

This is an electronic reprint of the original article. This reprint may differ from the original in pagination and typographic detail.

From epidemic to pandemic: Effects of the COVID-19 outbreak on high school program choices in Sweden

Aalto, Aino-Maija; Mueller, Dagmar; Tilley, J. Lucas

Published in:
Labour Economics

DOI:
[10.1016/j.labeco.2023.102346](https://doi.org/10.1016/j.labeco.2023.102346)

Published: 01/06/2023

Document Version
Final published version

Document License
CC BY-NC-ND

[Link to publication](#)

Please cite the original version:

Aalto, A.-M., Mueller, D., & Tilley, J. L. (2023). From epidemic to pandemic: Effects of the COVID-19 outbreak on high school program choices in Sweden. *Labour Economics*, 82. <https://doi.org/10.1016/j.labeco.2023.102346>

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.



From epidemic to pandemic: Effects of the COVID-19 outbreak on high school program choices in Sweden[☆]



Aino-Maija Aalto^{a,*}, Dagmar Müller^b, J. Lucas Tilley^c

^a Swedish Institute for Social Research (SOFI), Stockholm University and Faculty of Social Sciences, Business and Economics, and Law, Åbo Akademi University

^b Swedish Public Employment Service (Arbetsförmedlingen), UCLS and IZA

^c Swedish Institute for Social Research (SOFI), Stockholm University and UCLS

ARTICLE INFO

JEL classification:

I20
J24

Keywords:

COVID-19
Business cycle
Human capital investment
Field of study

ABSTRACT

We study whether the onset of the COVID-19 crisis affected the program choices of high school applicants in Sweden. Our analysis exploits the fact that the admission process consists of two stages: a preliminary round in which applicants initially rank programs in order of preference and a final round in which they can alter their preliminary rankings. In 2020, the timing of the two rounds happened to provide a unique pre- and post-crisis snapshot of applicants' field-of-study choices. Using school-level data on applicants' top-ranked programs for all admission rounds between 2016 and 2020, we implement a difference-in-differences method to identify the immediate effect of the crisis on demand for programs. We find no change in demand for academic programs, but a decline in top-ranked applications to some of the vocational programs. The declines are most pronounced and robust for programs related to the Accommodation and Food Services sector, which was the most adversely affected industry during the crisis. This finding suggests that labor market considerations influence the study choices made by relatively young students.

1. Introduction

The economic disruptions caused by the COVID-19 pandemic have been distributed unequally across age groups. Sectors that typically employ young workers were hit the hardest, and there is evidence that employment losses have disproportionately been borne by younger people (Eurofound, 2021). As a result, the crisis led to a decrease in students' outlook for financial security and may have affected their expectations about the employment prospects of different occupations, in turn altering their demand for different fields of study. Survey evidence by Aucejo et al. (2020) suggests that college students were indeed quick to reconsider their education decisions as economic disruptions became evident during the early stages of the pandemic: as early as mid-2020, US undergraduates began to switch from lower- to higher-paying fields.

The existing literature on how economic disruptions affect field-of-study choices primarily focuses on higher education levels. In contrast, we consider the effect of the COVID-19 pandemic on program choices

at the high school level, and to the best of our knowledge, our work is unique in this respect. This is an important contribution because the choice of high school major can have significant consequences for adult earnings and labor market prospects (Altonji et al., 2012; Dahl et al., 2023; SCB, 2017). Moreover, the vast majority of individuals in a birth cohort make field-of-study choices in high school,¹ while a much smaller subset of the population with above-average socioeconomic status makes this choice at the college level. Our evidence comes from the Swedish context, where high school students apply to field-specific programs that can be characterized as either academic (e.g., Natural Science) or vocational (e.g., Building & Construction) in nature. How-

¹ In Sweden, where our study is based, around 95% of a birth cohort applies to a high school program (Source: [The Swedish National Agency for Education](https://www.scb.se/en/press-releases/2020/0049)).

* We are grateful for comments from Akib Khan, Anna Sjögren, Oskar Nordström Skans, and Vincent Sterk. We also thank seminar participants at SOLE 2022, EALE 2021, the Department of Economics at Uppsala University, the Swedish Institute for Social Research at Stockholm University, and the Research Institute of Industrial Economics. We are especially indebted to all the administrators who helped extract and deliver the data that enabled us to carry out this project. We are also thankful for excellent research assistance from Ylva Forsberg, Didrik Prohorenko, Sandra Thiman, and Ana Tramosljanin. Aalto acknowledges financial support from the Knut and Alice Wallenberg Foundation, Müller acknowledges support from the Marianne and Marcus Wallenberg Foundation (2020.0049) and the Jan Wallander and Tom Hedelius Foundation, and Tilley acknowledges support from the Uppsala Center for Labor Studies and the Jan Wallander and Tom Hedelius Foundation.

* Corresponding author.

E-mail address: aino-maija.aalto@sofi.su.se (A.-M. Aalto).

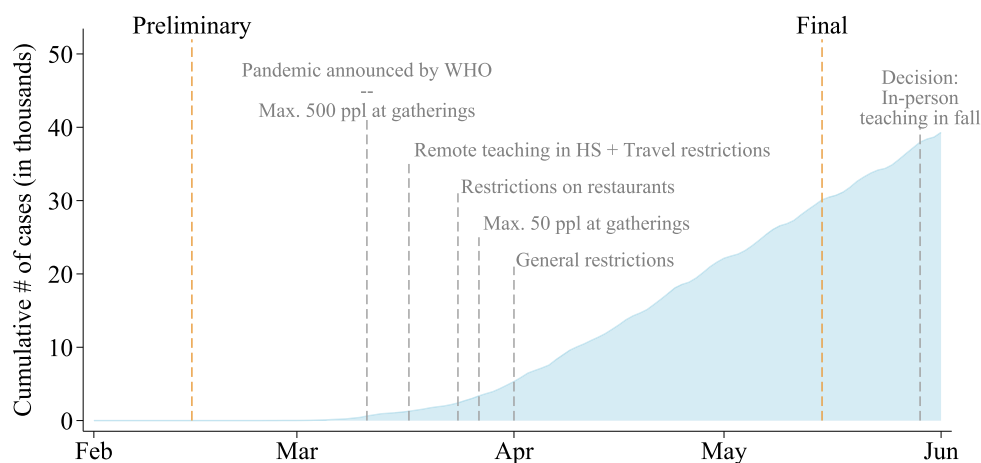


Fig. 1. Timeline of COVID-19 cases, pandemic-related restrictions, and high school admissions in Sweden during spring 2020. Notes: The shaded region depicts the cumulative number of COVID-19 cases in Sweden from February to June 2020 based on data from the Public Health Agency of Sweden. The vertical lines labeled “Preliminary” and “Final” indicate the dates that preliminary- and final-round high school applications were due. The other vertical lines indicate pandemic-related restrictions that were imposed at the national level.

ever, our results have broader relevance, given that high school students make similar choices in the majority of other European countries.²

To study how program demand changed in response to the COVID-19 crisis, we use a difference-in-differences strategy exploiting the fact that admission to Swedish high schools consists of two rounds. In the preliminary round, applicants rank their preferences for specific programs and submit their initial choices to a central admission authority by mid-February. After preliminary admission decisions are released, students have until mid-May to alter their preference rankings for the final admission round. As shown in Fig. 1, the timeline of the two rounds provides unique pre- and post-crisis snapshots of the 2020 admission cohort’s study choices. It is essential for our identification strategy that the crisis had not yet hit Sweden and was still considered an epidemic in Asia when applicants submitted their initial preference rankings. However, by the final admission round, the epidemic had turned into a pandemic and had spread to and within Sweden. This allows us to identify the immediate effect of the crisis on program demand by estimating the change in the number of top-ranked applications to specific programs between the admission rounds in 2020 as compared to the change between the rounds in the previous year.

In order to conduct our study, we built a unique data set on applicants’ program choices in the preliminary and final admission rounds in 2020, as well as several years before the crisis. Sweden’s official individual-level registry data does not contain any information on preliminary choices; however, most high school admission centers compile aggregate statistics for each program offered by a school. We contacted the admission centers and requested these statistics for all rounds from 2016 to 2020, collecting data for almost 700 schools and covering over 90% of applications nationwide. At the school level, we observe the number of applicants who list a particular program as the top-ranked choice on their application: we argue that this measure captures students’ demand for programs more accurately than admission or enrollment outcomes, which might be constrained by the availability of places. In addition, we link our data set to publicly available data on time-varying school-level characteristics of the student body and teaching staff from the Swedish National Agency of Education. In our main model, we exploit variation within a school over rounds and time and include school fixed effects as well as time-varying school-level controls that may affect the desirability of schools.

Our results show that the arrival of the pandemic led to a decline in top-ranked applications to some of the vocational programs, whereas

none of the academic programs were affected. The effect of the outbreak was particularly striking in the Hotel & Restaurant program, where demand between the rounds dropped by more than 100% compared to the change between the rounds in the previous year. In addition, we find a decline in demand for the Child & Recreation program. In both of the affected programs, the effect is robust throughout and non-trivial, amounting to an 8% and 6% drop, respectively, in relation to the mean number of applications to these programs. In contrast to papers showing that college enrollment increases in response to recessions, there is no indication that students systematically shift towards programs that tend to lead to higher-paying jobs or to programs that grant eligibility university studies after finishing high school. However, we note that graduates of the two programs where we find effects are among the lowest paid and have a slightly lower likelihood of finding a stable job upon graduation relative to graduates of other programs. Thus, our findings are in line with the interpretation that high school majors with poorer average job prospects become less attractive in economic downturns. Moreover, the decrease in top-ranked applications to the Hotel & Restaurant program is in line with responses to sector-specific shocks, and reflects that the decline in employment and vacancies was largest in the Accommodation & Food Services sector.³

We perform several sensitivity analyses to support our findings. First, we show that the main estimates are essentially unchanged when we estimate our model without school fixed effects or time-varying school-level controls, suggesting that changes in the desirability of schools are unlikely to bias our results. Second, we use our model to estimate whether the pandemic led to adjustments on the supply side. Supply-side adjustments may be rather limited given that we study the immediate effects of the crisis, but one motivation for Sweden’s two-step admission process is that schools have the possibility to adjust program capacity between rounds and can even remove programs from their offer list if necessary. Thus, we use the difference in the number of offered places per program between rounds as an outcome in order to show that distortions in the supply of available places do not explain our findings. There is also no evidence that distortions in the internship component of vocational programs explain our results.⁴

Our paper contributes to a large literature on how economic downturns affect human capital decisions. With regard to the length of education, there is ample evidence of the existence of a countercyclical pattern with regard to high school and college enrollment in the US and the UK, though the strength of the relationship varies widely (see, for instance, [Betts and McFarland, 1995](#); [Card and Lemieux, 2001](#); [Clark,](#)

² Despite differences in the design of education systems, all member states of the European Union offer possibilities for both general education and vocational education at the high school level. Out of all students who are enrolled in high school in the European Union, roughly 52% are enrolled in general academic programs, while 48% attend vocational tracks ([Eurostat, 2021](#)).

³ According to Statistics Sweden, employment in this sector reached a low in April 2020, shortly before final applications had to be submitted.

⁴ Our findings are robust to excluding applications to apprenticeship programs, which have a considerably higher share of on-the-job training.

2011; Rice, 1999). For Norway, Reiling and Strøm (2014) find that completion rates at the upper secondary level are countercyclical, in particular for students enrolled in vocational tracks. There is also a growing literature showing that students alter their choice of college majors to higher-paying fields when faced with a depressed labor market (Blom et al., 2021; Bradley, 2012; Liu et al., 2018). However, other studies find that sector-specific shocks can deter college students from generally well-paid or prestigious majors in the affected sectors (Han and Winters, 2020; Weinstein, 2022). Our study is one of the few that provides results for students who apply to vocational programs and generally come from families with a lower socioeconomic background.⁵ There is little direct evidence on how vocational field-of-study choices are affected with the exception of Acton (2021), who shows that local occupation-specific employment variations affect related field-of-study choices at the community college level and that students tend to switch between vocational programs that require similar skills.

The rest of the paper is structured as follows. Section 2 provides key institutional details about the Swedish school system, the two-step admission process that we exploit for identification, and the early impact of the COVID-19 crisis in Sweden. Section 3 describes our self-collected data and empirical model. Section 4 presents our main results, including a discussion of the parallel trends assumption. Section 5 reports several robustness checks of the main findings. Section 6 concludes the study with a discussion on the interpretation of our results and their policy relevance.

2. Institutional context

2.1. High school education in Sweden

In Sweden, compulsory schooling ends after ninth grade, when students are around 16 years old. All individuals who complete ninth grade are entitled to free high school education, and the vast majority choose to enroll even though it is not mandatory. High school education lasts for three years and is divided into programs that are either academic or vocational in nature. Table A.1 in the Appendix lists the 18 national programs that currently exist, though their availability differs somewhat across regions. There are 12 vocational programs (e.g., Child & Recreation, Vehicle & Transport, Hotel & Tourism), as well as six academic programs (e.g., Humanities, Natural Science, Social Science). Although vocational programs outnumber academic programs, overall enrollment is notably lower in vocational programs compared to academic programs. In total, the 12 vocational programs account for just one third of students enrolled in national programs.

The main difference between academic and vocational programs is the amount of theoretical versus practical content in the curricula. Academic programs primarily consist of theoretical courses and aim to prepare students for university studies. By contrast, vocational programs contain more practical content and aim to prepare students for specific occupations.⁶ Given their limited theoretical content, vocational programs do not automatically grant eligibility for university studies. However, students in vocational programs can elect to take certain theoretical courses in order to obtain the necessary qualifications for higher education. Many of the vocational programs are also offered as apprenticeship programs. Whereas ordinary vocational programs only contain a 15-week internship with an employer, at least half of the education in apprenticeship programs consists of on-the-job training in close co-

⁵ Since we do not have individual-level data, we cannot study heterogeneous effects by family background. However, we note that the programs in which we find significant effects typically attract applicants from relatively low socioeconomic backgrounds. For example, in the Hotel & Restaurant program, the average share with high-educated parents is about 40%, while the share is about 60% among all high school students.

⁶ In Table A.4 in the Appendix, we provide an overview of common industries for each vocational program.

operation between employers and schools. During our period of study (2016–2020), around 12% of students in vocational programs were enrolled in apprenticeships.

2.2. Admission to Swedish high school

In Sweden, individuals are eligible to apply to high school until age 20 as long as they have not yet completed a high school diploma. However, the standard practice is to apply at the end of compulsory school. Thus, most high school applicants in a given admission year—around 85%—are currently enrolled in the final term of ninth grade. The remaining 15% primarily consist of individuals who have applied in a previous admission year and are now submitting a new application, for example, because they want to transfer to a different program or because they did not get accepted to their desired program on their initial attempt.

By law, high school admission is strictly merit-based: with few exceptions, average grades from ninth grade are the only criteria used to admit students to programs. Regional admission centers are in charge of carrying out the admission process in accordance with national guidelines. In brief, the process works as follows. First, students submit their application to the admission center in the region where they reside. On the application, students choose specific program–school combinations that they would like to apply to, with each program–school combination listed in order of preference.⁷ After applications are submitted, a modified deferred-acceptance algorithm assigns students to the highest-ranked program–school combination for which they qualify based on their average grades from ninth grade.

A unique feature of the system is that the same application and admission procedure is repeated in two stages. First, there is a preliminary round in which prospective students submit a non-binding application and receive a non-binding admission placement. Second, there is a final round in which applicants can alter their preliminary choices before final admission placements are made. The purpose of repeating the procedure is twofold. On the one hand, students can gain insight into the chances of being admitted to certain programs and adjust their preferences if desired. On the other hand, schools can begin planning their resources for the upcoming school year and adjust program capacity if needed. We depict the standard timeline of the two-stage process in Fig. 2 and provide a more detailed description of the exact steps below.

The preliminary round starts in mid-January when the application system opens. Prospective students have until mid-February to submit an application with their initial preference rankings. After the application period closes, applicants are assigned to the highest-ranked program–school combination for which they qualify based on their current GPA from ninth grade.⁸ Thereafter, schools receive statistics about the preliminary number of applicants allocated to each program and decide whether to adjust program capacity before the final round.

The final round begins in mid-April. At this point, admission centers inform applicants which program–school combination they were allocated to during the preliminary round. In addition, they publish the minimum GPA required for preliminary admission to each program–school combination. After this information is released, there is a one-month period during which applicants have full flexibility to modify their preliminary application: they can add new choices to their original preference rankings, delete old choices, or re-order their current

⁷ Students can list programs and schools located outside their home region on the application. However, other regions have some discretion over how to handle these cases. Applicants from outside the home region are sometimes placed in a separate admission pool, and considered subject to availability after applicants who reside in the region have been admitted. These decisions are governed by local ordinances and agreements between regions.

⁸ If applicants have already completed ninth grade at the time of application, then their final grades from ninth grade are used in the preliminary admission round.

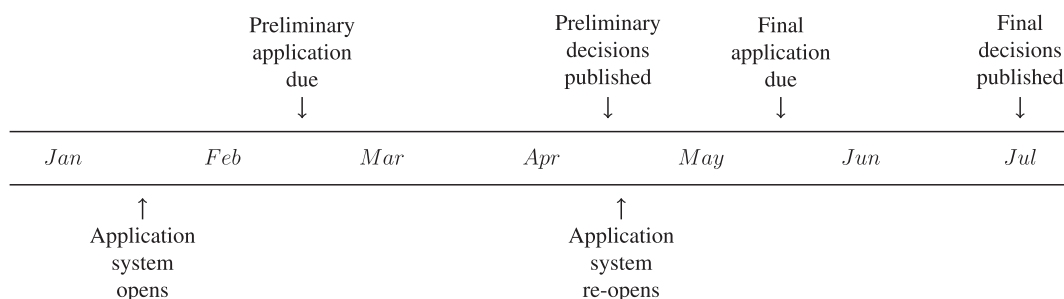


Fig. 2. Timeline of the high school admission process in Sweden. Notes: This figure depicts the standard timeline of the two-stage high school admission process in Sweden. Exact dates vary slightly by admission center, but all admission centers follow the same general timeline.

choices. Individuals who chose not to apply in the preliminary round also have the chance to apply during the final round. However, new applications are relatively rare: only 4–5% of final-round applicants do not submit preliminary choices.

Final preference rankings must be submitted by mid-May. Admission centers wait for compulsory schools to report ninth graders' final GPAs and then re-allocate students to a specific program–school combination on the basis of their final preference rankings and final GPA from ninth grade. Students who are allocated to one of their lower-ranked choices are listed as reserves for their higher-ranked choices. Final admission decisions are published around the end of June or beginning of July. Upon receiving the results, students must decide whether to accept the offered slot or whether they want to be considered for a program they are currently on the reserve list for. Slots that become available after the final admission round are re-allocated to students highest up on the reserve list.

If ninth graders end up earning insufficient grades to be eligible for admission to a vocational or academic program—i.e., if they end up failing mandatory courses—their home municipality must offer them remedial education so that they can obtain passing marks.⁹ These students can then re-apply to vocational or academic programs via the regular admission process the following year.

2.3. Early impact of COVID-19 in Sweden

Fig. 1 illustrates the evolution of COVID-19 cases and pandemic-related restrictions in Sweden during the early stages of the crisis. When high school applicants submitted their preliminary applications in mid-February 2020, there had been only one confirmed case of the new coronavirus in Sweden. The Swedish Public Health Agency's assessment was that the outbreak was predominantly contained in China and that the risk of community spread in Sweden was very low.¹⁰ However, the situation rapidly evolved from epidemic to pandemic, and by the time that high school applicants had to submit their final applications in mid-May, the outbreak and its consequences were highly salient.

Although international news outlets perceived the Swedish response as lenient, the government swiftly imposed a number of recommendations and restrictions after the World Health Organization declared that COVID-19 had become a pandemic. The first restriction was to limit attendance at public gatherings,¹¹ which was soon followed by social distancing measures, restrictions on foreign travel, and distancing requirements for restaurants. Furthermore, it was announced that high

⁹ The remedial education is offered in so-called “introductory programs” and may be provided at traditional high schools or special learning centers. Each student has an individualized study plan.

¹⁰ The Public Health Agency of Sweden, press release from February 13, 2020, “No spread of the new coronavirus in Sweden,” last retrieved February 9, 2023.

¹¹ The Public Health Agency of Sweden, press release from March 11, 2020, “Recommended restrictions: No public gatherings with more than 500 persons,” last retrieved February 9, 2023.

schools, colleges, and universities would shut down for on-site learning and switch to remote learning.¹² In early April, an even broader set of general restrictions were put in place, with far-reaching impacts on most aspects of daily life, for example, the public transit system, office work, retail stores, and sporting clubs.¹³

In addition to the effects on public life, the economic impact of the COVID-19 crisis quickly became evident in early 2020. Panel (a) of Fig. 3 shows that the arrival of the pandemic coincided with an unprecedented spike in the number of advance layoff notices. In March 2020 alone, over 40,000 notices were sent out. As seen in panel (b), almost one third of these notices were issued to employees working in Accommodation & Food Services. This is a remarkably high share, considering that this industry employed only 5% of the workforce at the end of 2019. Several other service-oriented sectors, most notably Administrative & Support Services, also experienced a sharp rise in layoff notices around this time (see Fig. B.1 in the Appendix). However, the increases are smaller in magnitude compared to the dramatic rise observed in Accommodation & Food Services, particularly when taking baseline employment into account.

Along with the increase in advance layoff notices came a sharp increase in the number of workers flowing into unemployment. Between mid-March and mid-May, around 60,000 additional workers were registered as unemployed compared to a decrease of 9,000 workers over the same time period in the previous year (Hensvik and Skans, 2020). Table A.2 in the Appendix shows that workers in search of a job faced dire prospects as the number of vacancies decreased by 15% and 53% in the first and second quarter of 2020, respectively, compared to the corresponding quarters in the previous year. Similar to the data on advance layoff notices, the service sector again stands out as the hardest hit, in particular Accommodation & Food Services, Transportation & Storage, and Arts, Recreation & Other Services.

3. Data and empirical framework

The aim of this paper is to analyze whether high school applicants in Sweden altered their program choices in response to the COVID-19 pandemic. The popularity of certain programs would likely vary across cohorts even in the absence of the pandemic; thus, simply comparing the level of applications in a post-pandemic year to the level of applications in a pre-pandemic year might be misleading. Instead, our empirical approach exploits a feature of the application process that allows students to submit preliminary preference rankings for different programs by mid-February and to alter their choices by mid-May. In 2020, the timeline of this two-step process happened to provide pre- and post-

¹² The Public Health Agency of Sweden, press release from March 17, 2020, “Switch to distance learning at universities and high schools,” last retrieved February 9, 2023.

¹³ The Public Health Agency of Sweden, press release from April 1, 2020, “New general guidelines: Keep distance and take personal responsibility,” last retrieved February 9, 2023.

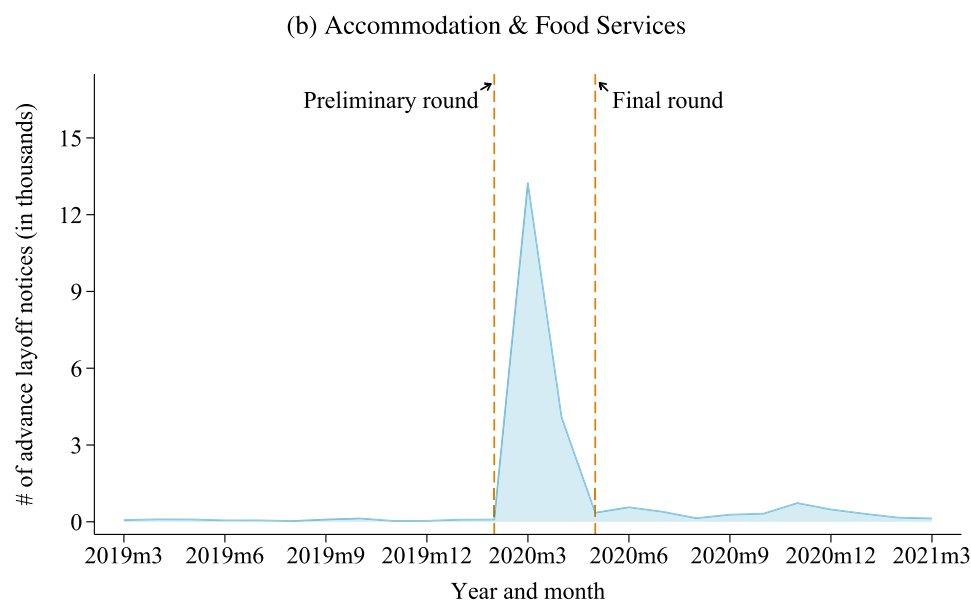
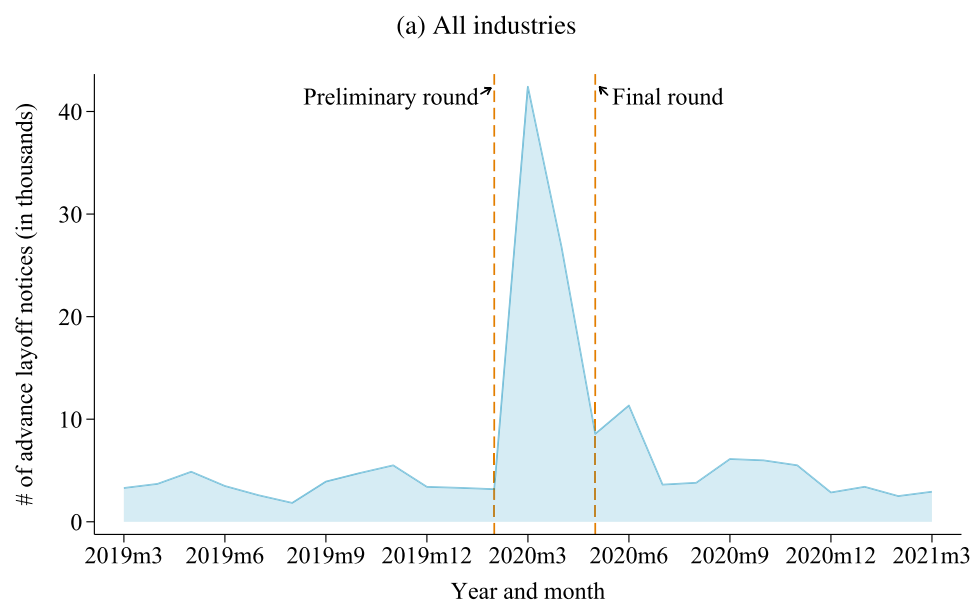


Fig. 3. Number of advance layoff notices per month, March 2019–2021. Notes: Data comes from the Swedish Public Employment Service and is measured at the monthly level. The dashed vertical lines indicate the approximate date that preliminary-round and final-round high school applications were due in 2020.

crisis snapshots of applicants’ program choices. We can therefore capture the immediate effect of the pandemic by estimating how the change in demand between the rounds in 2020 differs from the change in demand between the rounds in 2019. The advantage of this difference-in-differences approach is that we control for other factors in society that could affect applicants’ preference ranking of high school programs but which are not associated with the pandemic.

An important practical issue is that our identification strategy requires data from both the preliminary and final admission rounds each year. However, the Swedish National Agency for Education only collects data on final-round applications. To overcome this issue, we contacted all high school admission centers in Sweden and requested information on preliminary- and final-round applications for the year 2020, as well as several years prior to the pandemic. Although the admission centers could not provide individual-level data, the majority were able to provide school-level information on the number of applications to each specific program for both admission rounds. Our ensuing data set includes around 3,000 school and program combinations each year, cover-

ing more than 80% of schools and almost 90% of applicants nationwide (see Fig. 4). We have remarkable geographical coverage, with data from both rural and urban areas, including the three biggest cities in Sweden (Stockholm, Gothenburg, and Malmö) as well as remote areas in the north.¹⁴

¹⁴ We document the data coverage in more detail in the Appendix. Fig. B.2 plots the number of schools and program–school combinations each year, while Table A.3 provides descriptive statistics per program in the baseline year, including the number of schools, municipalities, and applicants, as well as the share of applicants nationwide that we cover with our self-collected data. In Table A.5, we also show descriptive statistics of grade nine students in the municipalities that our data covers and for those we do not cover. In most important respects, the characteristics of the grade nine students in non-covered municipalities are not significantly different from those we cover. However, the non-covered municipalities have slightly better employment opportunities for youth and higher share of grade nine students with Swedish background, in comparison to the municipalities that we cover in our data.

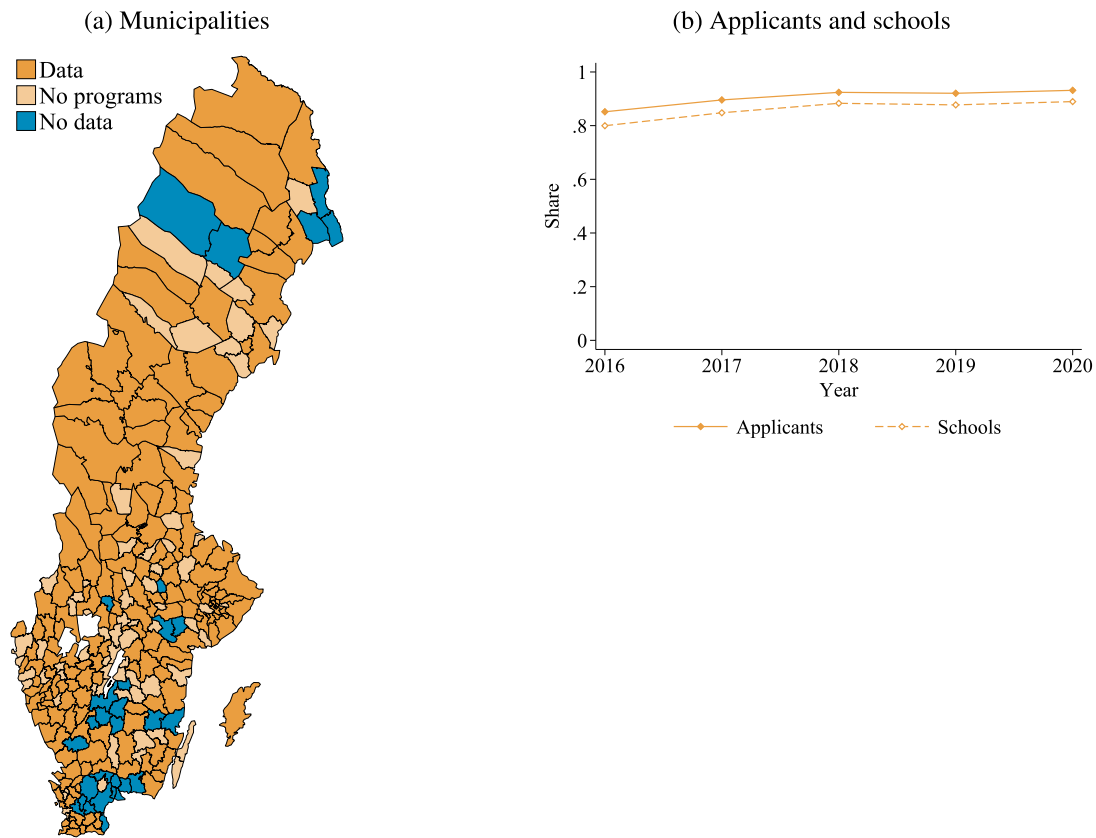


Fig. 4. Coverage of collected data. Notes: In the map in panel (a), all municipalities that are fully or partially covered by our data are shaded in dark orange. Municipalities without high school programs are shaded in light orange. Municipalities for which we were unable to obtain data are shaded in blue. In panel (b), the solid (dashed) line plots the share of final-round applicants (schools) that we cover nationwide for each year in our sample.

Importantly, even though we do not have individual-level data, we observe the number of applicants who list a specific combination of program and school as the top choice on their application in each admission round. We use this information to measure what we call the *change in demand for a program*. For ease of exposition, we aggregate together several closely related programs,¹⁵ and calculate the following outcome for each pooled program p :

$$\Delta Demand_{psy} = FinalApplications_{psy} - PreliminaryApplications_{psy} \quad (1)$$

where $FinalApplications_{psy}$ denotes the number of applicants who list program p at school s as the top choice on their application in the final round in admission year y , and $PreliminaryApplications_{psy}$ denotes the same number for the preliminary round. The outcome $\Delta Demand_{psy}$ thus measures how the demand for program p changed between the preliminary and final round, with positive values indicating increased demand.

In order to study the effect of the pandemic on program demand, we regress $\Delta Demand_{psy}$ —separately by program—on a set of time dummies (δ_y), school fixed effects (γ_s), and time-varying school characteristics (X_{sy}) that might affect the desirability of different schools. More specifically, our regression model has the following form, with the error term denoted by ϵ_{psy} and standard errors clustered at the school level

¹⁵ We aggregate programs that are closely related in terms of curriculum and/or occupational trajectory. See Table A.1 and the discussion in Appendix C for more detail. Note that our results are not sensitive to alternative methods of aggregating or pooling the data (results available upon request) or running the regressions separately by program (see Table B.4 in the Appendix).

for inference:

$$\Delta Demand_{psy} = \alpha + \sum_{y=2016}^{2018} \delta_y + \delta_{2020} + \gamma_s + \beta X_{sy} + \epsilon_{psy}, \quad (2)$$

Our parameter of interest, δ_{2020} , measures the difference in demand for program p between the two rounds in 2020 compared to the difference in demand between the two application rounds in the baseline year 2019. It captures the immediate causal impact of the pandemic, under the standard difference-in-differences assumption that the difference in the number of applications between the final and preliminary round would have been the same as in previous years in the absence of the pandemic. The inclusion of $\sum_{y=2016}^{2018} \delta_y$ allows us to estimate the same difference in previous years in the absence of the pandemic and test the plausibility of this assumption. If the estimates for these years differ from zero, the estimate for year 2020 is less reliable. We report the results of this exercise in Section 4.3 after discussing the main results.

In order to increase the plausibility of the parallel trends assumption, we include school fixed effects (γ_s) to control for local time-constant differences that might affect program demand between the rounds. We also include a vector of time-varying school-level characteristics of students and staff (X_{sy}) in order to account for the fact that changes at the school level could explain part of the variation in the change of the popularity of programs. To that end, we combine our self-collected data with information from the Swedish National Agency for Education on school-level characteristics that might affect the desirability of a school. The characteristics of the student body at school s include the share of female students, the share of students with a foreign background, and the share of students with highly-educated parents, and the characteristics of the staff at school s include the share of certified teachers and the student-

teacher ratio. We provide more detail on the definition of the control variables in [Appendix C](#).

3.1. Mechanisms for program changes between rounds

We want to capture how program demand changed between the preliminary and final rounds due to the arrival of the pandemic. To that end, our outcome variable $\Delta Demand_{psy}$ measures the change in top-ranked applications to each program between the two rounds. If it were mandatory to apply in the preliminary round, then these changes should sum to zero across all programs and schools. However, a small share of applicants—around 4 to 5%—do not submit an application until the final round. Thus, $\Delta Demand_{psy}$ captures several different sources of variation:

- (i) switches out of a program: applicants who initially ranked program p at school s as their top choice in the preliminary round but changed their top-ranked choice in the final round or withdrew their application entirely,
- (ii) switches into a program: applicants who ranked a different program and/or school as their top choice in the preliminary round but ranked program p at school s as their top choice in the final round,
- (iii) applicants who did not submit any application in the preliminary round but decided they wanted to attend program p at school s in the final round.

It is possible that the pandemic affected each of these channels. Below, we outline the possible drivers behind these changes.

One possibility is that students who applied during the preliminary admission round shifted their program preferences in response to the COVID-19 outbreak. A likely explanation with support in the literature is that students adjusted their expectations about the labor market prospects of certain fields of study in response to the economic fallout due to the pandemic. However, we cannot exclude the possibility that changes in applications could have been influenced by (true or perceived) supply-side considerations. While there is no evidence that schools changed the programs on offer between the preliminary and final rounds,¹⁶ there was a lot of uncertainty about how the pandemic would affect firms' ability to organize the practical training that is included in all vocational programs. For instance, there was uncertainty whether training in facilities such as retirement homes could take place during the pandemic. Students who anticipated such supply-side disruptions might have consequently chosen to opt out of programs with a higher likelihood of disruptions in the practical training. We conduct several robustness checks to try to rule out this supply-side channel in [Section 5.2](#).

Another possibility is that the pandemic altered the study preferences and application behavior of students who were already enrolled in a high school program. For example, students in programs that were hit hard by the pandemic might have wanted to switch to programs with better labor market prospects. Additionally, there might be students who in the absence of the pandemic would have applied to another program but decided to stay in their current high school program due to changed prospects. Unfortunately, our data does not allow us to differentiate between applicants who were applying to high school for the first time and applicants who were re-applying to a new school or program. However, official aggregate statistics at the national level indicate that the share of students who were still in their last year of compulsory school at the time of application was very stable over our study period, particularly between years 2019 and 2020 (see [Fig. B.3](#)).

A final possibility is that the pandemic may have influenced students' decisions to attend high school. Since it is not mandatory to apply in the preliminary round, even if this is the standard and recommended practice, there are students who only apply in the final round and who thus

do not contribute to preliminary round statistics. Our data reflects this fact, showing that the number of applications is always slightly higher in the final round as compared to the preliminary round. Another potential change in the number of final-round-only applications to a certain program could therefore reflect that students who did not submit a preliminary application were deterred from applying at all (if there was evidence of a decline in applications) or that students who would not have applied at all were induced to apply (if there was an increase in applications). Note that this potential explanation behind a change in number of applications is not in conflict with our identification strategy as long as the trends in preliminary- and final-round applications would not have been different in the absence of the pandemic.

4. Results

This section presents evidence on how the early stages of the COVID-19 pandemic affected students' demand for different high school programs. In [Section 4.1](#), we start by discussing some descriptive trends in the number of preliminary- and final-round applicants over our study period. Next, [Section 4.2](#) discusses our formal difference-in-differences estimates of the immediate effect of the pandemic on program demand. Finally, we evaluate the parallel trends assumption underlying our main model in [Section 4.3](#) using a difference-in-differences event-study setup.

4.1. Descriptive trends in demand for programs over time

[Fig. 5](#) shows the program-specific trends in the total number of first-choice applicants between 2016 and 2020. There are some general observations to make. First, there is considerable variation in how popular the different vocational programs are as measured by the number of applicants. Second, the trends are upward-sloping in the earlier years due to increasing cohort sizes and the fact that we have better coverage of applicants in the later years.¹⁷ Importantly, however, we have both preliminary and final round data for each program within a school for all years. Hence, we can conclude that the trends in applicants in both rounds seem to follow each other very closely until 2019 in most of the programs.

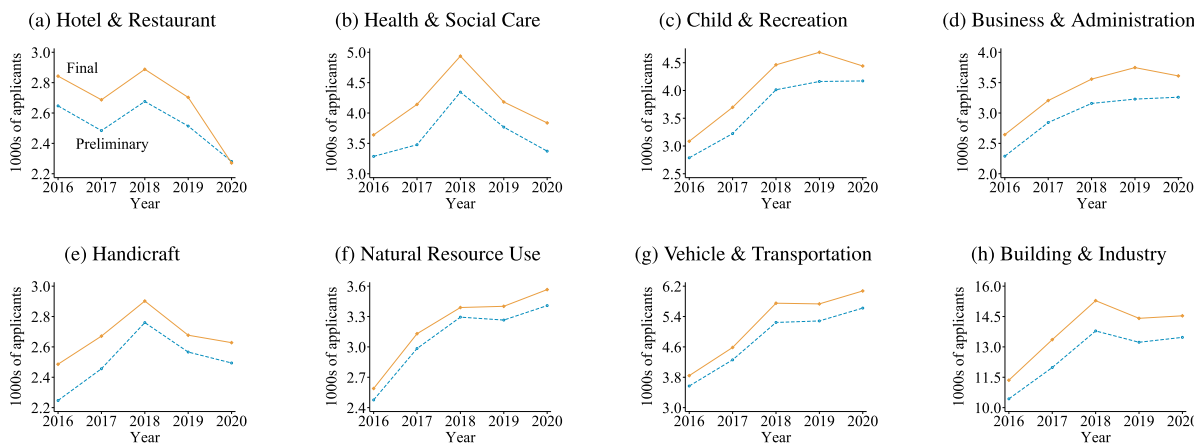
The trends in [Fig. 5](#) are indicative of a change in patterns in 2020. Within service-oriented programs, most notably the Hotel & Restaurant program and the Child & Recreation program, first-choice applications appear to have increased less between the preliminary and final round as compared to previous years. The decrease in demand for the Hotel & Restaurant program is particularly striking: it is the only program in which the number of applications in the final round is even lower than the number of applications in the preliminary round.

While the trends in the number of preliminary- and final-round applications evolve in a relatively parallel fashion in most of the programs, in some of the vocational programs we see slightly diverging trends in the earlier years. To understand these patterns, it is important to point out that, in 2017 and 2018, there were changes in the regulations for obtaining a residence permit for minors arriving in Sweden. Under the new regulations, minors who arrived prior to the end of 2015 and whose asylum application had previously been declined could be granted temporary asylum if they were enrolled in high school and fulfilled certain other requirements. The first of those laws was passed in May 2017, shortly before final applications had to be submitted in that year. It is likely that the increase in applicants in 2017 and 2018 can be (partly) explained by the large number of young, mainly male refugees who tried to gain asylum. The effect is most notable in the Health & Social Care

¹⁶ See the discussion on how the COVID-19 outbreak affected the number of available places per program in [Section 5.2](#).

¹⁷ We have cross-checked the final-round trends in our sample of municipalities with the final-round trends in nationwide public-use data and verified that they are quite similar. Results are available upon request. We cannot perform this exercise for the preliminary-round data because the Swedish National Agency for Education does not collect any data on preliminary-round applications.

Panel A: Vocational programs



Panel B: Academic programs

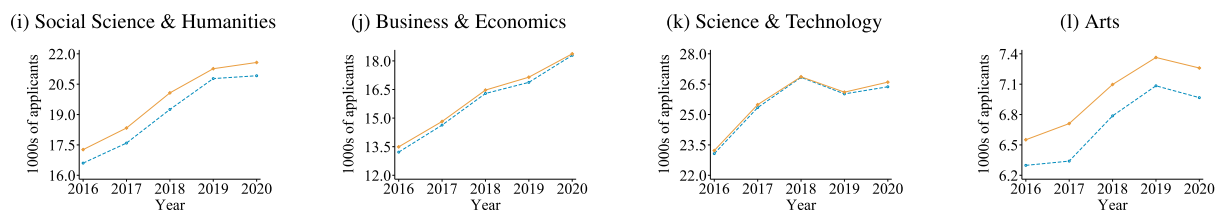


Fig. 5. Trends in number of first-choice applicants by program in preliminary and final rounds. Notes: The solid orange (dashed blue) line plots the number of applicants who rank a given program as their top choice in the final (preliminary) round.

program. Official statistics from the Swedish National Agency for Education on applicants nationwide show that the increase in applicants to this program coincides with a decrease in (mainly male) applicants who met admission requirements.¹⁸

4.2. Estimated effect of the pandemic on program demand

The trends in the number of applicants per program in Fig. 5 indicated that the arrival of the pandemic to Sweden in spring 2020 might have altered the demand for different high school programs. Formally, we analyze the impact of the pandemic on field-of-study choices by estimating the difference-in-differences specification in Equation 2. In Fig. 6, we display the estimate of interest, δ_{2020} , and corresponding 95% confidence intervals for each program.¹⁹ As described in Section C1, we pool programs that are closely related in terms of curriculum and/or occupational trajectory.²⁰ Each program-specific estimate shows the effect of the COVID-19 pandemic in 2020 on the demand for the indicated program.

The demand for most of the high school programs did not change due to the pandemic. However, we see a decrease in demand for some of the service-related sectors that were vulnerable to the pandemic early on. Most notably, we see a striking decrease in demand for the Hotel & Restaurant program. The point estimate implies that the pandemic led to a decrease of 1.5 applicants per school between the rounds, which

¹⁸ The share of applicants who met admission requirements for Health & Social Care decreased from 66% in 2016 to 60% in 2017 and 55% in 2018. The decrease in applicants who met admission requirements was most pronounced among male applicants, from 60% who met requirements in 2016 to 51% in 2017 and 43% in 2018 (Source: The Swedish National Agency for Education).

¹⁹ The corresponding point estimates are also displayed in Table 1, Column 4.

²⁰ For completeness, Fig. B.4 in the Appendix displays the results for each of the 18 national programs individually. The main findings are unchanged in these unpooled estimations.

corresponds to a decrease of 8% in relation to the mean number of applications to the program.²¹ If we compare the decreased demand for the program to the usual change between preliminary- and final-round applications, we find a decrease in demand above 100% compared to the usual change between the application rounds (see Table 1 for the mean changes between the rounds). In addition to the effect on the Hotel & Restaurant program, we also find significant effects on demand for the Child & Recreation and Business & Administration programs. In the Child & Recreation program, top-ranked applications decreased by 1.7 applications per school (roughly 6% in relation to the mean number of applicants) as compared to the previous year. The decrease for the Business & Administration program was slightly weaker at 1.1 applications per school (roughly 5% in relation to the mean number of applicants).

We note that all of the affected programs were related to some of the least resilient occupations in terms of reduced labor demand at the start of the pandemic, for example, waiters and bartenders, food preparation assistants, shop staff, fitness instructors, and recreational workers (Hensvik et al., 2021). However, we acknowledge that other factors besides labor market considerations may be at play. We discuss the robustness of these results, alternative explanations, and the interpretation of the effects more thoroughly in the robustness section and concluding discussion.

Interestingly, we do not observe that the decrease in top-ranked applications to the above-named vocational programs is mirrored by an increase in applications to other vocational programs. One possibility is that the students who opted out of the above-named vocational programs chose to enroll in academic programs instead. If students believed that the crisis would have a persistent negative effect on the labor mar-

²¹ A closer look at the non-aggregated results in Fig. B.4 in the Appendix shows applications to both the Hotel & Tourism and the Restaurant Management & Food program declined, though the estimate for Restaurant Management & Food is smaller in size and only significant at the 10% level (P-value 0.077).

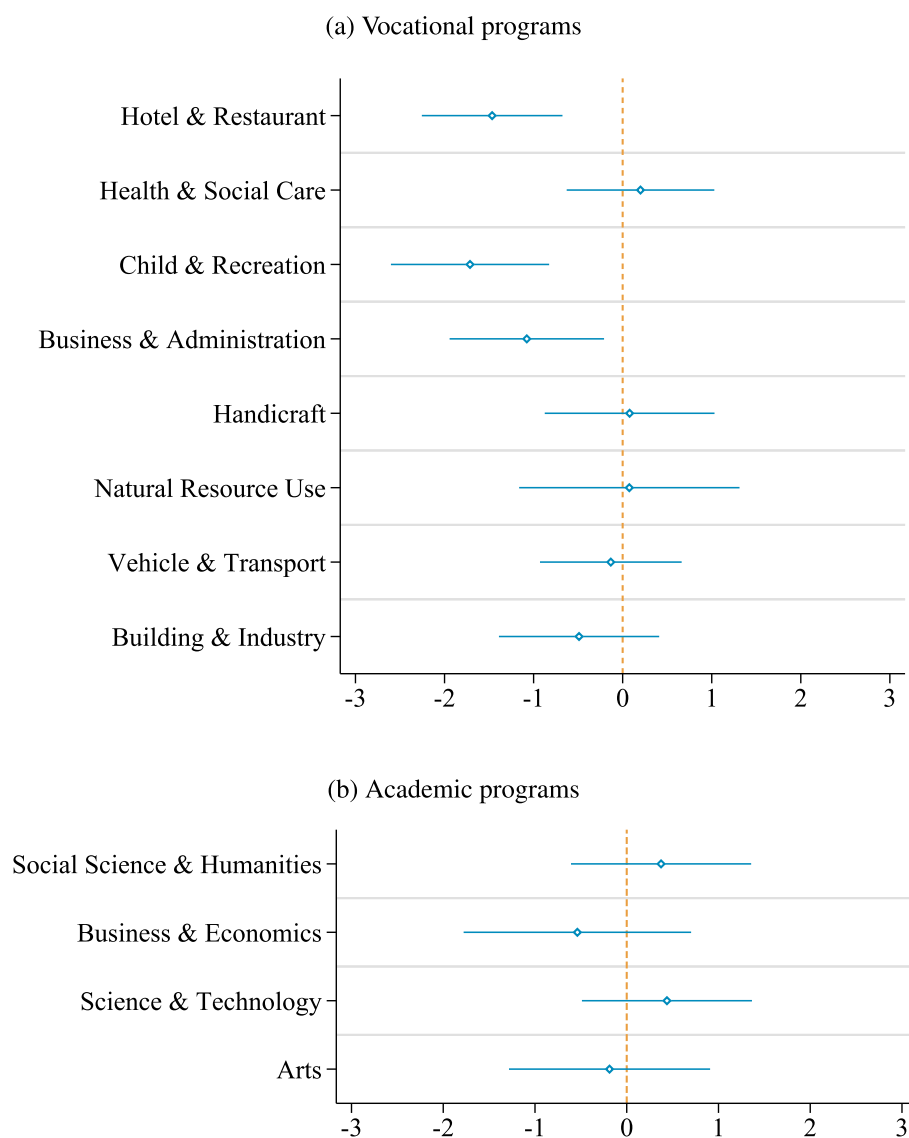


Fig. 6. Estimated effect per program, first-choice applicants. Notes: The regression specification controls for school fixed effects and time-varying school-level controls. The horizontal lines show 95% confidence intervals with standard errors clustered at the school level.

ket, more students might have opted for academic preparatory programs rather than vocational programs, as higher education is often perceived to offer better career prospects during a depressed labor market and allows students to postpone labor market entry during bad times. However, the results for the academic programs in Fig. 6b show that the declines in applicants are not compensated by systematic shifts towards any of the academic programs: none of the estimated effects for these programs are significantly different from zero.

The fact that the program-specific declines in applicants are not compensated by significant increases in other programs suggests that shifts towards other programs are not systematic and therefore too small to be picked up by our method. However, we also note the possibility that the decline in applications between the preliminary and final round is (at least partly) driven by undecided students who did not submit a preliminary application. Moreover, it is possible that high school students, who would have in the absence of the pandemic re-applied to another program, now decided to remain in their original program as certain sectors became more uncertain.²² This is in line with the fact

that we observe a slight decrease in the overall number of applications between rounds in 2020 relative to the base year (see Table C.2 for number of applications per round across the years). Note that these explanations are not in conflict with our identification strategy as long as the change between the rounds would have been the same in the absence of the pandemic. We test the plausibility of this assumption in the next section.

4.3. Assessing the parallel trend assumptions

Our main difference-in-differences model relies on the assumption that the change in top-ranked applications between the preliminary and final round would have evolved similarly in the absence of the pandemic. In order to assess the plausibility of this parallel trends assumption

year 2020 for Stockholm county: only 3.93% of final-round applicants did not submit an application in the preliminary round, and almost all applicants who waited until the final round to submit an application (96.16%) were currently enrolled in high school. This suggests that re-application to transfer to a new high school program is an important source of variation for our identification strategy, although changes in preferences between the rounds are relatively more common than new applications and should thus drive most of our results.

²² There is no official nationwide data on preliminary applications at the individual level, which means we cannot identify the characteristics of final-round-only applicants. However, we were able to obtain some summary statistics from

Table 1
Robustness checks for the main results.

	Specification checks				
	No controls or FEs (1)	Only school controls (2)	Only school FEs (3)	School FEs + controls (4)	Excluding apprentices (5)
Panel A: Vocational programs					
Hotel & Restaurant	-1.383*** (0.409)	-1.403*** (0.413)	-1.466*** (0.405)	-1.465*** (0.400)	-1.323*** (0.454)
Health & Social Care	0.333 (0.411)	0.214 (0.426)	0.221 (0.415)	0.200 (0.420)	0.279 (0.473)
Child & Recreation	-1.512*** (0.431)	-1.566*** (0.450)	-1.656*** (0.436)	-1.714*** (0.450)	-1.971*** (0.508)
Business & Administration	-0.949** (0.435)	-1.067** (0.438)	-1.098** (0.441)	-1.076** (0.440)	-1.177** (0.538)
Handicraft	0.205 (0.466)	0.223 (0.476)	0.117 (0.475)	0.078 (0.483)	0.167 (0.582)
Natural Resource Use	0.349 (0.630)	0.201 (0.661)	0.081 (0.605)	0.075 (0.624)	0.006 (0.670)
Vehicle & Transport	0.017 (0.397)	0.066 (0.403)	-0.099 (0.401)	-0.133 (0.403)	-0.088 (0.494)
Building & Industry	-0.358 (0.473)	-0.301 (0.471)	-0.490 (0.456)	-0.490 (0.457)	-0.448 (0.488)
Panel B: Academic programs					
Social Science & Humanities	0.353 (0.486)	0.284 (0.486)	0.362 (0.494)	0.374 (0.500)	N/A
Business & Economics	-0.645 (0.609)	-0.621 (0.613)	-0.651 (0.627)	-0.538 (0.630)	N/A
Science & Technology	0.311 (0.454)	0.323 (0.456)	0.355 (0.465)	0.438 (0.472)	N/A
Arts	0.008 (0.539)	-0.063 (0.602)	-0.156 (0.549)	-0.187 (0.556)	N/A

Notes: Each row reports the estimate of δ_{2020} for a particular program and model specification. The results from the main model (Equation 2) are in column 4. In square brackets, we list the average outcome in the baseline year 2019, as well as the number of observations for each regression (Obs_{1-4} for columns 1 to 4 and Obs_5 for column 5). Standard errors are clustered at the school level and shown in parentheses. Significance levels are denoted with stars: *** for $p < 0.01$, ** for $p < 0.05$, and * for $p < 0.10$.

tion, we analyze the impact of the pandemic on study choices in the years prior to the pandemic. We obtain a parameter estimate of the difference in applicants between the preliminary and final round for each sample year (2016–2018 and 2020) relative to our base year (2019). For ease of exposition, we only display the parameter estimate for 2020 in Fig. 6, which captures the effect of the COVID-19 pandemic on the demand for a specific program. In Fig. B.5 in the Appendix, we display event study plots of the full set of the δ -estimates, which measure the difference in applicants between the rounds for each sample year relative to base year 2019. If the parallel trends assumption holds, we would expect the estimates prior to 2019 to be close to zero.

In support of our main results, we see no evidence of diverging trends in the difference of top-ranked applications between the two rounds for the Hotel & Restaurant and Child & Recreation programs: the estimates of δ_y are very close to zero in all years prior to 2019. However, for the Business & Administration program, the point estimates are consistently below zero. Although they are not statistically significant, the pattern suggests that the result could be sensitive to the choice of base year. Indeed, if we look back to Fig. 5d, we notice that the difference in 2020 is rather similar to the other pre-pandemic years between the two rounds, while in 2019, there seems to be a slight increase in final-round applications relative to the other years. This pattern could be driven by different recruitment and application patterns leading up to a structural change in the program that was already under discussion prior to 2020 (see further discussion in Section 5.2). For several of the other vocational programs (e.g., Health & Social Care and Building & Industry), some of the pre-pandemic estimates are statistically different from the base year estimate. For years 2017 and 2018, one possible explanation is the increase in the number of applications by young male refugees (see discussion in Section 4.1), who were mainly directed towards the Health & Social Care program.

5. Robustness

5.1. Model specifications

In our main specification in Equation 2, we include school fixed effects and time-varying school characteristics in order to control for differences in the desirability of schools. In practice, it is reassuring that the inclusion of these characteristics has little impact on our estimates. This is illustrated in Table 1, which shows how our estimate of interest changes as we start out with a baseline difference-in-differences specification without any controls or fixed effects (Column 1) and step-wise introduce additional covariates (Columns 2–3) until we arrive at our preferred specification in Equation 2 (Column 4).

Instead of exploiting variation within the same school (and program) over rounds and time, the identifying variation in the uncontrolled specification (Column 1) stems from differences between rounds and programs across schools. Reassuringly, the results for all programs are very similar to the ones obtained in our main specification. In Column 2, we see that the introduction of school-level controls has little impact on our estimates. If anything, the inclusion of the controls only leads to a slight increase in magnitude of the results in the programs that we found were affected by the pandemic, suggesting that changes in the desirability of schools are of only little concern for our estimation strategy. In Column 3, we instead include school fixed effects, such that the identifying variation stems from changes within schools over time. Again, the point estimates for all programs are essentially unchanged.

5.2. Supply-side distortions

A potential concern for our interpretation of the results would arise if a decline in applicants would reflect supply-side changes (due to the

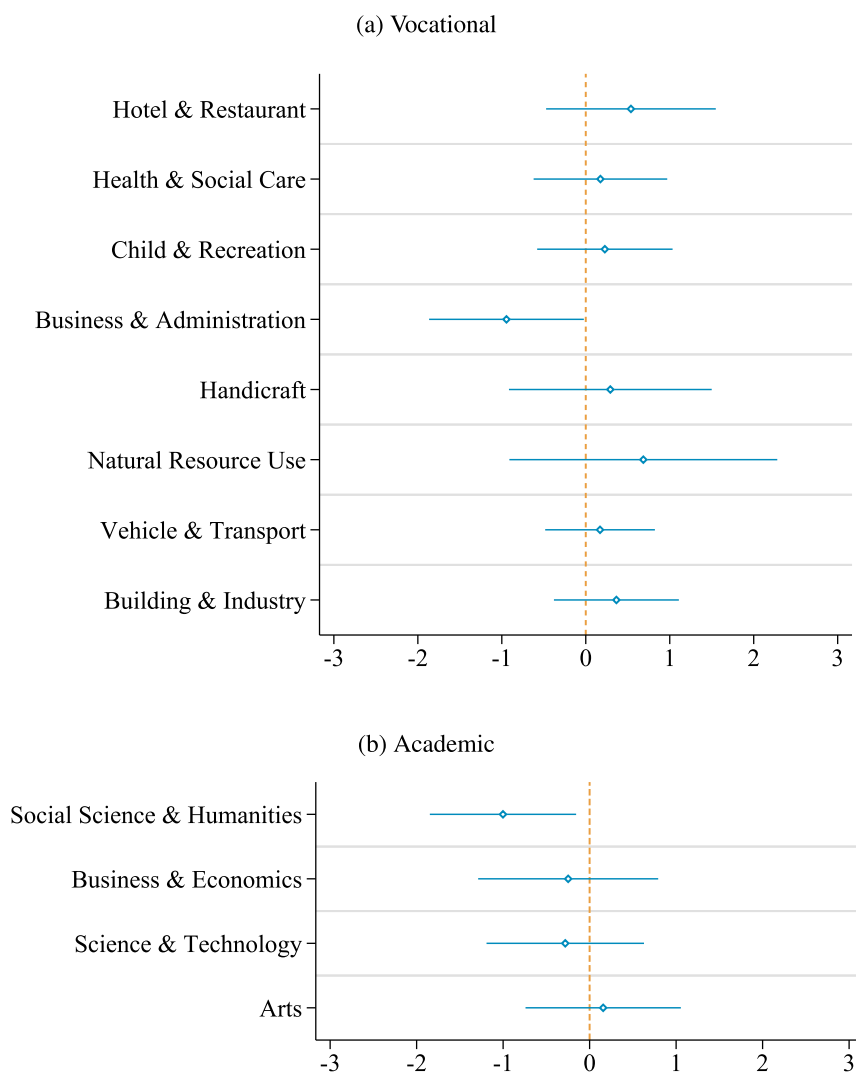


Fig. 7. Estimated effect on the number of available places per program. Notes: Each point plots the estimate of δ_{2020} from a modified version of Equation 2—run separately by program—in which the dependent variable is equal to the change in the number of available places ($\Delta Places_{psy}$). The horizontal lines show 95% confidence intervals with standard errors clustered at school level.

pandemic) rather than changes in the demand for programs. For instance, students might have altered their program choices due to concerns about whether on-the-job training could take place during the pandemic. The COVID-19 outbreak likely put limits on the provision of on-the-job training due to both economic and health concerns connected to taking on new personnel. This was likely a bigger concern in programs that require close contact between individuals, such as Child & Recreation, where on-the-job training includes close contact with children and social distancing is difficult. Such considerations should be even more relevant for so-called apprenticeship programs that are organized in close collaboration with employers and where a much larger share of the education (around 50%) consists of on-the-job training. About 12% of the programs in our data are apprenticeship programs.

In order to test whether our results could be driven by real or perceived limitations in available apprenticeship slots, we re-estimate our main results for all vocational programs after excluding apprenticeship programs.²³ The results without these programs are shown in Column 5 of Table 1. The effects are very similar to our main results and confirm the existence of a negative effect on the popularity of the Hotel

& Restaurant and Child & Recreation programs. Thus, these results do not appear to be driven by supply-side considerations with regard to the feasibility of apprenticeships programs during the pandemic.

Supply-side distortions could also arise if (perceived) changes in demand for certain programs led to expansions or contractions in the number of offered places. In the case of the pandemic, it is possible that schools reacted to anticipated changes in demand and/or tried to steer students towards or away from certain programs by adjusting the number of available places. Supply-side adjustments would likely be a bigger concern if we were looking at enrollment instead of applications, or if we were analyzing the longer-term effects of the pandemic after schools had more time to react. However, it is still possible that knowledge about changes in the availability of places had an effect on students' application decisions. Thus, a likely scenario that would affect the interpretation of our results would occur if students changed their program choices as they, rightly or wrongly, believed that adjustments in the number of available places affected the likelihood of being admitted to certain programs.

We can address this concern by using our difference-in-differences strategy to estimate how the COVID-19 pandemic affected the number of available places within a program between rounds. To be precise, we estimate Equation 2 using the difference in the number of available places per program, $\Delta Places_{psy}$, as the outcome. The results are displayed in Fig. 7.

²³ Since apprenticeship programs account for only 12% of all programs, we do not have enough precision to investigate the effect on apprenticeship programs separately.

There is no indication that changes in the availability of places can explain the decline in top-ranked applications to the Hotel & Restaurant or Child & Recreation programs. The point estimates are not statistically significant and slightly positive, suggesting that there is no evidence of a reduction of places in these programs. The only estimate that stands out is the estimate for Business & Administration, which points to a decrease of 0.94 available places per school. The estimates for the other vocational programs are generally small and clearly insignificant. Moreover, they mainly point to a slight expansion of places, which is unlikely to have a negative impact on applications and would point towards under- rather than overestimating our main results.

In the case of Business & Administration, we find that the significant result is driven by a small portion of schools offering orientation to Administration.²⁴ When these schools are removed, we find no effect on the number of places even for the Business & Administration program (see Fig. B.6). The orientation to Administration was removed in fall 2022 but the decision about this change was made in June 2020 and under discussion early on, even in the year prior to the pandemic. Thus, it is possible that municipalities adjusted the number of places already in spring 2020 in anticipation of the change.²⁵

The only academic program that appears to be affected by supply-side changes is the Social Science & Humanities program, for which we see a very slight reduction in available places of -0.9, corresponding to a decrease of less than 2% in relation to the mean number of places. Given the small and insignificant point estimate on the change in number of applications in Fig. 6b, the slight reduction in available places is unlikely to be of economic importance.

6. Concluding discussion

We document that the COVID-19 outbreak led to an immediate decrease in high school applicants' demand for several vocational programs that were vulnerable to the pandemic in some dimension. The decrease in demand is particularly striking for the Hotel & Restaurant program, which prepares students for occupations in the Accommodation & Food Services industry. Incidentally, this is the industry in which labor market prospects were most negatively affected during the pandemic, and in which pandemic-related restrictions were highly salient and likely to bind. The negative effect on demand for this program is thus consistent with the interpretation that students respond to sector-specific changes in labor market conditions when choosing their field of study.

In addition, there is robust evidence of a decline in demand for the Child & Recreation program. The reduced demand for this program is also in line with reduced labor demand in related sectors. For example, students who specialize in the Recreation track often work in swimming complexes, sports and recreational facilities, or as personal trainers, and evidence on job postings indicates that athletes, fitness instructors, and recreational workers were among the least resilient occupations in early 2020 (Hensvik et al., 2021). However, we acknowledge that occupations in other industries closely related to this program were not as hard hit, and it is possible that some factor besides labor market conditions contributed to the decline in demand. One possibility is that students wanted to avoid programs and occupations that they perceived to have

²⁴ Most programs have more specific orientations within the program, but the choice is usually made in the second year (and hence not available for us to see in the application data). In the case of Business & Administration, there are two different orientations to choose from.

²⁵ It should be noted that when we exclude schools with the orientation to Administration an effect on top-ranked application still remains (see Fig. B.6). Hence, the decline in demand is not driven by supply-side distortions. Since 2022, the program is known as the Sales & Service program.

relatively higher health risks, for example, increased risk of infection due to close contact with children.²⁶

Interestingly, we do not find any evidence of systematic shifts towards academic programs that grant eligibility to university studies or towards vocational programs with higher annual earnings. However, we note that students who graduate from the Hotel & Restaurant and Child & Recreation programs are among some of the lowest-paid high school graduates, and have a relatively low likelihood of finding a stable job within three years of graduation (see Table A.4). Thus, our findings suggest that high school majors with poorer average job prospects become less attractive in economic downturns.

The fact that we find any change in demand for programs is remarkable given that we study the early stages of the pandemic. While the majority of programs were unaffected, applicants to programs with worsening labor market prospects reacted quickly at a time when there was little certainty about the long-term economic impacts of the pandemic. An open question is whether these immediate shifts in program choices will last or whether students might gravitate back to hard-hit industries. Our identification strategy is not well suited to evaluate the longer-term effects of the pandemic,²⁷ but we can shed some light on this question by providing descriptive evidence on how final-round applications to different programs changed in 2021 relative to our base year 2019.

In line with our main findings, Fig. 8 shows that the demand for several service-oriented programs, in particular the Hotel & Restaurant program, was still well below pre-pandemic levels one year into the COVID-19 crisis. These service-oriented programs were already struggling to recruit candidates prior to the pandemic, and based on our results, it seems likely that the crisis has accelerated the decline in the attractiveness of these programs and occupations in related industries. These trends are particularly concerning for the Accommodation & Food Services sector. At the same time as travel restrictions have been relaxed and tourism in Sweden has hit record levels (Tillväxtverket, 2022), hotels and restaurants are struggling to find experienced employees to meet the high demand in the industry.²⁸ Previous research suggests that this is partly driven by reduced job search (see, e.g., Hensvik et al., 2021 for evidence from Sweden) and by experienced workers switching to higher-paying occupations (see, e.g., Forsythe et al., 2022 for evidence from the US). Our results point to yet another channel that may exacerbate labor market frictions in the years to come: students' decreased interest in lower-paid, service-oriented occupations at the critical time when field-of-study choices are first made, and consequently, lower supply of graduates with relevant skills going forward.

In order to counteract negative trends in hard-hit industries, policy-makers could consider measures to boost the popularity of related fields of study. Generally speaking, our findings highlight the importance of carefully planning support for vocational education during times of economic downturn to help ensure that there is sufficient labor supply in hard-hit industries in the future. The context of our study is Sweden, where sorting into vocational and academic programs first happens at the high school level. However, similar choices are made in the major-

²⁶ It was not until June 2020, when students had already submitted their application, that the Public Health Agency concluded that there is no particular risk of infection among children.

²⁷ We exploit Sweden's two-round high school admission process, which happened to provide pre- and post-pandemic snapshots of applicants' program choices in 2020. We cannot implement the same method to evaluate the effects of the pandemic on program choices in 2021 because both admission rounds occurred post-pandemic.

²⁸ There has been extensive media coverage of these struggles (see, e.g., The Confederation of Swedish Enterprise, Svenska Dagbladet and Sveriges Television, last retrieved January 27, 2023). In addition to this anecdotal evidence, the lack of labor supply is evident in the industry's vacancy rate: it is notably higher in 2021 and 2022 compared to pre-pandemic years, particularly in the second quarter when summer tourism is about to peak (Source: Statistics Sweden).

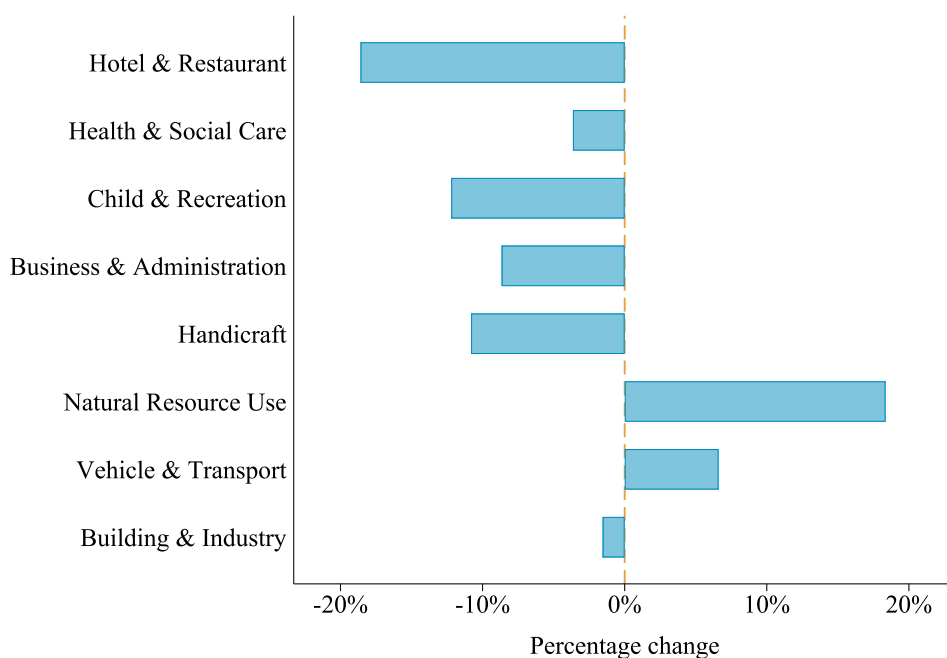


Fig. 8. Percentage change in demand for programs in the final admission round, 2019 to 2021. Notes: The blue bars show the percentage change from 2019 to 2021 in the number of final-round applicants who rank each program as the top choice on their application. The data comes from Statistics Sweden’s official nationwide statistics and was obtained via the Swedish National Agency for Education.

ity of European countries at this level of education. The vocational programs prepare students for many different types of occupations that are essential for the functioning of our society and infrastructure (e.g., assistant nurses, salespersons, food preparation assistants, truck drivers, electricians). Thus, students in vocational programs are an important part of the workforce, particularly for service-oriented jobs that tend to be less attractive but are necessary to our society. Policymakers should have significant interest in ensuring that the demand for these programs is sufficient even at times of economic downturns.

At the same time, we acknowledge that Sweden’s unique pandemic response may affect the generalizability of our results. When it comes to labor market shocks, we have shown that despite the lack of strict lockdowns, there were nonetheless adverse economic consequences similar to those observed in other countries. Thus, we believe that the change in labor market considerations should be relatively similar for students in other countries. However, we cannot rule out that students’ preferences for work versus study may have been influenced by lockdowns and the fact that on-the-job training may have been even more difficult in other countries. Moreover, whereas there is no evidence that Swedish students’ academic performance declined in the early stages of the pandemic,²⁹ if student performance was adversely affected in other countries due to school closures, this may have affected students’ chance of admission to vocational versus academic education and in turn altered their preferences for different types of programs. We stress the importance of taking these institutional factors into account when assessing the extent to which our findings generalize to other contexts.

Data availability

Data will be made available on request.

Appendix A. Tables

Table A.1
National high school programs in Sweden.

Vocational programs	Academic programs
Hotel & Tourism†	Social Science¶
Restaurant Management & Food‡	Humanities¶
Health & Social Care	Business Management & Economics
Child & Recreation	Natural Science§
Business & Administration	Technology§
Handicraft	Arts
Natural Resource Use	
Vehicle & Transport	
Building & Construction‡	
Electricity & Energy‡	
HVAC & Property Maintenance‡	
Industrial Technology‡	

Notes: We denote the programs that we pool together for our main analysis with the following symbols: † for Hotel & Restaurant, ‡ for Building & Industry, ¶ for Social Science & Humanities, and § for Natural Science & Technology.

²⁹ The Swedish National Agency for Education, press release from September 30, 2021, “Final grades in grade 9 are stable during the pandemic,” last retrieved February 9, 2023.

Table A.2
Vacancies per industry.

	2019		2020		%change	
	Q1	Q2	Q1	Q2	Δ Q1	Δ Q2
Industry						
Manufacturing & Mining	4,421	3,991	3,898	1,991	-12%	-50%
Energy & Environment	404	540	676	488	67%	-10%
Construction	2,938	5,153	2,662	2,722	-9%	-47%
Wholesale & Retail Trade	4,361	4,573	4,702	3,114	8%	-32%
Transportation & Storage	1,886	3,139	1,022	518	-46%	-83%
Accommodation & Food Services	2,218	1,827	308	.	-86%	.
Information & Communication	6,224	6,365	5,960	3,888	-4%	-39%
Real Estate, Finance & Insurance	2,304	1,354	2,146	1,314	-7%	-3%
Professional & Technical Activities	5,104	5,589	4,300	1,960	-16%	-65%
Administrative & Support Services	3,020	2,746	2,152	965	-29%	-65%
Education, Health & Social Work	1,619	2,383	1,417	1,064	-12%	-55%
Arts, Recreation & Other Services	523	799	367	206	-30%	-74%
Total	35,022	38,459	29,610	18,230	-15%	-53%

Notes: Data on vacancies comes from Statistics Sweden. Missing observations are due to data unavailability or uncertainty. No data is available for the Agriculture, Forestry & Fishing industry. The following Swedish industry codes are aggregated together: B and C (Manufacturing and Mining & Quarrying); D and E (Electricity Supply and Water Supply); K and L (Financial & Insurance Activities and Real Estate Activities); P and Q (Education and Human Health & Social Work); and R and S (Arts, Entertainment & Recreation and Other Service Activities).

Table A.3
Descriptive statistics in 2019 by program.

	Schools	Municipalities	Applicants	Coverage
Vocational programs				
Hotel & Tourism†	82	63	1,009	0.920
Restaurant Management & Food†	110	89	1,694	0.913
Health & Social Care	184	135	4,182	0.877
Child & Recreation	174	126	4,688	0.907
Business & Administration	177	118	3,748	0.889
Handicraft	128	67	2,677	0.916
Natural Resource Use	94	70	3,401	0.933
Vehicle & Transport	179	132	5,733	0.892
Building & Construction‡	191	132	5,250	0.901
Electricity & Energy‡	221	135	5,893	0.908
HVAC & Property Maintenance‡	101	69	1,499	0.917
Industrial Technology‡	131	107	1,770	0.941
Academic programs				
Social Science¶	388	165	20,577	0.929
Humanities¶	39	30	688	1.000
Business & Economics	308	149	17,147	0.938
Natural Science§	337	162	15,686	0.930
Technology§	252	146	10,420	0.912
Arts	193	97	7,364	0.937
All programs	708	188	113,426	0.921

Notes: We denote the programs that we aggregate together for our main analysis with the following symbols: † for Hotel & Restaurant, ‡ for Building & Industry, ¶ for Social Science & Humanities, and § for Natural Science & Technology. Applicants refers to the total number of individuals who rank the program as the top choice on their application in the final round. Coverage refers to the share of all such applications that we cover nationwide.

Table A.4
Average labor market outcomes three years after graduation from vocational programs.

Vocational program	Median annual labor earnings	Percent with stable job:		Most common industries among graduates with stable jobs (% in given industry)
		All graduates	Excl. students	
Hotel & Tourism†	263,116 SEK	52.2%	67.7%	Accommodation & Food Services (27.3%) Wholesale & Retail Trade (21.4%) Accommodation & Food Services (38.7%)
Restaurant Management & Food†	277,024 SEK	59.3%	69.1%	Wholesale & Retail Trade (16.6%) Human Health & Social Work (80.3%) Education (4.9%)
Health & Social Care	277,091 SEK	52.6%	77.8%	Education (36.8%) Human Health & Social Work (18.6%) Wholesale & Retail Trade (48.1%)
Child & Recreation	267,457 SEK	53.6%	72.0%	Manufacturing (9.7%) Wholesale & Retail Trade (31.3%) Personal & Cultural Services (22.5%)
Business & Administration	275,687 SEK	57.0%	71.6%	Agriculture, Forestry & Fishing (22.2%) Wholesale & Retail Trade (13.7%) Wholesale & Retail Trade (31.7%) Transportation & Storage (30.1%)
Handicraft	257,036 SEK	53.1%	66.9%	Construction (68.2%) Manufacturing (10.4%) Construction (44.6%) Manufacturing (17.9%) Construction (61.3%)
Natural Resource Use	276,538 SEK	51.6%	68.9%	Manufacturing (12.9%) Manufacturing (70.0%) Professional & Technical Activities (8.7%)
Vehicle & Transport	349,191 SEK	79.3%	82.4%	
Building & Construction‡	375,390 SEK	73.9%	78.9%	
Electricity & Energy‡	333,234 SEK	69.4%	79.2%	
HVAC & Property Maintenance‡	374,057 SEK	75.3%	81.4%	
Industrial Technology‡	358,276 SEK	67.2%	79.7%	

Notes: Data comes from Statistics Sweden and the Swedish National Agency for Education. All statistics are measured in 2019 for the cohort who received their degree in 2016. We denote programs that we pool for our analysis as follows: † for Hotel & Restaurant and ‡ for Building & Industry. Median earnings is computed for graduates who work (and do not study) during the year. Graduates have a stable job if they are employed in November; have yearly earnings $\geq 206,500$ SEK; and have not been unemployed during the year. The column “excl. students” excludes graduates who study during the year. In the industry classifications, Wholesale & Retail Trade includes Repair of Motor Vehicles.

Table A.5
Characteristics of municipalities.

	Data	No data	Difference	P-value
A. Characteristics of grade nine students				
Number of students	272.906	513.431	-240.525	0.134
Share girls	48.503	48.237	0.267	0.688
Share with Swedish background	74.536	78.422	-3.886	0.025
Share with high educated parents	48.928	52.022	-3.094	0.142
Share who passed all courses	71.184	73.347	-2.162	0.174
Final GPA	218.134	221.892	-3.757	0.195
Share with academic program as top choice	51.044	51.968	-0.924	0.682
Share with vocational program as top choice	45.563	43.346	2.216	0.344
Share not continuing to HS	2.669	2.338	0.331	0.323
Share with study interruptions after 1 year of HS	4.031	3.543	0.489	0.174
B. Other municipal characteristics				
Share in urbanized areas	78.281	78.809	-0.527	0.830
Long-term youth unemployment rate	2.654	2.005	0.649	0.000
Youth unemployment rate	6.115	4.810	1.305	0.000
Number of municipalities	188	32		

Notes: All characteristics are measured in the base year (2019).

Appendix B. Figures

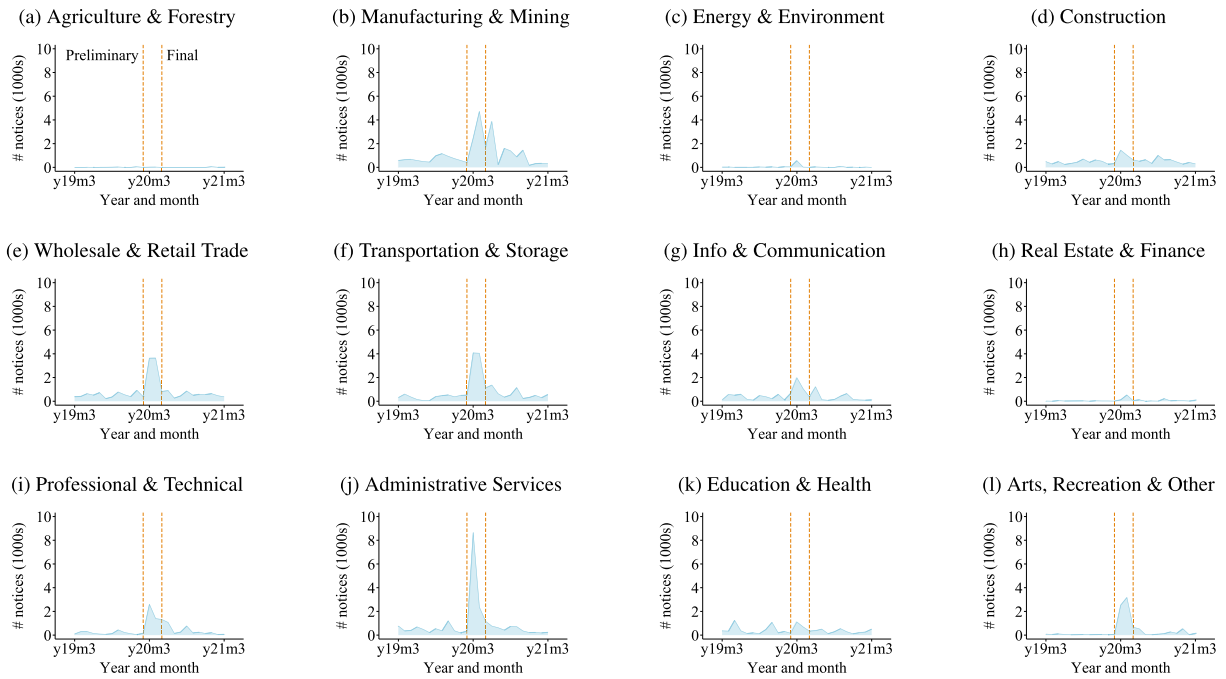


Fig. B.1. Number of advance layoff notices per month, March 2019–2021, by industry. Notes: Data comes from the Swedish Public Employment Service. Each panel plots the number of advance layoff notices by industry for the period March 2019–March 2021. The dashed orange lines indicate February 2020 (when preliminary-round applications were due in 2020) and May 2020 (when final-round applications were due in 2020). The same plot for the Accommodation & Food Services industry is shown in Fig. 3 in the main text.

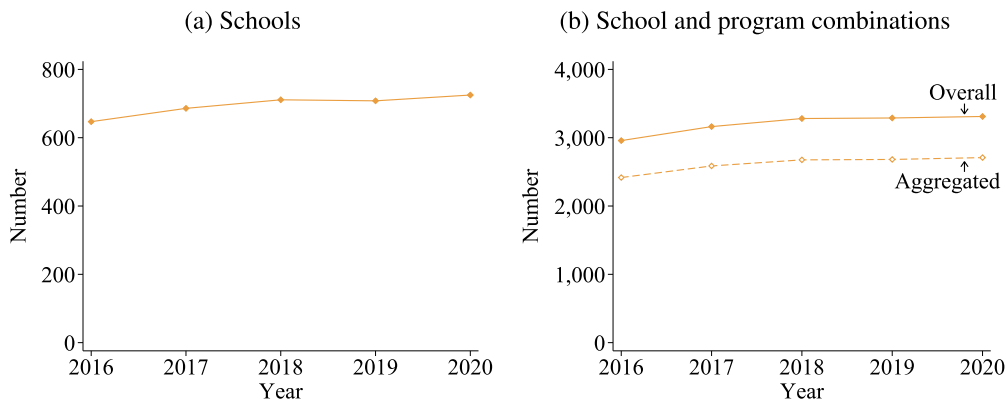


Fig. B.2. Number of schools and programs in our self-collected data. Notes: Panel (a) reports the total number of schools in our self-collected data each year, while panel (b) reports the total combinations of school and program. In panel (b), the dashed line labeled “aggregated” indicates the total combinations that remain after aggregating together similar programs.

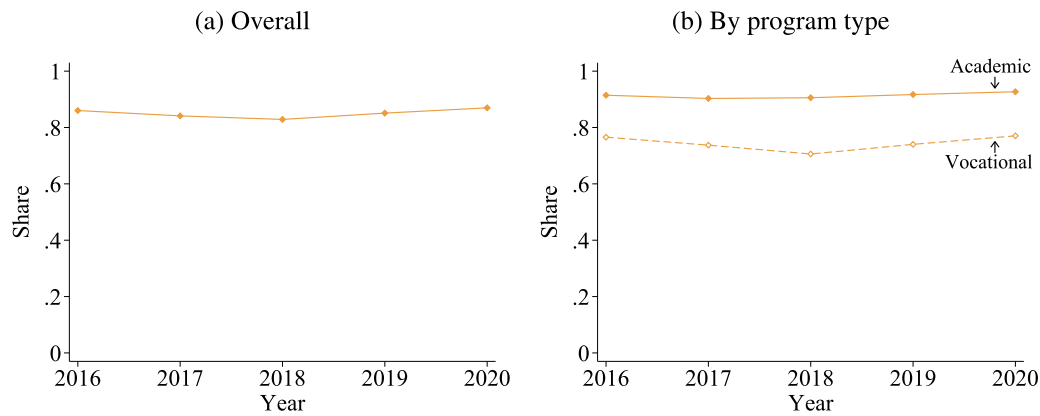


Fig. B.3. Share of applicants currently enrolled in last year of compulsory school. Notes: Data comes from the Swedish National Agency for Education. Shares are computed based on official final-round statistics for the entire nation.

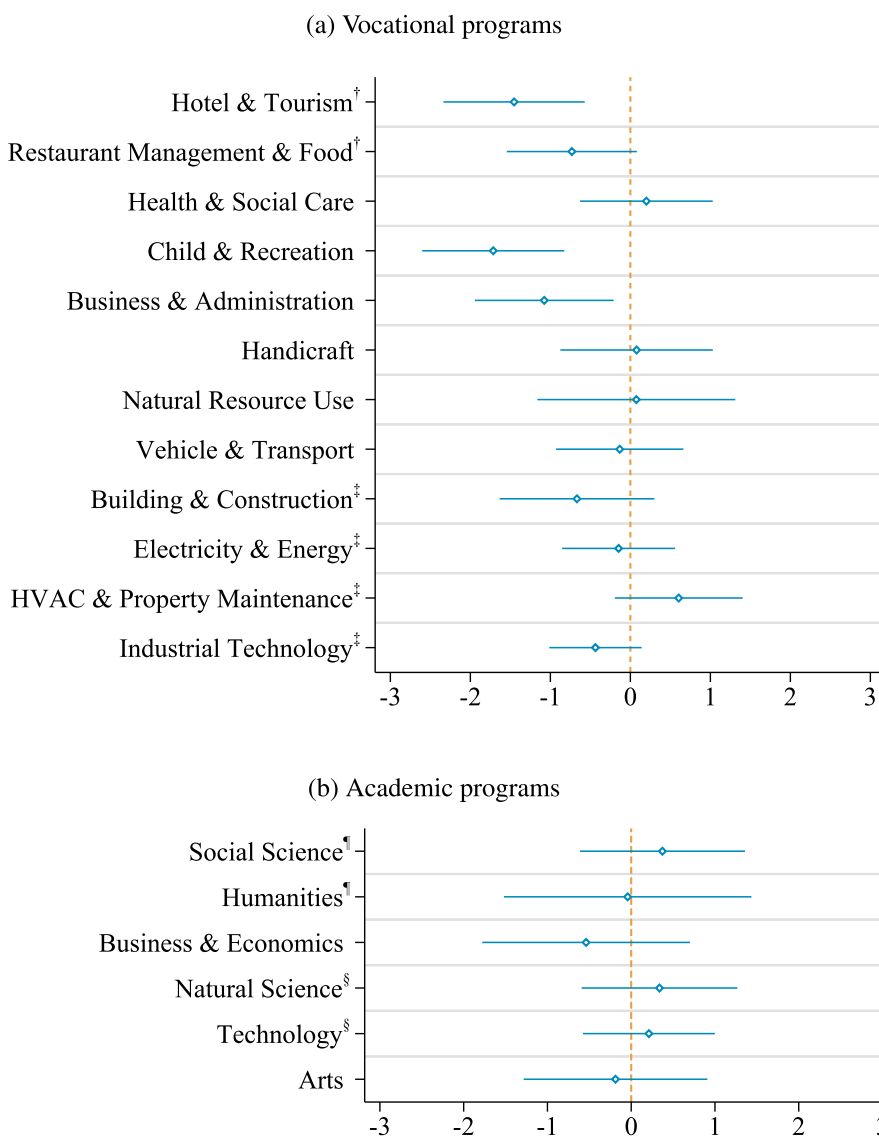
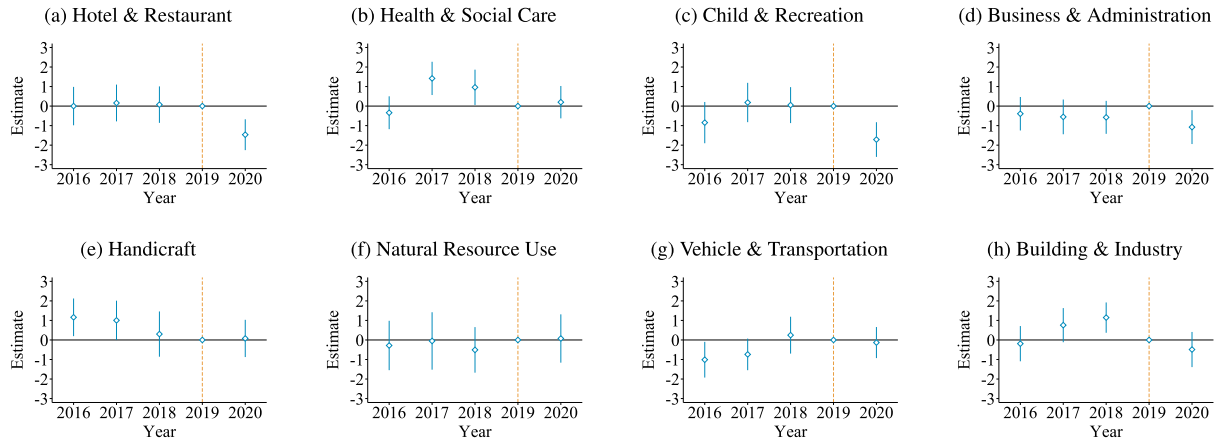


Fig. B.4. Estimated effect per program, first-choice applicants. Notes: The regression specification controls for school fixed effects and time-varying school-level controls. The horizontal lines show 95% confidence intervals with standard errors clustered at the school level. We denote the programs that we aggregate together for our main analysis with the following symbols: † for Hotel & Restaurant, ‡ for Building & Industry, ¶ for Social Science & Humanities, and § for Natural Science & Technology.

Panel A: Vocational programs



Panel B: Academic programs

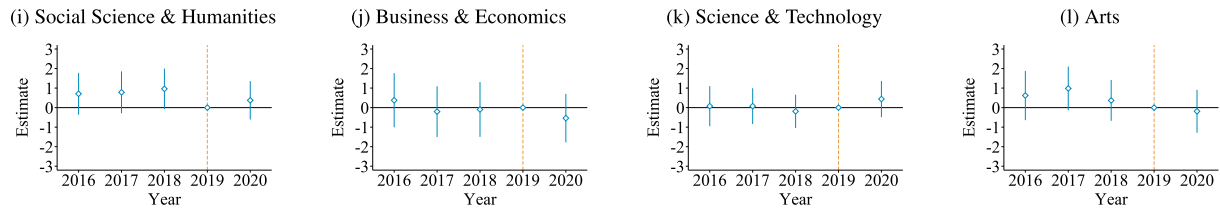


Fig. B.5. Event study plots. Notes: Each point plots the estimates of δ_y from Equation 2 run separately by high school program. The vertical bars represent the 95% confidence intervals with standard errors clustered at the school level. The dashed orange line denotes the baseline year 2019.

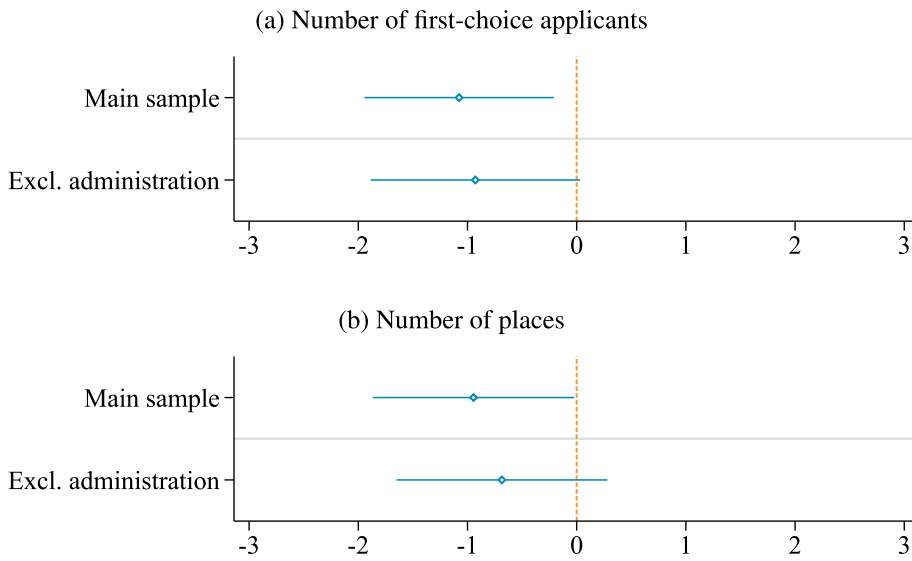


Fig. B.6. Robustness checks for Business & Administration program. Notes: Each point plots the estimate of δ_{2020} from Equation 2 for the Business & Administration program. In panel (a), the dependent variable is the number of first-choice applicants, and in panel (b), the dependent variable is the number of places. The top row in each panel is estimated on the full sample, and the bottom row is estimated after excluding schools where students can specialize in administrative services. The vertical bars represent the 95% confidence intervals with standard errors clustered at the school level.

Appendix C. Data appendix

We obtained information about all high school admission centers in Sweden from the Swedish Association of Local Authorities and Regions (SALAR).¹ During spring and summer 2020, we contacted the admission centers via their e-mail or web address, and requested data on applicants' program choices in the preliminary and final admission rounds for years 2016 through 2020. We had a response rate of 85.246%. As documented in Table C.1 below, the majority of the admission centers could provide the data that we required for our analysis, either for the full study period (59.016%) or a subset of the requested years (16.393%). A small share of admission centers (8.197%) replied that they could not provide data on program choices in the preliminary round, and an even smaller share (1.639%) replied that they could not provide any data whatsoever.

Table C.1
Outcome of data requests to high school admission centers.

Outcome	Percentage
Data received for all years 2016–2020	59.016%
Data received for subset of requested years	16.393%
No response to initial e-mail or follow-ups	14.754%
No data on application choices in preliminary round	8.197%
No data on application choices in either round	1.639%

Table C.2
Descriptive statistics for applications by year.

	Admission year				
	2016	2017	2018	2019	2020
Total applicants					
Preliminary round	88,920	97,616	108,446	108,771	110,629
Final round	93,020	102,835	113,673	113,426	114,770
Share vocational					
Preliminary round	0.334	0.345	0.362	0.350	0.344
Final round	0.349	0.364	0.380	0.366	0.357

In 2020, we record 110,629 applicants in the preliminary admission round and 114,770 applicants in the final round in our data, of which 34% and 36%, respectively, applied to vocational programs (see Table C.2). Between 2016 and 2020, the number of total applicants in both rounds increased by about 25%, in part due to better data coverage during later years but also due to an increase in cohort size accounting for about half the increase in applicants. Prior to 2020, applications increased by around 5% between preliminary and final admission rounds, while the corresponding increase in our sample was less than 4% in 2020. The increase between the preliminary and final round reflects that it is not mandatory to submit an application in the preliminary round, although this is the standard and recommended practice.

C1. Aggregation of programs for the analysis

For ease of exposition, we aggregate together the number of applications to programs with similar course content and occupational trajectories. For the vocational programs, we combine the Hotel & Tourism program and the Restaurant & Food program, and refer to these programs jointly as the Hotel & Restaurant program. These two programs were part of the same program prior to 2011 and prepare students for occupations in the hospitality industry. Students in these programs tend to work in the Accommodation & Food Services sector after graduation (see Table A.4). Additionally, we analyze the Building & Construction,

^{C1} In Swedish, the association is known as Sveriges Kommuner och Regioner (SKR). Their [website](#) provides contact information for all of the admission centers.

Electricity & Energy, Industrial Technology, and HVAC & Property Maintenance programs jointly as the Building & Industry program. The Building & Industry programs all have very technical content and are broadly related to the production of goods and energy, with many students working in the Construction & Manufacturing industries after graduation (see Table A.4). For the academic programs, we combine the Social Science and Humanities programs. These two programs used to be part of the same program prior to 2011 and have similar course content. Graduates of these programs tend to continue with Social Science majors at university. We also aggregate together the Natural Sciences and Technology programs, which are more mathematics intensive and aim to prepare students for STEM fields at the university level.

C2. Definition of control variables

In our main regression specification, we use school-level characteristics of the student body and teaching staff as control variables. These data come from public-use files from the Swedish National Agency for Education. We measure all control variables, with the exception of students' grade point average (GPA), in the fall term immediately prior to the high school admission process. This is due to the fact that these school-level characteristics are collected only once per year in mid-October. The application process occurs several months after this, but it would be unusual for there to be significant changes between the fall and spring term of the same school year. Thus, the characteristics from October should accurately capture the characteristics at the time of application. Students' GPA is also collected only once per year, but because it is measured for the graduating class, it is collected at the end of the school year in June. To ensure that this control variable is measured before our outcome variable, we lag students' GPA by one year, such that it is measured in the spring prior to the current admission round. However, our results are unchanged if we use the contemporaneous GPA measure instead.

Our vector of student characteristics includes the share of female students, the share of students with a foreign background, and the share of students with highly educated parents. The Swedish National Agency for Education defines the share of students with a foreign background as the share of students who are either born outside of Sweden or as students whose parents both were born outside of Sweden. Students without a national identity number are counted as foreign. In practice, all children born to Swedish residents are assigned a national identity number at birth. Children of non-residents obtain a national identity number once they are registered as residents, which requires a residence permit or right of residence within the European Union. Students are counted as having highly educated parents if their parents have obtained at least one full-time semester of studies (equivalent to 30 higher education credits) at the tertiary education level. In addition, we control for the GPA of the most recent graduating class (i.e., students who graduated in the spring before the current admission round).

Our vector of staff characteristics includes the share of certified teachers and the student–teacher ratio. The share of certified teachers is measured as the share of teachers who have a university degree in pedagogy out of all teachers with full-time positions. The student–teacher ratio is measured as the number of students enrolled in October per full-time equivalent teacher.

References

- Acton, R.K., 2021. Community College Program Choices in the Wake of Local Job Losses. *Journal of Labor Economics* 39 (4), 1129–1154. doi:10.1086/712555.
- Altonji, J.G., Blom, E., Meghir, C., 2012. Heterogeneity in human capital investments: High school curriculum, college major, and careers. *Annual Review of Economics* 4 (1), 185–223.
- Aucejo, E.M., French, J., Ugalde Araya, M.P., Zafar, B., 2020. The impact of COVID-19 on student experiences and expectations: Evidence from a survey. *Journal of Public Economics* 191, 104271. doi:10.1016/j.jpubeco.2020.104271.
- Betts, J.R., McFarland, L.L., 1995. Safe port in a storm: The impact of labor market conditions on community college enrollments. *The Journal of Human Resources* 30 (4), 741–765.

- Blom, E., Cadena, B.C., Keys, B.J., 2021. Investment over the business cycle: Insights from college major choice. *Journal of Labor Economics* 39 (4), 1043–1082. doi:10.1086/712611.
- Bradley, E.S., 2012. The effect of the business cycle on freshman major choice. MPRA Paper 42412.
- Card, D., Lemieux, T., 2001. Dropout and Enrollment Trends in the Post-war Period: What Went Wrong in the 1970s? In: Gruber, J. (Ed.) *Risky Behavior among Youths: An Economic Analysis*. University of Chicago Press, pp. 439–482.
- Clark, D., 2011. Do recessions keep students in school? The impact of youth unemployment on enrolment in post-compulsory education in England. *Economica* 78 (311), 523–545.
- Dahl, G., Rooth, D.-O., Stenberg, A., 2023. High school majors and future earnings. *American Economic Journal: Applied Economics* 15 (1), 351–382.
- Eurofound, 2021. Impact of COVID-19 on Young People in the EU. Technical Report. Publications Office of the European Union.
- Eurostat, 2021. Eurostat Regional Yearbook, 2021 Edition. Technical Report. Publications Office of the European Union.
- Forsythe, E., Kahn, L.B., Lange, F., Wiczer, D., 2022. Where have all the workers gone? Recalls, retirements, and reallocation in the COVID recovery. *Labour Economics* 78, 102251. doi:10.1016/j.labeco.2022.102251.
- Han, L., Winters, J.V., 2020. Industry Fluctuations and College Major Choices: Evidence from an Energy Boom and Bust. *Economics of Education Review* 77, 101996. doi:10.1016/j.econedurev.2020.101996.
- Hensvik, L., Le Barbanchon, T., Rathelot, R., 2021. Job search during the COVID-19 crisis. *Journal of Public Economics* 194, 104349. doi:10.1016/j.jpubeco.2020.104349.
- Hensvik, L., Skans, O.N., 2020. IZA COVID-19 Crisis Response Monitoring: Sweden. Technical Report. IZA.
- Liu, S., Sun, W., Winters, J., 2018. Up in STEM, down in business: Changing college major decisions with the Great Recession. *Contemporary Economic Policy* 37 (3), 476–491. doi:10.1111/coep.12396.
- Reiling, R.B., Strøm, B., 2014. Upper secondary school completion and the business cycle. *The Scandinavian Journal of Economics* 117 (1), 195–219.
- Rice, P., 1999. The impact of local labour markets on investment in further education: Evidence from the England and Wales youth cohort studies. *Journal of Population Economics* 12, 287–312.
- SCB, 2017. The Entrance to the Labour Market – Employment and Entrance to Further Education among Upper Secondary School Leavers 2013/14. Working Paper. Statistics Sweden.
- Tillväxtverket, 2022. Nytt rekord för sommarturismen [“New record for summer tourism”]. Technical Report. Swedish Agency for Economic and Regional Growth.
- Weinstein, R., 2022. Local labor markets and human capital investments. *Journal of Human Resources* 57 (5), 1498–1525.