MATHEMATICAL APPENDIX

A1. Proof of Proposition 1

PROOF:

Let $U_M(t_M;x) := g_1(x)t_M - \frac{c_M(t_M)}{g_2(x)}$ and $U_m(t_m;x) := g_1(x)\phi(t_m) - \frac{c_m(t_m)}{g_2(x)}$. We can rewrite $U_{total}(t_M,t_m;x)$ as

$$
\begin{aligned}
U_{total}(t_M,t_m;x) &= g_1(x) \cdot (t_M + \phi(t_m)) - \frac{c_M(t_M) + c_m(t_m)}{g_2(x)} \\
&= \left(g_1(x)t_M - \frac{c_M(t_M)}{g_2(x)} \right) + \left(g_1(x)\phi(t_m) - \frac{c_m(t_m)}{g_2(x)} \right) \\
&= U_M(t_M;x) + U_m(t_m;x)
\end{aligned}
$$

(A1)

This implies that the utility from the total Gaokao score can be split into two parts: the main subject and the selective subject.

To maximize the student's utility, t_M satisfies the first-order condition:

$$
\begin{aligned}
0 &= \frac{\partial U_{total}}{\partial t_M} \\
&= \frac{\partial U_M}{\partial t_M} + \frac{\partial U_m}{\partial t_M} \\
&= \left(g_1(x) - \frac{c'_M(t_M)}{g_2(x)} \right) + 0
\end{aligned}
$$

(A2)

Solving the first-order condition yields $t_M = c'^{-1}_M(x)$, which depends only on x and $c_M(\cdot)$. Similarly, we know that t_m satisfies $x\phi'(t_m) = c'_m(t_m)$, which only depends on x, c_m and $\phi(\cdot)$, namely the grading system on selective subjects.

Q.E.D.

A2. Proof of Proposition 2

PROOF:

Denote $I_1(n)$ and $I_2(n)$ as

$$
I_1(n) := \int_0^1 g_1(x)y_n(x)f(x)\mathrm{d}x, \; I_2(n) := \int_0^1 \frac{f(x)}{g_2(x)}\mathrm{d}x \int_0^x y_n(\tilde{x})\mathrm{d}\tilde{x}.
$$

It suffices to prove that $I_1(n)$ is monotonically decreasing with respect to n, and $I_2(n)$ is monotonically increasing with respect to n.

For $I_1(n)$, taking the difference between $I_1(n)$ and $I_1(n+1)$ yields:

$$
\begin{aligned}
\Delta I_1(n) &= I_1(n) - I_1(n+1) \\
&= \int_0^1 g_1(x) y_n(x) f(x) \mathrm{d}x - \int_0^1 g_1(x) y_{n+1}(x) f(x) \mathrm{d}x \\
&= \int_0^1 g_1(G_n^{-1}(F(x)) - G_{n+1}^{-1}(F(x))) f(x) \mathrm{d}x \\
&= \int_0^1 g_1(F^{-1}(x))(G_n^{-1}(x) - G_{n+1}^{-1}(x)) \mathrm{d}x
\end{aligned}
$$

(A3)

Let $h(x) = g_1(F^{-1}(x))$, then $h(x) > 0$ and is monotonically increasing with respect to x.

(A4)

$$
\begin{aligned}
\Delta I_1(n) &= \int_0^1 h(x)(G_n^{-1}(x) - G_{n+1}^{-1}(x)) \mathrm{d}x \\
&= \sum_{i=1}^{n-1} \int_{\frac{i}{n+1}}^{\frac{i}{n}} h(x)\beta\left(\frac{i-1}{n-1} - \frac{i}{n}\right)\mathrm{d}x + \sum_{i=1}^{n-1} \int_{\frac{i}{n}}^{\frac{i+1}{n+1}} h(x)\beta\left(\frac{i}{n-1} - \frac{i}{n}\right)\mathrm{d}x \\
&\geq \sum_{i=1}^{n-1} \int_{\frac{i}{n+1}}^{\frac{i}{n}} h\left(\frac{i}{n}\right)\beta\left(\frac{i-1}{n-1} - \frac{i}{n}\right)\mathrm{d}x + \sum_{i=1}^{n-1} \int_{\frac{i}{n}}^{\frac{i+1}{n+1}} h\left(\frac{i}{n}\right)\beta\left(\frac{i}{n-1} - \frac{i}{n}\right)\mathrm{d}x \\
&= \beta \sum_{i=1}^{n-1} h\left(\frac{i}{n}\right)\left(\left(\frac{i-1}{n-1} - \frac{i}{n}\right)\left(\frac{i}{n} - \frac{i}{n+1}\right) + \left(\frac{i}{n-1} - \frac{i}{n}\right)\left(\frac{i+1}{n+1} - \frac{i}{n}\right)\right) \\
&= \beta \sum_{i=1}^{n-1} h\left(\frac{i}{n}\right)\left(\frac{i(i-n)}{(n-1)n^2(n+1)} + \frac{i(n-i)}{(n-1)n^2(n+1)}\right) \\
&> 0
\end{aligned}
$$

Thus, $I_1(n)$ is monotonically decreasing with respect to n.

For $I_2(n)$, taking the difference between $I_2(n)$ and $I_2(n+1)$ yields:

$$
\begin{aligned}
\Delta_{\text{latter}} &= \int_0^1 \frac{f(x)}{g_2(x)}\mathrm{d}x \int_0^x y_n(\tilde{x})\mathrm{d}\tilde{x} - \int_0^1 \frac{f(x)}{g_2(x)}\mathrm{d}x \int_0^x y_{n+1}(\tilde{x})\mathrm{d}\tilde{x} \\
&= \int_0^1 \frac{f(x)}{g_2(x)}\mathrm{d}x \int_0^x (y_n(\tilde{x}) - y_{n+1}(\tilde{x}))\,\mathrm{d}\tilde{x}
\end{aligned}
$$

(A5)

It suffices to show that $\int_0^x (y_n(\tilde{x}) - y_{n+1}(\tilde{x}))\mathrm{d}\tilde{x} \leq 0$ holds for any $x \in [0,1]$.

For any $n \geq 2$, G_n^{-1} is symmetric about $\left(\frac{1}{2}, \frac{\beta}{2}\right)$, and F is symmetric about $\left(\frac{1}{2}, \frac{1}{2}\right)$, hence

y_n is symmetric about $\left(\frac{1}{2}, \frac{\beta}{2}\right)$. Thus, for all $a \in \left[0, \frac{1}{2}\right)$:

$$
\int_{\frac{1}{2}-a}^{\frac{1}{2}+a} (y_n(\tilde{x}) - y_{n+1}(\tilde{x})) d\tilde{x}
$$

$$
= \int_{\frac{1}{2}-a}^{\frac{1}{2}} (y_n(\tilde{x}) - y_{n+1}(\tilde{x})) d\tilde{x} + \int_{\frac{1}{2}}^{\frac{1}{2}+a} (y_n(\tilde{x}) - y_{n+1}(\tilde{x})) d\tilde{x}
$$

(A6)
$$
= \int_{\frac{1}{2}-a}^{\frac{1}{2}} (y_n(\tilde{x}) - y_{n+1}(\tilde{x})) d\tilde{x} + \int_{\frac{1}{2}-a}^{\frac{1}{2}} (y_n(1-\tilde{x}) - y_{n+1}(1-\tilde{x})) d\tilde{x}
$$

$$
= \int_{\frac{1}{2}-a}^{\frac{1}{2}} (y_n(\tilde{x}) - y_{n+1}(\tilde{x})) d\tilde{x} + \int_{\frac{1}{2}-a}^{\frac{1}{2}} ((\beta - y_n(\tilde{x})) - (\beta - y_{n+1}(\tilde{x}))) d\tilde{x}
$$

$$
= \int_{\frac{1}{2}-a}^{\frac{1}{2}} (y_n(\tilde{x}) - y_{n+1}(\tilde{x})) d\tilde{x} + \int_{\frac{1}{2}-a}^{\frac{1}{2}} (y_{n+1}(\tilde{x}) - y_n(\tilde{x})) d\tilde{x}
$$

$$
= 0
$$

Thus, it suffices to consider the case where $x \in \left[0, \frac{1}{2}\right]$.

For all $i \in \{1, 2, \ldots, n-1\}$, note that when $\tilde{x} \in \left(F^{-1}\left(\frac{i}{n+1}\right), F^{-1}\left(\frac{i}{n}\right)\right)$, we have:

(A7)
$$
y_n(\tilde{x}) - y_{n+1}(\tilde{x}) = \beta \cdot \left(\frac{i-1}{n-1} - \frac{i}{n}\right) < 0
$$

And when $\tilde{x} \in \left(F^{-1}\left(\frac{i}{n}\right), F^{-1}\left(\frac{i+1}{n+1}\right)\right)$, we have:

(A8)
$$
y_n(\tilde{x}) - y_{n+1}(\tilde{x}) = \beta \cdot \left(\frac{i}{n-1} - \frac{i}{n}\right) > 0
$$

Thus, it suffices to show that for all $i \in \{1, 2, \ldots, n-1\}$ and $F^{-1}\left(\frac{i+1}{n+1}\right) \leq \frac{1}{2}$, we have:

(A9)
$$
\int_{F^{-1}\left(\frac{i}{n+1}\right)}^{F^{-1}\left(\frac{i}{n}\right)} (y_n(\tilde{x}) - y_{n+1}(\tilde{x})) d\tilde{x} + \int_{F^{-1}\left(\frac{i}{n}\right)}^{F^{-1}\left(\frac{i+1}{n+1}\right)} (y_n(\tilde{x}) - y_{n+1}(\tilde{x})) d\tilde{x} \leq 0
$$

Rewrite the left-hand side of Equation (A9) yields:

$$
\begin{aligned}
LHS &= \left(F^{-1}\left(\frac{i}{n}\right) - F^{-1}\left(\frac{i}{n+1}\right)\right)\beta\left(\frac{i-1}{n-1} - \frac{i}{n}\right) \\
&\quad + \left(F^{-1}\left(\frac{i+1}{n+1}\right) - F^{-1}\left(\frac{i}{n}\right)\right)\beta\left(\frac{i}{n-1} - \frac{i}{n}\right) \\
&= \frac{\beta}{n(n-1)}\left(iF^{-1}\left(\frac{i+1}{n+1}\right) + (n-i)F^{-1}\left(\frac{i}{n+1}\right) - nF^{-1}\left(\frac{i}{n}\right)\right) \\
&= \frac{\beta}{n-1}\left(\frac{i}{n}F^{-1}\left(\frac{i+1}{n+1}\right) + \left(1 - \frac{i}{n}\right)F^{-1}\left(\frac{i}{n+1}\right)\right. \\
&\qquad\qquad \left. - F^{-1}\left(\frac{i}{n}\cdot\frac{i+1}{n+1} + \left(1 - \frac{i}{n}\right)\cdot\frac{i}{n+1}\right)\right) \\
&\le 0 = RHS
\end{aligned}
$$

(A10)

The last inequality in Equation (A9) is true from the assumption that $F''(x) = f'(x) \ge 0$ holds for any $x \in \left[0, \frac{1}{2}\right]$.

Q.E.D

ANALYSIS OF CFPS DATA

The China Family Panel Studies (CFPS)[13], initiated in 2010, is a nationally representative, biennial longitudinal survey of Chinese communities, families, and individuals. In its 2010 baseline survey, the CFPS successfully interviewed nearly 15,000 families and approximately 30,000 individuals within these families. The sample was drawn using a scientific stratification method, ensuring diversity in geographical distribution and richness in social contexts. CFPS collects comprehensive data across multiple domains, including education, economics, health, and family dynamics. As of now, the CFPS data has been updated through 2022.

This study focuses on the 2017 Gaokao reform implemented in two pivotal regions, Shanghai and Zhejiang, to examine how the shift from absolute grading to relative grading in selective subjects affects student effort. Specifically, we treat the reform as a quasi-natural experiment and employ the Difference-in-Differences (DiD) method to identify its impact on high school students' effort choices. Because a mainstream of Gaokao reform in other provinces was implemented in year 2021, we restrict our analysis to CFPS data up to 2020.

We estimate the following equation using ordinary least squares (OLS):

(B1) $y_{it} = \beta_0 + \beta_1 \times reform_{it} + \beta_2 \times post_{it} + \beta_3 \times (reform_{it} \times post_{it}) + \gamma C + \varepsilon,$

where y can be the study time measured in hours per week (*week*), per weekday (*weekday*), or per weekend (*weekend*). The variable *reform* is dummy variable indicating if the obser-

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[13] The website for CFPS is available at https://www.isss.pku.edu.cn/cfps/en/, providing a more detailed introduction to the CFPS.

vation is from a region affected by the 2017 Gaokao reform, and *post* is a dummy indicating if the observation is from a year following the reform. *C* includes control variables such as Gaokao year, sleep time, self-reported pressure, school ranking, family support, and others. The coefficient β_3 estimates the impact of the relative grading system on student effort.

TABLE B1— IMPACT OF THE 2017 GAOKAO REFORM ON STUDY TIME

Dependent Variables:	*week*	*weekday*	*weekend*
	(1)	(2)	(3)
reform × *post*	-6.269	-1.066	-0.469
	(11.240)	(1.666)	(1.706)
Control Variables	Yes	Yes	Yes
Observations	1,697	1,697	1,697

Notes: This table reports the regression results estimating the impact of the 2017 Gaokao reform on students' study time using CFPS data. The dependent variables are weekly study time (*week*), study time per weekday (*weekday*), and study time per weekend (*weekend*), measured in hours. The key variable of interest is *reform* × *post*, which captures the effect of the 2017 Gaokao reform on student study time. *reform* is a dummy indicating observations from regions affected by the reform, and *post* is a dummy indicating observations from a year after the reform. Control variables include year factors, sleep time, self-reported pressure, school ranking, family support, and others. Heteroskedasticity-robust standard errors are reported in parentheses.

The regression results in Table B1 align with the model's predictions. The coefficients of *reform* × *post*, the estimate of the 2017 Gaokao reform on student effort, indicate that the reform leads to an average decrease of 4.36 hours in students' weekly study time. Specifically, the reform reduces study time by 0.604 hours per weekday and 0.670 hours per weekend. While these coefficients are not statistically significant, their magnitudes are economically meaningful. The lack of statistical significance can largely be attributed to the limited sample size of students affected by the Gaokao reform.

Although the CFPS theoretically tracks tens of thousands of families biennially, only 3% of the sample consists of high school students. Furthermore, since the 2017 Gaokao reform was implemented in only two pivotal regions, there is a significant disparity in sample size between reform and non-reform regions, as illustrated in Figure B1. This increases the variability of the estimates. Despite these limitations, the results are suggestive of the answer to our research question, indicating that the Gaokao reform reduces student effort.

FIGURE B1. SAMPLE SIZES OF HIGH SCHOOL STUDENTS IN 2017 GAOKAO REFORM AND NON-REFORM REGIONS
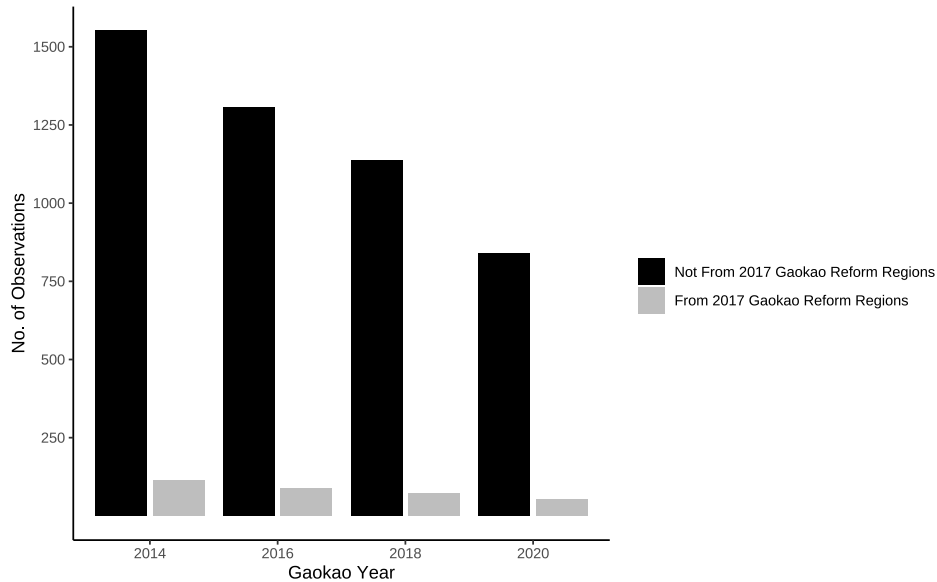
APPENDIX FOR QUESTIONNAIRE SURVEY

C1.   Contents of the Questionnaire Survey

**Survey on High School Student Study Mode for the Gaokao**[14]

Thank you for participating in this survey!

This survey asks about aspects related to your subject choices and preparation for the Gaokao, such as your performances in different subjects and your time allocation on them. We will not ask for sensitive information such as specific scores or rankings.

Completing this survey is expected to take approximately **5 minutes**.

During the survey, you may encounter questions involving sliders:

[Sample Slider Question] How would you rate your proficiency in a given subject? / What is the proportion (%) of time you allocate to a given activity?
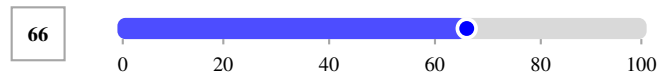
You may drag this slider to familiarize yourself with it.

For such slider questions, you can either directly input a number on the left or drag the slider to the desired position.

Click "Next Page" to begin.

[Page Break]

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[14]This survey was designed and implemented using the Wenjuanxing platform at https://www.wjx.cn.

1) Which province did (or will) you take the Gaokao in? [Single Choice]

   Options: Shanghai, Zhejiang, Beijing, Tianjin, Shandong, Hainan, Hebei, Liaoning, Jiangsu, Fujian, Hubei, Hunan, Guangdong, Chongqing, Heilongjiang, Jilin, Anhui, Jiangxi, Guangxi, Guizhou, Gansu, Shanxi, Inner Mongolia, Shaanxi, Ningxia, Qinghai, Sichuan, Yunnan, Henan, Xinjiang, Tibet, Other (e.g., Hong Kong, Macao, Taiwan, overseas).

2) Which year did (or will) you take the Gaokao? [Single Choice]

   Options: 2015 or earlier, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025, 2026 or later.

3) Select your Gaokao mode[15]

   (3-1) Please determine whether the following statement is true: Your Gaokao policy follows the traditional Gaokao mode (in which you have to choose either the arts or science bundle). [Single Choice]

   Options: True, False.

   (3-2) Please determine whether the following statement is true: Your Gaokao policy follows the "3+3" mode[16] (If "False" in (3-1)). [Single Choice]

   Options: True, False.

   (3-3) Please determine whether the following statement is true: Your Gaokao policy follows the 3+1+2 mode[17] (If "False" in (3-1)) . [Single Choice]

   Options: True, False.

4) Subject Selection[18]

   (4-1) What was your subject stream selection? [Single Choice]

   Options: Arts, Science.

   (4-2) What were your selected subjects? [Multiple Choice, Choose 3]

   Options: History, Geography, Politics, Physics, Chemistry, Biology, (Technology).

---

[15] If it can be deduced from the Gaokao year and Gaokao province the respondent gives in the previous two questions that this province has implemented Gaokao reform at her Gaokao year, then (3-1) is displayed. If the province is going to implement "3+3" mode after Gaokao reform that had not been implemented at her Gaokao year, then (3-2) is displayed. If the province is going to implement "3+3" mode after Gaokao reform that had not been implemented at her Gaokao year, then (3-3) is displayed. These guarantees that any valid answer for this question must be "False."

Based on the respondent's reported province and year, the system determines the Gaokao policy in place at that time. Depending on the policy, one of the above questions is displayed, ensuring attentive respondents select "False" as the answer.

[16] "3+3" mode allows students to freely choose the three selective subjects out of six as they wish. The grading system under "3+3" mode is relative grading whose score difference between adjacent grades is 3. This corresponds to the *coarse* relative grading system.

[17] "3+1+2" mode requires students to choose one from physics and history, and choose 2 subjects from chemistry, biology, geology and politics. The grading system under "3+3" mode is relative grading whose score difference between adjacent grades is 1. This corresponds to the *granular* relative grading system.

[18] If the respondent selects "True" for (3-1) or "False" for (3-2) or (3-3), (4-1) is shown; otherwise, (4-2) is displayed. The option "Technology" is only available for respondents from Zhejiang province.

5) During the school days in your senior year of high school, how much time did you spend on average each day preparing for the Gaokao? _____hours _____minutes.

> This includes time spent in class, completing assignments, and additional practice.

6) During the weekends[19] in your senior year of high school, how much time did you spend on average each day preparing for the Gaokao? _____hours _____minutes.

7) Of the total study time mentioned above: The proportion spent on core subjects (Chinese, Mathematics, and Foreign Language) was approximately _____%; The proportion spent on selective subjects was approximately _____%. Please ensure that the two percentages add up to 100%.

The following questions will assess your proficiency and time allocation across six Gaokao subjects[20]. A good standard for your proficiency in each subject can be the percentile of this subject's score among the school in the most recent exam.

8) Regarding Chinese [Input a number between 0 and 100]

   How proficient do you think you are in Chinese? _____

   What proportion (%) of your study time is allocated to Chinese? _____

9) Regarding Mathematics [Input a number between 0 and 100] How proficient do you think you are in Mathematics? _____

   What proportion (%) of your study time is allocated to Mathematics? _____

10) Regarding Foreign Language [Input a number between 0 and 100]

   How proficient do you think you are in Foreign Language? _____

   What proportion (%) of your study time is allocated to Foreign Language? _____

11) Regarding History [Input a number between 0 and 100]

   How proficient do you think you are in History? _____

   What proportion (%) of your study time is allocated to History? _____

12) Regarding Geography [Input a number between 0 and 100]

   How proficient do you think you are in Geography? _____

   What proportion (%) of your study time is allocated to Geography? _____

13) Regarding Politics [Input a number between 0 and 100]

   How proficient do you think you are in Politics? _____

   What proportion (%) of your study time is allocated to Politics? _____

---

[19] Specifically, this refers to days that students do not need to go to school. It may not necessarily be the weekends, because some school have classes in weekends in practice. On the other hand, it includes holidays, winter or summer vacations, etc.

[20] Questions 11 to 17 will selectively appear only if the respondent indicates they have selected the corresponding subjects.

14) Regarding Physics [Input a number between 0 and 100]

    How proficient do you think you are in Physics? _____

    What proportion (%) of your study time is allocated to Physics? _____

15) Regarding Chemistry [Input a number between 0 and 100]

    How proficient do you think you are in Chemistry? _____

    What proportion (%) of your study time is allocated to Chemistry? _____

16) Regarding Biology [Input a number between 0 and 100]

    How proficient do you think you are in Biology? _____

    What proportion (%) of your study time is allocated to Biology? _____

17) Regarding Technology [Input a number between 0 and 100]

    How proficient do you think you are in Technology? _____

    What proportion (%) of your study time is allocated to Technology? _____

18) Do you believe you are significantly stronger in some subjects and weaker in others (i.e., a significant proficiency gap)? [Single Choice] Options: Yes, No.

19) What is your average daily sleep time (including naps)? _____hours _____minutes.

20) How often do you utilize fragmented time for studying (e.g., memorizing classical texts while waiting in line or learning vocabulary on the bus)? (0 indicates never using fragmented time to study, and 100 indicates always use fragmented time to study.)
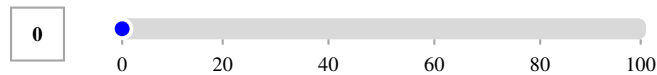
21) To what extent do you think your family supported your Gaokao preparation in your senior year (e.g., better nutrients, extracurricular educational expenses, companionship)? (0 indicates no support, and 100 indicates fully support.)
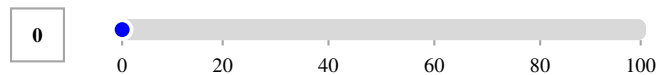

22) How would you rate the amount of homework assigned by your school during your senior year? (0 indicates no homework, 100 indicates overwhelming amount of homework.)
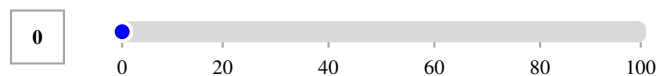
23) During your senior year, how many exams did your school organize? _____times.

This includes exams such as weekly tests, monthly tests, midterms, finals that provide scores and rankings.

24) In your senior year, what percentage (%) of the students of your Gaokao year in your school do you believe you were academically stronger than? (0 indicates the weakest in the school, and 100 indicates the strongest.)

0

0   20   40   60   80   100
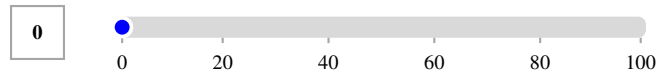
25) In your senior year, what percentage (%) of the students of your Gaokao year in your Gaokao province do you believe you were academically stronger than? (0 indicates the weakest in the province, and 100 indicates the strongest.)

0

0   20   40   60   80   100
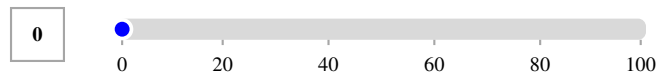
26) What percentage (%) of schools in your Gaokao province do you think your school's overall Gaokao performance was stronger than? (0 indicates the weakest in the province, and 100 indicates the strongest.)

0

0   20   40   60   80   100
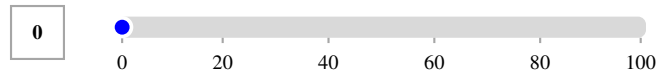
27) What was your level of academic pressure during your senior year? (0 indicates no pressure at all, and 100 indicates overwhelming pressure.)

0

0   20   40   60   80   100
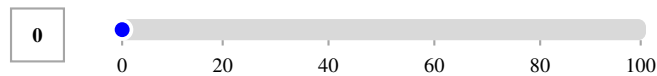
28) In your senior year, what percentage (%) of senior students in your province do you think you face more pressure than? (0 indicates experiencing the least pressure in the province, and 100 indicates the greatest.)

0

0   20   40   60   80   100
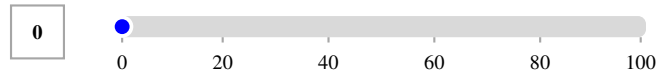
29) Considering the difficulty of the Gaokao in your province, the number of competing students and their overall ability, and the number of available university seats, what percentage (%) of your peers nationwide do you think you faced more pressure for college admission than? (0 indicates experiencing the least pressure in the country, and 100 indicates the greatest.)

0

0   20   40   60   80   100
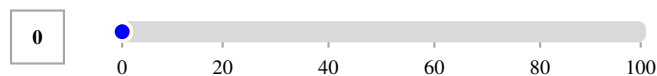
C2.   Survey Sample

For a response to be considered valid, it must satisfy the following five data filtering criteria:

1) The respondent's Gaokao year and Gaokao province must match their reported Gaokao mode. (By design, a valid response corresponds to a "False" answer in the question asking the respondent to verify their Gaokao mode.)

2) The reported proportions of time spent on main subjects and selective subjects must sum to 100%.

3) The respondent is not from Hainan, Hong Kong, Macao, Taiwan, or other regions where the Gaokao mode or college admission process differs significantly from the majority.

4) The respondent's Gaokao year must not be 2015, 2016, 2024, or 2025, as there are extremely few respondents from these years. Since year factors are controlled in the analysis, including such samples would obscure the year effect.

5) The respondent's answers must be logically reasonable. For example, one cannot report studying for 24 hours per day.

Initially, we received 1,196 responses, of which 760 met these criteria. Figure C1 presents the distribution of respondents by Gaokao year and grading system in selective subjects. Figure C2 illustrates the geographical distribution of respondents across China.

FIGURE C1. DISTRIBUTION OF RESPONDENTS BY GAOKAO YEAR AND GRADING SYSTEM IN SELECTIVE SUBJECTS
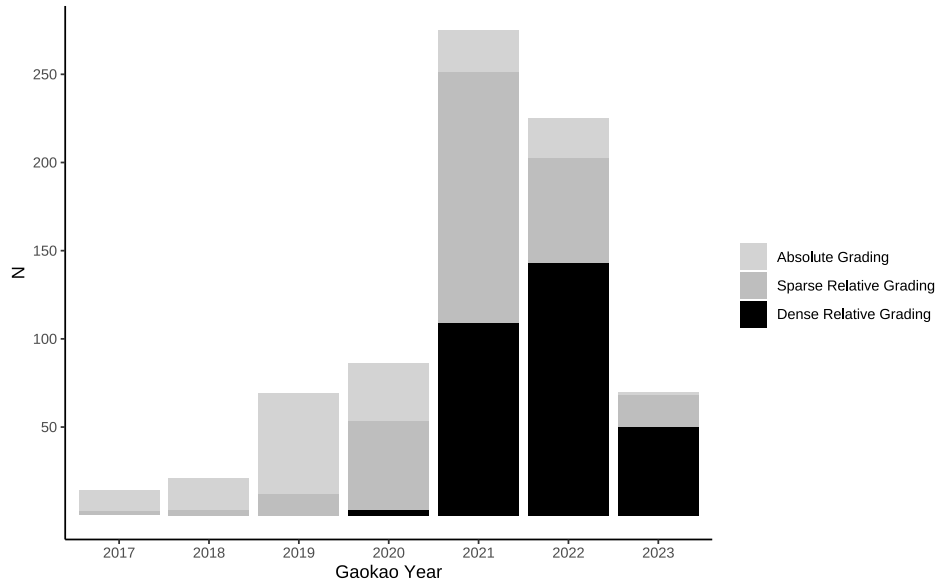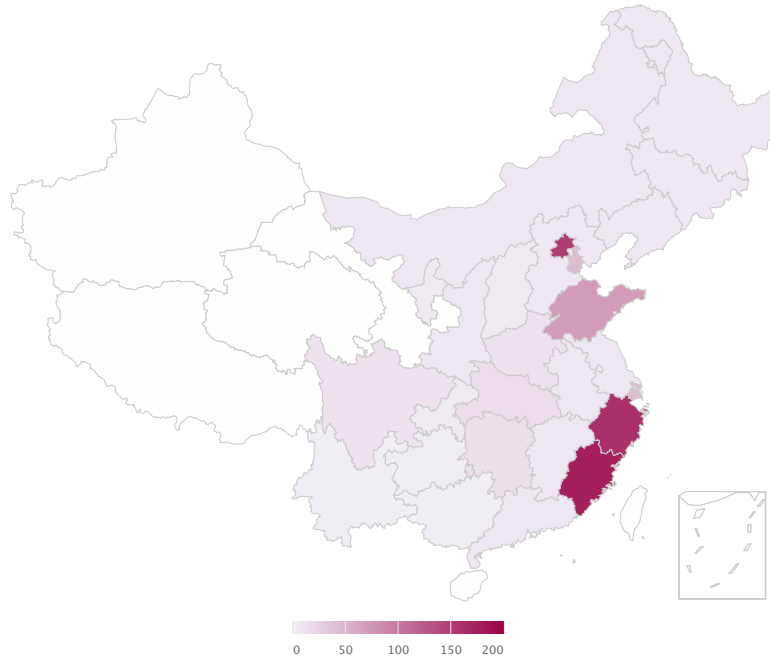
FIGURE C2. GEOGRAPHICAL DISTRIBUTION OF SURVEY RESPONDENTS ACROSS CHINA

C3.   Additional Analysis

We have demonstrate through the main results (see Section III.A) and heterogeneity analysis (see Section III.B) that the Gaokao reform reduces student effort. Building on these findings, we further explore its broader implications by examining how the reform affects students' self-reported pressure levels and sleep time. Specifically, we set *y* in Equation (13) and (14) as self-reported pressure level (*pressure*, ranging from 0 to 100) and daily sleep time (*sleep*, measured in hours), and estimate these equations using ordinary least squares (OLS). The regression results are presented in Table C1.

For self-reported pressure levels, the regression results reveal that the Gaokao reform significantly alleviates student pressure by around 5.41% ($p = 0.031$). This finding highly correlates with, and strongly supports our earlier results that the Gaokao reform leads to reduced student effort. The implication is that the relative grading system not only successfully makes students physically spend less time studying, but also makes them mentally feel less stressful.

For sleep time, the results show that the Gaokao reform, as well as both types of relative grading systems, has no significant impact. This finding, however, may not be a bad thing. It suggests that the time saved from reduced effort in selective subjects is likely redistributed to other daytime extracurricular activities, such as sports or music, which contributes to students' well-being. Notably, while the coefficient for Gaokao year (*year*) is negative and statistically significant, its magnitude is negligible. This indicates that high

TABLE C1— IMPACT OF GAOKAO REFORM ON PRESSURE LEVEL AND SLEEP TIME

Dependent Variables:	*pressure*		*sleep*	
	(1)	(2)	(3)	(4)
reform	-5.409		0.055	
	(2.509)		(0.093)	
granular		-4.185		0.043
		(2.923)		(0.109)
coarse		-6.136		0.062
		(2.611)		(0.098)
year	1.926	1.712	-0.085	-0.083
	(0.789)	(0.821)	(0.031)	(0.032)
Control Variables	Yes	Yes	Yes	Yes
Observations	760	760	760	760

Notes: This table presents the regression results for the impact of the Gaokao reform on self-reported pressure levels and daily sleep time. The dependent variables are self-reported pressure levels (*pressure*, ranging from 0 to 100) in Columns 1–2, and sleep time per day (*sleep*, in hours) in Columns 3–4. The variable *reform* indicates whether the respondent experienced the Gaokao reform, while *granular* and *coarse* represent granular and coarse relative grading systems, respectively. Control variables include Gaokao year, student ranking, self-reported pressure, the degree of imbalance between subjects, and other relevant factors. Heteroskedasticity-robust standard errors are reported in parentheses.

school students have already allocated nearly all their available time to studying. Although they attempt to reduce sleep time to study more, this strategy appears to have reached its limit. Thus, engaging in extracurricular activities becomes crucial for maintaining students' mental health, which highlights the broader implications of this finding.

APPENDIX FOR EXPERIMENT

D1. Experiment Manual

Thank you for participating this experiment!

We are conducting a study to assess fundamental office skills. The experiment includes two tasks: *typing* and *mental arithmetic*. Your task is to test your typing speed and mental arithmetic skills. The experiment data and results will only be used for our research purpose. If you have any concerns, please feel free to contact the organizers.

To encourage you to perform at your best, we will additionally reward participants ranked in the top 2%–10% for their overall performance across both skills with **20** CNY per person, and those ranked in the top 2% with **100** CNY per person.

For both tasks, we take the best score for each subject, and you are allowed to make multiple attempts. It takes some time to get adapted to the specific contexts, so we encourage you to try multiple times.

———————— Below is for Control group ————————

Your overall score will be calculated as follows:

Overall Score = Best Typing Speed (cpm) + Best Mental Arithmetic Score (points)

(*Please answer this question for your understanding*) If a participant's best typing speed is 20 cpm and their best mental arithmetic score is 15 points, what is their overall score?

_____

Note: We provide the correct answer of *35* after they submit the answer.
———————————————— Below is for Dense group ————————————————

Your overall score will be calculated as follows:

We will rank all participants' fastest typing speeds. Rankings will be divided into 11 categories, with the top 5%, 5%–15%, 15%–25%, ..., 85%–95%, and the bottom 5% receiving grades of A+, A, A-, B+, B, B-, C+, C, C-, D, and E, respectively. These grades correspond to scores of 20, 18, 16, ..., 2, and 0. This score will be added to your best mental arithmetic score (points) to determine your overall score. See the table below for details.

TABLE D1—GRADING RULE FOR GRANULAR GROUP

Rank	Grade	Score
Top 5%	A+	20
5%–15%	A	18
15%–25%	A-	16
25%–35%	B+	14
35%–45%	B	12
45%–55%	B-	10
55%–65%	C+	8
65%–75%	C	6
75%–85%	C-	4
85%–95%	D	2
Bottom 5%	E	0

(*Please answer this question for your understanding*) If a participant's best typing speed is 20 cpm, their best mental arithmetic score is 21 points, and their typing speed ranks in the 30% percentile among all participants, what is their overall score? _____
Note: We provide the correct answer of *35* after they submit the answer.
———————————————— Below is for Coarse group ————————————————

Your overall score will be calculated as follows:

We will rank all participants' fastest typing speeds. Rankings will be divided into 5 categories: Top 1/8, 1/8–3/8, 3/8–5/8, 5/8–7/8, and Bottom 1/8, which will receive grades of A, B, C, D, and E, respectively. These grades correspond to scores of 20, 15, 10, 5, and 0. This score will be added to your best mental arithmetic score (points) to determine your overall score. See the table below for details.
(*Please answer this question for your understanding*) If a participant's fastest typing speed is 25 cpm, their highest mental arithmetic score is 20 points, and their typing speed ranks in the 2/8 fraction (i.e., 1/4), what is their overall score? _____
Note: We provide the correct answer of *35* after they submit the answer.
————————————————Below is the same for all groups————————————————

TABLE D2—GRADING RULE FOR COARSE GROUP

Rank	Grade	Score
Top 1/8	A	20
1/8–3/8	B	15
3/8–5/8	C	10
5/8–7/8	D	5
Bottom 1/8	E	0

Please proceed to the following websites as instructed. If you encounter any technical or operational issues during the experiment, please feel free to contact the organizers.

1) Typing Test

   For the typing test, please use the website https://dazi.91xjr.com. Once you enter the site, you will see the following interface... (details omitted)[21].

2) Mental Arithmetic Test

   For the mental arithmetic test, please use the website https://www.preplounge.com/en/mental-math/add/1. Once you enter the site, you will see the following interface... (details omitted)[22]

D2. *Additional Results*

Table D3 presents the comparisons of invested time between the control and granular groups, as well as between the control and coarse groups. The results generally align with the patterns observed in Table 5. Notably, the effect is more pronounced in the comparisons between the control and granular groups. In contrast, the coarse group shows less distinction from the control group. These findings are consistent with the model predictions: the granular relative grading system differs more markedly from the absolute grading system, as it is more effective in reducing effort compared to the coarse relative grading system.

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[21]The details in the manual include instructions for using the typing test website. As it is lengthy and not essential, it is omitted.

[22]The details in the manual include instructions for using the mental arithmetic test website. As it is lengthy and not essential, it is omitted.

TABLE D3—ADDITIONAL COMPARISONS OF INVESTED TIME: CONTROL VS. GRANULAR AND CONTROL VS. COARSE

| | Panel A. Control and Granular Groups | | | |
| | Mean | | | |
	Granular	Control	Difference	p-value
Time in Typing	6.111	9.000	-2.889	0.043
	(0.732)	(1.195)	(1.360)	
Time in Mental Arithmetic	4.806	6.265	-1.459	0.137
	(0.429)	(0.870)	(0.9705)	
Total Time	10.918	15.265	-4.347	0.034
	(1.012)	(1.742)	(2.015)	
Number of Subjects	39	42		

| | Panel B. Control and Coarse Groups | | | |
| | Mean | | | |
	Coarse	Control	Difference	p-value
Time in Typing	6.111	7.212	-1.788	0.278
	(0.732)	(1.195)	(1.635)	
Time in Mental Arithmetic	7.066	6.265	0.801	0.595
	(1.224)	(0.870)	(1.501)	
Total Time	14.278	15.265	-0.987	0.697
	(1.830)	(1.742)	(2.526)	
Number of Subjects	36	42		

Notes: This table presents comparisons of average time invested (in minutes) in typing, mental arithmetic, and total activities. Panel A reports comparisons between the granular group and the control group. Panel B compares the coarse group with the control group. The "Difference" column shows the mean differences between the groups. p-values are computed using a two-sample t-test, allowing for unequal variances.