Why Do Asian Students Study Harder? Implications of a Model of Academic Competition

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Abstract

We construct a model of competition for college admissions to investigate the plausible reasons for Asian students to exert more academic effort than students elsewhere. We find that more limited higher education resources and higher-aptitude peers in Asian countries do not play a role, whereas a larger reward to a college degree rooted in the Asian culture emphasizing education and a more narrowly focused admissions criterion reducing the randomness in performance measurement may provide an explanation for the observed difference in academic efforts.

1.Introduction

Popularized by the OECD's PISA rankings of a few dozen countries/regions according to the test results of their 15 year olds, Asian students' impressive academic achievements are now well known. For example, PISA's top five for combined reading and math based on tests taken in 2012 are respectively Shanghai (China), Hong Kong (China), Singapore, Japan and South Korea. In contrast, the U.K. is 23rd and the U.S. is 24th. As the old saying goes, "no pain, no gain." There is evidence that Asian students spend considerably more time on schoolwork to achieve their high academic performance. Kim et al. (2009) find that South Korean teenagers on average spend 49.43 hours per week on studying, compared to the OECD average of 33.92 hours per week. Larson and Verma (1999) find that adolescents is East Asia spend 5.5 to 7.5 hours per day on studying, compared to North America's 3.0 to 4.5 hours per day.[1]

Then a question arises as to why Asian students study harder. While there is substantial attention to Asian students' academic success and the underlying hard-working ethic, systematic economic analyses of the determining factors of academic effort are still scarce.[2]

In this note, we provide a formal theoretical analysis of how various factors affect precollege students' academic input, using Asian students' exceptional effort on

[1] Hsin and Xie (2014) also find that Asian-American students' superior academic performance over other ethnic groups is mainly attributable to their exerting greater academic effort. In addition, the causal effect of studying on grade performance is also found by Keith (1982), Park and Kerr (1990), Stinebrickner and Stinebrickner (2004), Stinebrickner and Stinebrickner (2008), De Fraja et al. (2010) and Grodner and Rupp (2013).

[2] Precollege students' academic effort in the context of college admission competition has been analyzed in Fu (2006), Liu and Neilson (2011), Bodoh-Creed and Hickman (2015) and Chung and Lee (2017), among others, but these studies have a very different focus than that of the present paper. For effort determination in models where students have a different goal than college admission, see Becker (1982), Becker and Rosen (1992), Allgood (2001), Landeras (2009) and Thiemann (2017).

schoolwork as an example for explanation and intuition. Specifically, our investigation will focus on the following four channels through which precollege students' academic effort could be potentially affected. First, limited higher education resources may motivate students to make more effort in order to get in a (more selective) college. If this is true, then it could provide an explanation for some Asian students' more intensive effort because compared with the U.S. and the U.K. that are rich in higher education resources, China is certainly more capacity-constraint in the percentage of high school graduates that can be admitted to college. Second, students with higher-aptitude peers may be motivated to study more in order to win the college-admission competition against stronger peers. If this is true, then it could also provide an explanation for Asian students' more intensive effort because they face peers who are known to have higher cognitive aptitude. Third, a larger reward to a college degree may motivate students to try harder to get in a (selective) college. If this is true, then it could provide an explanation as well for Asian students' more intensive effort because the East Asian culture influenced by the Confucianism emphasizes the value of education. Fourth, a lower degree of randomness in the performance measurement (or the college admissions criterion) may motivate students to study more, for effort is more likely to make a difference in this case. If this is true, then it too could provide an explanation for Asian students' more intensive effort because in many Asian countries college admissions decision is almost entirely based on the test scores on a college entrance examination that is more narrowly focused and as a result less random than the college admissions criteria in the U.S. and the U.K. that are more broadly based and include some subjective elements such as application essays and recommendation letters.

2. A Model of Academic Competition

Students are each endowed with a level of aptitude $a > 0$. A student with aptitude a can make a costly effort $e \geq 0$ to improve his academic performance. Performance, denoted p, depends on aptitude, effort and luck, and can be generally specified as

(1) $$p = f(a,e) + \tilde{\varepsilon},$$

where $f(a,e)$ is a production function satisfying $f_a > 0$, $f_e > 0$, $f_{aa} < 0$ and $f_{ee} < 0$, and $\tilde{\varepsilon}$ is a mean-zero continuous random variable.[3] Note that we place no restriction on the sign of f_{ae}. Aptitude and effort can be either complements (where $f_{ae} > 0$) or substitutes (where $f_{ae} < 0$). Note also that while p is the actual performance inclusive of the impact of uncontrollable randomness, $f(a,e)$ is the expected performance that is determined by aptitude and effort alone.

When a student's performance p meets a certain standard, denoted s, he will be awarded a prize π. For concreteness, p will be interpreted as the score on a comprehensive college entrance exam, s the cutoff score for college admission, and π the college premium. The student is admitted to college if and only if $p \geq s$ or

(2) $$\tilde{\varepsilon} \geq s - f(a,e).$$

[3] Note that performance (or achievement) considered in this paper is not the same as productivity upon which earnings are based. In a survey article by Hanushek (1986), it is pointed out that almost all studies of earnings that include both quantity of schooling and achievement (test score) measures find significant effects of quantity that are independent of achievement differences, suggesting that the education process may have multiple outputs, some of which are very poorly measured by test scores (achievements). Liu and Neilson (2011) address the discrepancy between performance (scores) and productivity (skills).

Using $G(\varepsilon)$ to denote the CDF of the continuous random variable ε, the student's probability of getting in college is $1-G\big(s-f(a,e)\big)$. The PDF of ε is denoted as $g(\varepsilon)$, where $g(\varepsilon)\equiv G'(\varepsilon)$.

The utility of the student is the expected college premium minus the disutility from effort, i.e.,

$$\pi\Big[1-G\big(s-f(a,e)\big)\Big]-c(e), \tag{3}$$

where $c(e)$ is the cost function with $c'>0$ and $c''>0$.

For a given cutoff score s, the student with aptitude a chooses effort e to maximize (3). The first-order condition is

$$\pi g\big(s-f(a,e)\big)f_e(a,e)-c'(e)=0. \tag{4}$$

The model implicitly assumes that students are "standard-takers," that is, no individual student can influence the standard s by changing effort.[4] Only a portion of the student population can get in college because the number of college seats is smaller than the number of applicants. As a result, the standard s is endogenously determined so that, in expectation, the number of college seats equals the number of students with above-standard scores. Formally, the condition determining the equilibrium standard is

$$\int_0^{\infty}\Big[1-G\big(s-f(a,e)\big)\Big]dH(a)=r, \tag{5}$$

where $H(a)$ is the CDF for the distribution of aptitude, and r is the ratio of the number of college seats to the number of college applicants.

[4] In this aspect, the academic competition model here is different from those employing the Tullock-type (Tullock 1980) contest success functions where changes in one student's effort level directly affect other students' probabilities of getting in college (e.g., Fu 2006 and Chung and Lee 2016).

Under any given specifications of the CDFs *H*(a) and $G(\varepsilon)$, conditions (4) and (5) fully determine the equilibrium level of effort for each aptitude, *e*(*a*), and the equilibrium level of standard, *s*, with *r* and π being the other exogenous parameters of the model. To simplify the analysis, however, two assumptions are made for the rest of the paper regarding CDFs *H*(*a*) and $G(\varepsilon)$. First, it is assumed that *H*(*a*) is a Bernoulli distribution. That is, a portion of the student population, denoted λ, is endowed with a high aptitude a_H, and the rest is endowed with a low aptitude a_L, where $a_H > a_L$. Second, it is assumed that $G(\varepsilon)$ is a uniform distribution (with a zero mean), which implies that $g(\varepsilon)$ is a constant, denoted *g*, over the corresponding interval, $\left[-\frac{1}{2g}, \frac{1}{2g}\right]$.

Note that λ can be interpreted as the level of group aptitude and *g* can be interpreted as indicating the degree of randomness in performance measurement – the larger the *g*, the less random the measurement (note that the larger the *g*, the smaller the variance of ϑ).

With these simplifying assumptions about *H*(*a*) and $G(\varepsilon)$, equilibrium condition (4) becomes

(6) $$\pi g f_e(a_H, e_H) - c'(e_H) = 0$$

and

(7) $$\pi g f_e(a_L, e_L) - c'(e_L) = 0,$$

and equilibrium condition (5) becomes

$$\lambda\left[\tfrac{1}{2} - g \times \left(s - f(a_H, e_H)\right)\right] + (1-\lambda)\left[\tfrac{1}{2} - g \times \left(s - f(a_L, e_L)\right)\right] = r,$$

which is equivalent to

(8) $$s = \frac{\frac{1}{2} - r + \lambda g f(a_H, e_H) + (1-\lambda) g f(a_L, e_L)}{g}.$$

Given values for exogenous parameters r, λ, π and g, the equilibrium e_H and e_L are determined by (6) and (7) respectively, and the equilibrium s is then determined by (8).

Of these two simplifying assumptions on $H(a)$ and $G(\varepsilon)$, the more critical one is that $G(\varepsilon)$ is a uniform distribution, whereas $H(a)$ being a Bernoulli distribution is made without loss of generality. Note that in (6) and (7), the equilibrium e_H and e_L are determined independent of the admissions standard s, which is the implication of making $G(\varepsilon)$ a uniform distribution in (4). While this assumption seems strong, it should be pointed out that replacing the uniform distribution with another one, say a mean-zero normal distribution, would not necessarily shift the analysis in a specific direction. This is because the g function is (4) has both an increasing region and a decreasing region, and therefore the effect of s on effort cannot be signed a priori.

Comparative statics analyses with respect to the exogenous parameters of the model – r, λ, π and g – are the focus of the paper and are provided in the next section. We conclude this section by comparing $f(a_H, e_H)$ and $f(a_L, e_L)$. Because $a_H > a_L$, it is easy to see that e_H - e_L has the same sign as f_{ae}. That is, when aptitude and effort are complements, high-aptitude students will make more effort than low-aptitude students. Then, it is obvious that $f(a_H, e_H) > f(a_L, e_L)$ in this case. Of course, a high-aptitude student does not have to make more effort to achieve a higher expected performance than a low-aptitude student. A weaker sufficient condition for $f(a_H, e_H) > f(a_L, e_L)$ than complementarity is that the marginal rate of technical substitution between effort and aptitude, f_e / f_a, is non-increasing as effort increases.[5]

3. Comparative Statics: Why Do Asian Students Study Harder?

From the equilibrium conditions (6) – (8), the following comparative statics results – with respect to *r*, λ, π and *g* respectively – can be readily obtained. We omit the derivations because they are pretty straightforward. Our discussion will focus on the role each proposition plays in understanding why Asian students study harder.

Proposition 1. As *r* increases, e_H and e_L stay the same, and *s* decreases.

Proposition 2. As λ increases, e_H and e_L stay the same, and (as long as $f(a_H, e_H) > f(a_L, e_L)$) *s* increases.

Proposition 3. As π increases, e_H and e_L increase, and *s* also increases.

Proposition 4. As *g* increases, e_H and e_L increase.

These comparative statics results have implications for why Asian students study harder. First, according to Proposition 1, a larger degree of scarcity in higher education opportunities – represented by a lower *r* – should not be responsible for the observed more intensive student efforts in some Asian countries (such as China, as opposed to the U.K. and the U.S.), even though the college admissions standards are higher in these countries as a result. This result is consistent with the fact that as China's higher

[5] The proof of this result is omitted to save space. The positive relationship between performance and aptitude is consistent with the positive relationship between SAT scores and freshman grade point averages found by some SAT validity studies (e.g. Bridgeman et al. 2000, and Camara and Echternacht 2000).

education resources have become less scarce over time, academic efforts of pre-college students in China have remained high.

Second, according to Proposition 2, Asian students having smarter peers – represented by a larger λ – does not provide an explanation for their more intensive academic efforts, although it could be a factor for the more fierce competition as indicated by the higher college admission standards.

Third, according to Proposition 3, a stronger cultural emphasis on (higher) education – represented by a larger π – may be an explanatory factor for both more intensive academic efforts and more fierce college admission competition in some Asian countries.[6] This is consistent with the observation that Asian-American students tend to put more efforts in studying than other ethnic groups in the U.S.

Fourth, according to Proposition 4, a smaller degree of randomness in performance measurement – represented by a larger g – would lead to more intensive student efforts.[7] To see how this result may provide an explanation for why Asian students study harder than those in the U.S. and the U.K., note that in many Asian countries (such as China, Japan and South Korea) college admissions decisions heavily depend on a student's performance on a college entrance examination. In the U.S., in contrast, scores on standardized tests (such as SAT and ACT) are merely one component of the student's application portfolio. It is reasonable to assume that the more holistic

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[6] π is broadly defined to include not only the wage premium for college graduates compared to high school graduates, but also the job satisfaction and social status associated with a college degree. It has been documented that Asian parents tend to have higher expectations for their children's educational achievements (Hsin and Xie, 2014).

[7] It is well known that in a Tullock-type contest model, contestants' equilibrium efforts decrease when a contest prize with certainty is made random while the mean is kept the same (e.g., Treich 2010 and Liu et al. 2017). The result here shows that additional randomness in the winner selection process would also have a disincentive effect on effort.

admissions criterion in the U.S. generates more randomness in performance measurement than the more narrowly focused admissions criterion in those Asian countries that rely on an all-important college entrance examination. That is, Asian students face a higher g, and study harder as a result.

4. Conclusion

We construct a model of academic competition to investigate the plausible reasons for Asian students to exert more academic effort than students elsewhere. Among the four potential factors that may motivate students to study harder, we find that more limited higher education resources and higher-aptitude peers in Asian countries do not play a role, whereas a larger reward to a college degree rooted in the Asian culture emphasizing education and a more narrowly focused admissions criterion reducing the randomness in performance measurement may provide an explanation for the observed difference in academic efforts between Asian students and students elsewhere.

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