing on the transition process to long term segregation and under what conditions it can arise. An alternative analysis would be to focus on steady states. As is clear from the above, in a steady state, if a private school exists, the beliefs in the school are 0. There are therefore two possible steady states: one without a private school, and one with a private school where beliefs are set at 0.

5 Implications and discussion

5.1 School selectivity and fees

Our main result about the break up of segregation relies on the assumption that admittance to the private school is according to the willingness to pay, which can become non-monotone in beliefs (the fact that the school has a capacity constraint and always admits a fixed share ρ is not important). The implication of this result then is that if the

private school admits those with the highest willingness to pay, those with the “wrong” beliefs for the school might enter. In that case, the school cannot survive and segregation breaks.

Our analysis indicates then that it is not optimal for a school to filter pupils only according to the willingness to pay. To maximize some combination of long term survival and profits, the school either has to choose a stream of prices or admittance rules non-myopically, or, schools may wish to screen also according to beliefs. This may explain why many schools in the UK are screening students through interviews (with students as well as with parents). Interviews may reveal some hidden information about ability, but also about beliefs and parental beliefs. Web sites that provide advice for private (independent) schools’ prospective students in the UK, state for example that it is important to mention in an interview that previous generations in the family have attended the school.²⁵ Students are expected to be able to talk about their family.²⁶ For lower grade schools, the advice for parents is “most of the time the school is really interviewing you, and it’s you who need the preparation”.²⁷ For secondary schools, interview advice for the parents themselves includes “expect to talk about yourself..remember to discuss long term values for your child..remember to talk about the things you can bring to the school”.²⁸

Note that in our model private school dynasties believe that the benefit from attending a private school is higher than it actually is, as their beliefs about state school graduates are wrong. If their willingness to pay is fully extracted, they would be worse off compared with state school dynasties. But, if school admissions are not necessarily according to the highest willingness to pay, fees would be lower and thus they would be better off compared with state school dynasties. Moreover, other network effects might play a role (for example, the ability of private school graduates to become employers which is more likely to be associated with higher gains) may be higher. This may imply that overtime state school dynasties will be poorer, and thus would not be able to afford the fees up-front, even if their willingness to pay is higher. This will naturally further increase segregation.

²⁵<http://independenteducationconsultants.co.uk/tips-for-preparing-your-child-for-interview-at-a-top-independent-school/>

²⁶<http://privateschool.about.com/od/visitsandinterviews/a/How-To-Prepare-For-Private-School-Interviews.htm>

²⁷<http://www.goodschoolsguide.co.uk/help-and-advice/school-admissions/79/independent-schools-admissions-insider-information-on-getting-in>

²⁸<http://www.kidsinthehouse.com/teenager/education/applying-to-private-school/navigating-the-private-school-parent-interview>

5.2 Efficiency and integration

In our model it is efficient that all have the correct beliefs at one, and thus segregation is inefficient in a utilitarian sense, as state schools graduates miss employment opportunities, while private school employers miss opportunities to employ. Note that more generally welfare in a utilitarian sense will increase even if there are some asymmetries in the model, for example if the true ability of state school graduates is somewhat lower (but not too low), as segregation imposes a large cost on society. Policies of integration would therefore be helpful in the model and generally the success of integration will depend on the strength of peer influence vis a vis learning from true observations.

Other policies can be considered in the prism of our model. For example, anti-discrimination policies in the labour market, or labour laws which allow for long term employment and thus better learning about the true ability of individuals.

5.3 Generalizations and other applications

Our model can be extended in several directions. First, in terms of instilling beliefs, we have only considered peer influence. One can also extend this to consider how teachers or school entrepreneurs affect beliefs. Naturally, a strong ethos of a private school highlighting its advantages in education compared to state schools will strengthen segregation. Another way to extend the model is to consider two-way discrimination. For simplicity, we have focused on one-sided discrimination but of course discrimination can go in both directions.

Next, other applications can be considered. In the context of selective schools, one can consider selection according to gender or religion. Segregation of schools according to gender might influence beliefs about the opposite gender which may persist in the employment market.

Peer influence and segregation need not arise only in schools. Such “social learning” can be done more generally: Segregation in neighborhoods or communities between rich and poor can create different beliefs for example of the rich on the ability and motivation of the poor. Living in a segregated community might also have standard peer effects which changes one’s behaviour and thus allow the individuals to identify one another.

Another example could be segregation through religious affiliation. Religion, as schools in our model, serves a dual role: it allows individuals to distinguish themselves (by its set of rituals, special cloths) as well as affects the beliefs of individuals (not only through peer influence, but also through preaching).²⁹ Some religions, who believe for example that they are the chosen people while others are inferior, may segregate themselves physically and economically and our model can be applied in this context as well.

²⁹See Levy and Razin (2012).

6 Appendix

Proof of Proposition 1:

Preliminaries: Note that (i) after the first period, all in $[\bar{q}, 1]$ will have beliefs 1; (ii) the condition in the Proposition implies that $\bar{q} < 0.5$; (iii) if an individual \bar{q} attends the private school, and in the worst case scenario mingles with n other individuals with the same beliefs, his beliefs become $\bar{q}_g \equiv \frac{\bar{q}^n}{\bar{q}^n + (1-\bar{q})^n} < \bar{q}$ (as $\bar{q} < 0.5$). If such an individual later on employs a state school graduate, his beliefs become $\bar{q}_e = \frac{\bar{q}_g p}{\bar{q}_g p + (1-\bar{q}_g)(1-p)}$. If $\frac{\bar{q}_g p}{\bar{q}_g p + (1-\bar{q}_g)(1-p)} < \bar{q}$, then the dynasty's beliefs are still below $\bar{q} < \frac{1}{2}$. The condition in the Proposition insures that $\frac{\bar{q}_g p}{\bar{q}_g p + (1-\bar{q}_g)(1-p)} < \bar{q}$. Moreover, the mapping of q to $\frac{q_g p}{q_g p + (1-q_g)(1-p)}$ has a unique fixed point so that for all $q < \bar{q}$, $\frac{q_g p}{q_g p + (1-q_g)(1-p)} < q$, and for all $q > \bar{q}$, $\frac{q_g p}{q_g p + (1-q_g)(1-p)} > q$.

Sufficiency: We know from the above that beliefs in the private school always remain below $\bar{q} < \frac{1}{2}$. We will now show that for all $q < \frac{1}{2}$, given that beliefs in the private school are below a half for all others as well, then $\Delta_i^t > \Delta_s^t$. This implies that only the original dynasties remain in the school. We therefore need to show that:

$$\hat{\Delta}_i^t = \pi_i^t - (q_{i,e}^t - \frac{1}{2}) = \int_{\mathbf{q}^{t+1}} \left(\int_0^{\chi(\mathbf{q}^{t+1}, q_{i,e}^t)} (q_{i,e}^t - w) dw \right) dF_n^{t+1}(\mathbf{q}^{t+1}) - (q_{i,e}^t - \frac{1}{2}) > 0 = \hat{\Delta}_s^t,$$

where $F_n^{t+1}(\mathbf{q}^{t+1})$ is the distribution over vectors \mathbf{q}^{t+1} of length n which describes the beliefs of children in the school as inherited from their parents (recall that $q_i^{t+1} = q_{i,e}^t$).

A sufficient condition for this is that for any \mathbf{q}^{t+1} :³⁰

$$\begin{aligned} \int_0^{\chi(\mathbf{q}^{t+1}, q_{i,e}^t)} (q_{i,e}^t - w) dw - q_{i,e}^t + \int_0^1 w dw &> 0 \Leftrightarrow \\ \int_0^{\chi(\mathbf{q}^{t+1}, q_{i,e}^t)} q_{i,e}^t dw - \int_0^{\chi(\mathbf{q}^{t+1}, q_{i,e}^t)} w dw - \int_0^1 q_{i,e}^t dw + \int_0^1 w dw &> 0 \Leftrightarrow \\ \int_{\chi(\mathbf{q}^{t+1}, q_{i,e}^t)}^1 (w - q_{i,e}^t) dw &> 0 \end{aligned} \quad (3)$$

Finally note that the beliefs in the private school converge to the singleton 0 as they are always below a half. This concludes the sufficiency part.

³⁰Note that (3) is guaranteed by the wage being distributed uniformly. In fact any distribution that first order stochastically dominates the uniform will satisfy this. For other distributions, one would potentially need to add another condition to insure that no ‘‘contamination’’ arises but there would always be a low enough initial \bar{q} that would satisfy such condition. The necessary part does not depend on the uniform distribution at all.

Necessity: Let q^* satisfy $[\frac{q^*}{1-q^*}]^{n-1} = \frac{1-p}{p}$ and suppose that the condition in the proposition is violated so that $[\frac{\bar{q}}{1-\bar{q}}]^{n-1} > \frac{1-p}{p}$. This implies that $\bar{q} > q^*$ and that all those in $(q^*, \bar{q}]$ if they draw only peers from this set, will have new beliefs that are higher than what they started with. In particular, one can find sequences of dynasties whose beliefs will converge to one. We will show that this implies that we can find a positive measure of such dynasties, for whom eventually $\Delta_i^t < \Delta_s^t$.

By Lemma 1, dynasties must converge to have beliefs on zero, one or a half. We next show that long term segregation implies that a strictly positive measure of dynasties will converge to beliefs of zero.

First note that if long term segregation exists, it cannot be that almost all dynasties converge to one. If this is the case the benefit from sending one's child to private school for any parent will converge to that of state school parents.

The next step is to note that if the measure of dynasties whose beliefs converge to zero goes to zero, then it must be that the measure of dynasties whose beliefs go to one, goes to one. To see this note that if there was in the limit a strictly positive measure of dynasties going to a half, this would unravel as these would learn from work experience with strictly positive probability and their beliefs would start to drift to one.

The conclusion from the above is that if there is long term segregation, in the limit, there must be a strictly positive measure, α , of dynasties converging to zero. This implies that for any $\varepsilon > 0$ there exist a time T_ε such that there are at least a measure $\frac{\alpha}{2}$ of dynasties with beliefs below ε . We will now look at the strictly positive measure of dynasties at $(q^*, \bar{q}]$ whose beliefs are increasing and show that as a measure $\frac{\alpha}{2}$ of other dynasties have beliefs below ε , then their loss from peer influence in the private school is large.

To do so, we focus on such dynasties in $(q^*, \bar{q}]$ whose beliefs increase sufficiently slow so that others can converge to have beliefs below ε . Specifically, note that by choosing which individuals in the private school members of a dynasty interact with each period and whether they learn in the labour market, we can construct a feasible sequence of beliefs for a dynasty $\{q_i^t\}_{t=1}^\infty$ that lingers as long as we wish below a half, i.e. for any T we can find such a sequence such that $q_i^t \rightarrow 1$ but such that $q_i^t < 0.5$ for any $t < T$. Note further that by continuity of $\chi(\mathbf{q}^{t+1}, q_{i,e}^t)$ and full support we can also construct a whole set of such sequences all going to one in a similar rate.

Note now that,

$$\begin{aligned} & \hat{\Delta}_i^t - \hat{\Delta}_s^t \\ &= \int_{\mathbf{q}^{t+1}} \left(\int_0^{\chi(\mathbf{q}^{t+1}, \bar{q}_{i,e}^t)} (\bar{q}_{i,e}^t - 1) dw \right) - \int_{\chi(\mathbf{q}^{t+1}, \bar{q}_{i,e}^t)}^1 (1 - w) dw dF_n^{t+1}(\mathbf{q}^{t+1}) + (1 - \bar{q}_{i,e}^t) \\ &< - \int_{\mathbf{q}^{t+1}} \left(\int_{\chi(\mathbf{q}^{t+1}, \bar{q}_{i,e}^t)}^1 (1 - w) dw \right) dF_n^{t+1}(\mathbf{q}^{t+1}) + (1 - \bar{q}_{i,e}^t) \end{aligned}$$

Now choose ε and T_ε such that a measure $\frac{\alpha}{2}$ of dynasties have beliefs below ε . Note that if i interacts with n of these dynasties, the measure of all such interactions is $(\frac{\alpha}{2})^n$. Choose a sequence of a strictly positive measure of dynasties whose beliefs converge to one slow enough so that at T_ε their distance from one is $\eta > 0$ such that $\chi(\mathbf{q}^{t+1}, q_i^t)$ is at most 2ε . Then we will have:

$$\begin{aligned}\hat{\Delta}_i^t - \hat{\Delta}_1^t &< - \int_{\mathbf{q}^{t+1}} \left(\int_{\chi(\mathbf{q}^{t+1}, \bar{q}_{i,e}^t)}^1 (1-w)dw \right) dF_n^{t+1}(\mathbf{q}^{t+1}) + (1 - \bar{q}_{i,e}^t) \\ &\quad - \left(\frac{\alpha}{2}\right)^n \left(\int_{2\varepsilon}^1 (1-w)dw \right) + \eta \\ &< 0\end{aligned}$$

Note that α does not depend on ε , and hence when ε and η are low enough this expression will be negative and so in the next period a strictly positive measure of state school parents will send their kids to the private school.

Once a strictly positive measure of dynasties with beliefs at 1 enter the school, this will be the case for all future periods (as from that point onwards, the measure of dynasties with beliefs less than 1 is smaller than ρ). They will then “infect” whoever they meet and so all dynasties will converge to beliefs of 1 which is a contradiction to long term segregation. ■

References

- [1] Angrist, J., and K. Lang (2004), Does School Integration Generate Peer Effects? Evidence from Boston’s Metco Program, " American Economic Review, 94(5), 1613-1634.
- [2] Arrow, K. J. (1973): “The Theory of Discrimination,” in Discrimination in Labor Markets, ed.by O. Ashenfelter, and A. Rees, pp. 3—33. Princeton University Press.
- [3] Benabou, R. (2013). "Groupthink: Collective Delusions in Organizations and Markets," Review of Economic Studies, vol. 80(2), pages 429-462.
- [4] Benabou, R. (1993), "Workings of a City: Location, Education, and Production" Quarterly Journal of Economics, 108, 619-652.
- [5] Benabou, Roland. 1996. “Heterogeneity, Stratification and Growth.” American Economic Review 86: 584-609.
- [6] Bisin, A. and T. Verdier (2001), The economics of cultural transmission and the dynamics of preferences, Journal of economic theory 97(2), 298-319.
- [7] Black, D. (1995), Discrimination in an Equilibrium Search Model, Journal of Labor Economics, Vol. 13, No. 2, pp. 309-334.
- [8] Burke, M., and T. Sass (2013), Classroom Peer Effects and Student Achievement," Journal of Labor Economics, 31(1), 51-82.

- [9] Calvó-Armengol A, Jackson M. (2004), The effects of social networks on employment and inequality. *Am. Econ. Rev.* 94:426–54.
- [10] Carrell, S., B. Sacerdote, and J. West (2013), From Natural Variation to Optimal Policy? The Importance of Endogenous Peer Group Formation, *Econometrica*, 81(3), 855-882.
- [11] Chaudhuri, S. and R. Sethi (2008), Statistical Discrimination with Peer Effects: Can Integration Eliminate Negative Stereotypes?, *Review of Economic Studies*, Volume 75, Issue 2, pp. 579-596.
- [12] Coate, S. and G. Loury (1993), Will affirmative action policies eliminate stereotypes?, *American Economic Review* 83(5), 1220-40.
- [13] Duncan, G., J. Boisjoly, M. Kremer, D. Levy, and J. Eccles (2005), Peer Effects in Drug Use and Sex among College Students, *Journal of Abnormal Child Psychology*, 33(3), 375-385.
- [14] Eeckhout, J. (2006): “Minorities and Endogenous Segregation,” *Review of Economic Studies*, 254, 31—53.
- [15] Epple, D., and R. Romano (1998), “Competition between Private and Public Schools, Vouchers, and Peer-Group Effects.” *American Economic Review* 88: 33-62.
- [16] Fang, H., and A. Moro (2010): “Theories of Statistical Discrimination and Affirmative Action: A Survey,” in *Handbook of Social Economics*, Vol., ed. by J. Benhabib, A. Bisin, and M. Jackson.
- [17] Fudenberg, D. and D. Levine (1993), Self Confirming Equilibria, *Econometrica* 61(3), 523-545.
- [18] Glaeser, E. and Cass R. Sunstein (2009), “Extremism and social learning.” *Journal of Legal Analysis*, Volume 1, Number 1.
- [19] Granovetter, M. (1974), *Getting a Job*, Chicago University Press.
- [20] Hoxby, C. (2000), Peer Effects in the Classroom: Learning from Gender and Race Variation, Working paper 7867, National Bureau of Economic Research.
- [21] Lang, K., M. Manove and W. Dickens (2005), “Racial Discrimination in Labor Markets with Posted Wage Offers,” *American Economic Review*, 95(4), 1327-1340.
- [22] Levy, G. and R. Razin (2014), A simple Bayesian heuristic for social learning and groupthink, working paper, LSE.
- [23] Levy, G. and R. Razin (2012), Religious Beliefs, Religious Participation and Cooperation", joint with Ronny Razin, *American Economic Journal: Microeconomics*, 4(3), pp. 121-151.
- [24] Marmaros, D., and B. Sacerdote (2002), Peer and Social Networks in Job Search, *European Economic Review*, 46(4-5), 870-879.
- [25] Mobius, M. and T. Rosenblat (2014), “Social Learning in Economics”. *Annu. Rev.*

Econ. 6:827–47.

- [26] Moro, A., P. Norman (2004): “A General Equilibrium Model of Statistical Discrimination,” *Journal of Economic Theory*, 114, 1-30.
- [27] Peski, M. and B. Szentes (2013), “Spontaneous Discrimination,” *American Economic Review*, vol. 6, 2412-2436.
- [28] Piketty, Thomas. 1995. “Social Mobility and Redistributive Politics.” *Quarterly Journal of Economics* 110: 551-83.
- [29] Sacerdote, B. (2001), Peer Effects with Random Assignment: Results for Dartmouth Roommates, *Quarterly Journal of Economics*, 116(2), 681-704.
- [30] Sacerdote, B. (2011), Peer Effects in Education: How Might They Work, How Big Are They and How Much Do We Know Thus Far?, in *Handbook of the Economics of Education Volume 3*, ed. by E. Hanushek, S. Machin, and L. Woessmann, pp. 249-277. Elsevier.
- [31] Simon, C. and J. T. Warner (1992), Matchmaker, Matchmaker: The Effect of Old Boy Networks on Job Match Quality, Earnings, and Tenure, *Journal of Labor Economics*, Vol. 10, No. 3, pp. 306-330
- [32] Sobel, J. (2014), “On the relationship between individual and group decisions”, *Theoretical Economics* 9, 163–185.