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# The impact of local supply of upper secondary field of study

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# The impact of local supply of upper secondary field of study[a]

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This paper evaluates the impact on students' educational and labour market trajectories of local supply variations in fields of upper secondary education in Sweden. It takes a broad approach and studies the overall, reduced form, effects on several short-, medium- and long-term outcomes. The results highlight the multidimensional impact of educational supply; expanding supply of one track increases its admission rates, but also leads to a redistribution of students across programs. Increased supply is furthermore associated with decreasing average school peer ability, but also with smaller class sizes, and a higher likelihood of getting into one's top ranked program. There is no strong evidence of any long-term effects on the labour market outcomes of local youth – a finding that may reflect the multifaceted short-run impacts.

Keywords: supply of education, upper secondary school, earnings effects of schooling and field of education

JEL codes: I J

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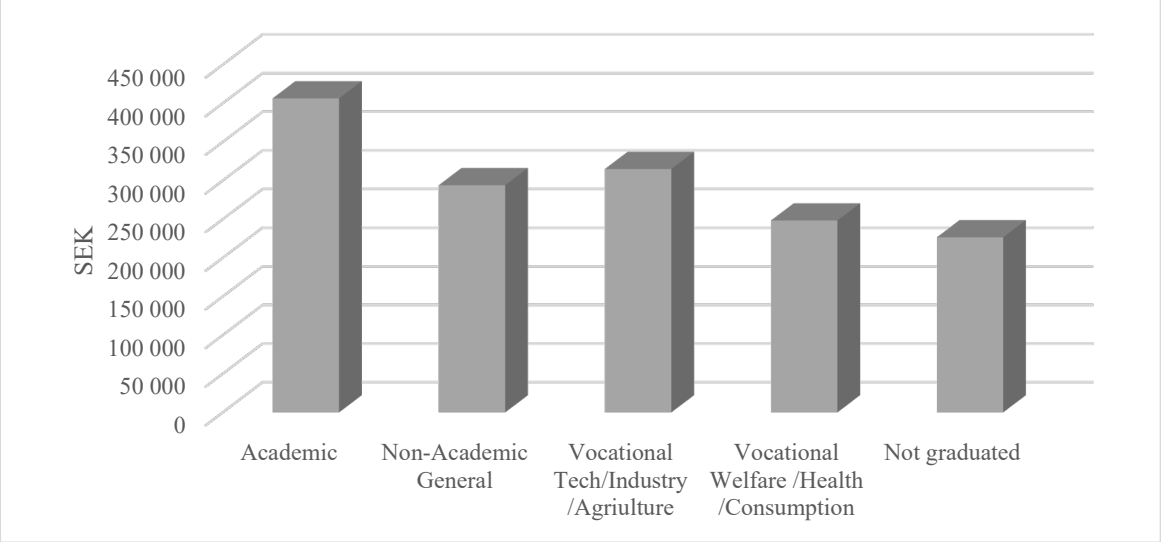
# 1. Introduction

The education system has the grand tasks of fostering informed and responsible citizens and providing a productive labour force. How best to design it is a million-dollar question for policy makers around the world – not least when it comes to the upper secondary level, where there are plenty of possible routes. Among OCED-countries, there is substantial variation in features such as starting age, duration of studies, and the degree to which upper secondary students choose among specializations (Stronati, 2023). In Sweden, students choose among a large set of academic, non-academic general, and vocational upper secondary programs.[1] Selection into oversubscribed programs is determined based on the final lower secondary school grades. As a result, the combination of students' choices, grades, and the supply of programs in relation to local cohort sizes determines what program a student gains access to. Since the degree of specialization is high, admission to an upper secondary track has strong implications also for access to tertiary education.

The long-term importance of upper secondary education is underlined by Figure 1, which shows substantial variation in adult earnings across individuals who graduated from different upper secondary fields, or who had not graduated from secondary school, by age 20.

**Figure 1. Average annual earnings at age 41-43 of cohorts that were 16 years old in 1975-86, by upper secondary graduation status measured at age 20.**




*Note: Earnings are measured in SEK (1 SEK approximately equals 0.1€) in year 2018 monetary value, and include parental and sickness benefits.*

[1] The terminology relating to the upper secondary programs follows Dahl et al. (2023).

Academic program students are in the top, while students of vocational welfare/health/consumption related programs have the lowest earnings among the upper secondary graduates. Not having graduated at all by age 20 is associated with the lowest levels of average earnings.

Although these patterns can reflect differences between groups of students that go beyond their field of education, for example in personal interests and abilities, they still point to the relevance of studying upper secondary education, and motivate the research question of this study: Is expansion of upper secondary education – and in particular of programs that are associated with higher pay-off in the labour market – a viable route for increasing the future average earnings of local youth?

This study[2] contributes to answering this question by evaluating how changes in the local supply of upper secondary programs, in Swedish school regions in the 1970s and -80s, affected the educational and labour market trajectories of local youth. This is done by comparing the outcomes of school age youth who resided in the same school region, but faced different supply due to changes in the available program slots per school age resident from one year to another. In order to capture differences in impacts across fields, I estimate separate coefficients for each of the four categories of upper secondary programs shown in Figure 1 (academic, non-academic general, and two categories of vocational programs).

The identifying variation stems from an arguably exogenous and policy-relevant source of variation in the form of expansions and contractions of the number of slots offered per program and school region, during a period when these decisions were highly centralized and made public prior to students' applications to upper secondary school. The supply variables are constructed by dividing the number of available program slots by the projected local school age cohort size, in order to take into account that access is determined by the level of supply in relation to the number of potential students.

In order to gain a broad understanding of how the local youth were affected by changes in the supply of the four upper secondary program groups, I investigate a range of short- medium- and long-run outcomes. Firstly, to gauge the short-term impacts, I study admissions to – and graduations from – upper secondary school, as well as the alternative activity being employed as a youth. Secondly, I analyse a number of outcomes related to the upper secondary school

[2] An informal pre-plan analysis for this project can be found at https://osf.io/pxmfd/, and revisions to the plan are documented here https://osf.io/4ctga/. Appendix section A1.1 lists additional revisions made thereafter.

environment, such as class size and school peer academic ability. Thirdly, I investigate aspects related to the application process, in the form of the likelihood to apply to different programs, and to be admitted to one's top listed choice. Finally, I follow individuals until their early 40ies, and measure the long-term impact on field and level of education, and on earnings, wages and employment.

The study thus takes a broad approach and studies the overall, or "reduced form", effects of the local educational supply on several education- and labour market related outcomes. It is consequently related to various strands of the literature on the impact of access to education.[3]

First, a large literature uses distance to schools, or institutional variations in aspects such as the minimum school leaving age, as instrumental variables for educational attainment. Card (2001) includes an overview of early studies, which overall suggest fairly large earnings effects of schooling. More recent studies find that reduced travel time to Norwegian upper secondary schools positively impacts the graduation rate (Falch et al., 2013), and that geographical proximity affects the type of educational institution an individual attends in the UK, but not participation rates per se (Gibbons and Vignoles, 2012). Grau et al. (2018) find that decreased access, measured as school closures in Chile, increases the probability of high-school dropout.[4]

Another strand of literature makes use of variation from policy reforms that affect the duration and/or content of the education system, for example the introduction of nine years of compulsory comprehensive education in Sweden (see Holmlund, 2020, for an overview of articles evaluating the reform), and the prolongation of the compulsory instruction time in Swedish primary schools (Fischer et al., 2020). The evidence from these reforms suggests that access to more education (in terms of more years or more instruction time) at the primary and lower secondary level is beneficial for students' long-term earnings. On the other hand, a reform that prolonged the duration of the vocational upper secondary tracks in Sweden, while at the same time increasing their theoretical subject content, had mixed results. Whereas it did increase the average years of education, it did not affect earnings (Hall, 2012). Among students with low academic ability, it furthermore led to higher dropout rates (Hall, 2012) and

[3] As the literature is vast, I will make no attempt to cover it all, but will focus on references that are more closely related. The current study can also be related to the research on school funding, peer effects, class sizes, etcetera. I will abstain from reviewing those literatures in the introduction, but will add comments on relates articles throughout the paper.

[4] Other studies related to education supply include e.g. Lovén et al., 2020, Kelchtermans and Verboven (2010a and 2010b).

a higher risk for unemployment later in life (Hall, 2016).[5] [6] Overall, a large set of studies thus suggest that that better access to education improves education levels, and often earnings. But there is also evidence that more is not always better; for example, that longer and more theoretical specializations do not always benefit low-ability students.

A third line of research compares students around admission thresholds to study the impact of educational specializations. Kirkeboen et al. (2016) evaluate the impact field of education at the college level in Norway, by comparing the outcomes among students who were marginally accepted into one field instead of another. Their results suggest large differences in the labour market payoffs across fields, and that estimated payoffs are higher for the fields in which students have a comparative advantage.[7] Two recent articles, that are closely related to the present study, use regression discontinuity (RD) design to evaluate admissions to different types of upper secondary programs.[8] Silliman and Virtanen (2022) study upper secondary tracks in Finland, and find that admission to a vocational instead of non-vocational program had a persistent positive impact on earnings. Dahl et al. (2023) analyse the impact of different types of academic programs in Sweden. They report that admission to the academic Natural Science, Engineering and Business programs had mostly positive, and the academic Social Science and Humanities programs mostly negative, effects on adult earnings, when the fall-back option was another academic program. Among students whose fall-back option was a non-academic general or a vocational program, the impact of admission to an academic program was however often negative, or zero – a finding broadly in line with the positive impact of vocational studies found by Silliman and Virtanen (2022).

The present study provides an interesting complement to the above articles, by levying a source of identifying variation that enables estimation of other types of effects and for a broader group of students. Whereas RD-type studies respond to the question of how a student near the admission threshold is affected by just getting in to her top choice compared to the fall-back option, the present study analyses the average effect on all local school age youth of

[5] The reform's impacts on a host of additional outcomes has been evaluated, including transition to university, teenage pregnancies, voting participation, and network effects on employment; an overview is available at: https://www.ifau.se/Press/Forskningssammanfattningar/effekter-av-trearigt-yrkesgymnasium/

[6] Hämäläinen and Uusitalo (2008) study a reform that was similar in character in the sense that it led to an upgrading of the level and duration of the education, but at the tertiary level; namely the transformation of Finnish vocational colleges so polytechnics. They estimate positive earnings effects on graduates of the schools.

[7] There are also studies using RD to study the impact of admission to a particular form of education. Goodman et al. (2017) find that admission to a 4-year instead of a 2-year college increased the likelihood of completing a bachelor degree, Öckert (2010) reports a long-term positive impact on years of education of admission to Swedish colleges and finds no evidence of earnings effects.

[8] For further reviews on the impact of field of education, see for example Altonji et al. (2016).

changes in their school regions' educational supply. As mentioned above, this means that a host of aspects are relevant to study – including not only the effects related to increased chances of getting into an expanding track, but also effects related to potentially fewer students attending the other available tracks, and changing peer compositions or class sizes. Ultimately, the estimated long-term impacts on earnings, wages and employment will reflect the aggregate of these potential channels – including the impacts that go through track attendance as well as those that go through peer composition, class sizes, the likelihood to attend upper secondary school at all, etcetera. The aim of this paper is thus twofold: i) to provide evidence on such intermediate channels, and ii) to evaluate how the long-term labour market prospects of local youth are affected by increases and decreases in the local supply of different upper secondary specializations.

As was briefly explained above, the analysis is based on comparing cohorts of school age youth who reside in the same school region, but face different upper secondary supply due to changes over time in the available slots per school age resident. By limiting the analysis to comparisons two year-windows of data, in a stacked regression setting, I make sure that the analysis is not affected by long term regional labour market trends that could be associated with both educational supply and student outcomes. In order to isolate specific track effects, I analyse the impact of supply changes for each program group (academic, non-academic general, vocational welfare/health/consumption, and vocational technical/industry/agriculture), while holding constant for supply changes to the other groups.

The results suggest that students responded to increases in the number of available program slots per school age youth by listing the program type as top choice in their upper secondary applications more often, and that students were more often admitted to, and graduated from, the programs that became more widely available. There is also evidence of reshuffling of students across programs; for example, more admissions to the non-academic general studies as more slots in that sector opened up, came at the cost of a reduction in admissions to vocational programs in the welfare/health/consumption sectors. Increased supply of general programs (academic and non-academic) furthermore led to higher chances that local school age individuals were accepted to any upper secondary program, but that the impact on having graduated from any upper secondary school program by age 20 was higher if the supply increase came in form of (the generally shorter and academically easier) vocational program slots. There is also evidence that increased supply of upper secondary programs contributed to decreasing class sizes, as well as to a reduction of the average GPA of the school peers.

Finally, overall, there is no substantial evidence that changes to the supply of different types of upper secondary programs affected students adult labour market outcomes, measured as earnings, wages and employment in their early 40ies.

I also estimate the impact of supply for each of the five academic programs that were studied by Dahl et al. (2023). The results are generally in line with those for the broader program groups: positive impacts on admissions, and mostly non-significant effects on long-term labour market outcomes. There is an indication that more supply of the Business program was harmful for students' long-term wages and earnings, but only in cases where the supply increase took place from already low admission threshold levels.

The overall non-significant results of supply of upper secondary programs on long term labour market outcomes contrast to the strong evidence of upper secondary field-effects on long-run earnings that were found by the RD-studies of Dahl et al. (2023) and Silliman and Virtanen (2022). Although the results of this study are not precise enough to rule out the presence of supply effects, and although some evidence was found for a negative supply effect of the Business program when admission thresholds were already low, the mostly non-significant results serve as a reminder for caution regarding the generalizability of RD-based studies. Specifically, this paper has demonstrated that RD-estimates of upper secondary program admission may not translate directly to the effects of changing the supply of the program. The comprehensive reduced form type analysis of this paper thus provides a valuable complement to that literature.

The remaining sections of the paper present the background institutional setting (section 2), the data and empirical method (section 3), and the results (section 4). Section 5 concludes.

# 2. Upper secondary education in Sweden in the 1970s and 1980s

During the 1970s and -80s, the organization of Swedish secondary education was strongly centralized. The local (municipal) level of government was responsible for providing education, but was subject to detailed national regulation. Planning and funding decisions were to a large extent made at the national level or by the 24 counties, and teachers and principals were national government employees. This section gives an overview of the content and local supply of upper secondary educational programs during the period (more detailed information is given in Appendix section A1.2).

### 2.1 Upper secondary admissions and educational program content

Students entering upper secondary education could choose among over 20 educational programs. The application process started during the spring, when students submitted an ordered list of preferred programs to their school region. There was no option to choose among schools. Admissions were determined by the final grade point average from lower secondary school, and students competed on equal basis within their school region. After students were accepted to a program, they were assigned to a school based on travel time and in order to make effective use of facilities and other resources.[9] [10]

The educational programs consisted of five 3-year long academic tracks (among which one had the option of taking a fourth year of Engineering studies); five 2-year non-academic general programs; and seventeen 2-year vocational programs (see Appendix section A1.2 for a complete list of programs).[11] The programs varied greatly in character. Among the *academic programs*, the Engineering and Natural Science programs had, as the names suggest, a strong focus on Math and Science, and the Natural Science program was the broadest in content, giving eligibility to all university educations. The Social Science, Humanities and Business programs were also university-preparatory, but gave eligibility to a narrower set of university educations, excluding Engineering, Science and Medicine. The *2-year non-academic general programs* were directed towards Business; Engineering; Social studies; Music; and Arts. Compared to the 3-year programs, these programs placed less emphasis on preparing for tertiary studies, although students were eligible for some post-secondary educations, and placed relatively more emphasis on preparing for labour market entry/practical skills. A broad variety of *2-year vocational programs* prepared students for vocations within e.g. the industry; transportation; agriculture and forestry; social service; nursing; trade and administration. In the analysis, they are grouped into two broad categories: vocational technical/industry/agriculture and welfare/health/consumption.

Students in the academic programs tended to have higher grades from lower secondary school and more educated parents (Table 1). Female students are starkly under-represented in vocational technical/industry/agriculture programs (10 percent) and strongly overrepresented in vocational welfare/health/consumption programs (87 percent). In the academic and non-

[9] See e.g. *SOU 1973:48*, and government bills *Prop. 1985/86:10*; *Prop. 1981/82:157* and *Prop. 1973:77*.
[10] A special regulation was in place for the school regions of Stockholm county, which formed a joint admission region (see Appendix section A1.2 for details). This makes the link between the school region supply and the admissions a bit unclear for these school regions, and they are therefore excluded from the analysis presented in this paper. Results when adding them, treated as one joint region, are presented in the Appendix section A3.
[11] The number of 2-year programs varied during the study period; the number of non-academic general programs grew from three to five, and the number of vocational programs grew from 13 to 17.

academic general program groups, the gender distribution is fairly even, although there were variations among the programs within the groups. (Appendix section A2.1 includes a table showing student background per program).

**Table 1. Background characteristics of students admitted to upper secondary programs, 1975-1986**

| *Type of program* | *Observations* | *Final GPA lower secondary school* | *Female* | *Parent secondary education* | *Parent post-secondary education* |
|---|---|---|---|---|---|
| Academic | 442 253 | 38.64 | 0.49 | 0.59 | 0.47 |
| Non-Academic General | 174127 | 32.52 | 0.59 | 0.61 | 0.27 |
| Vocational Welfare/Health/Consumption | 239712 | 30.98 | 0.87 | 0.58 | 0.16 |
| Vocational Technical/Industry/ Agriculture | 311333 | 28.23 | 0.10 | 0.58 | 0.15 |

Note: The sample consists of admitted students who turn 16 the year of admission (the regular school age). The final GPA lower secondary school represents the average GPA among admitted students, whereas the female and parental education variables measure shares. The information on parental education is measured in year 1990, which is the first year for which this information is available in the project data, and they represent the share of students with at least one parent with the respective education level.

### 2.2 Upper secondary program supply

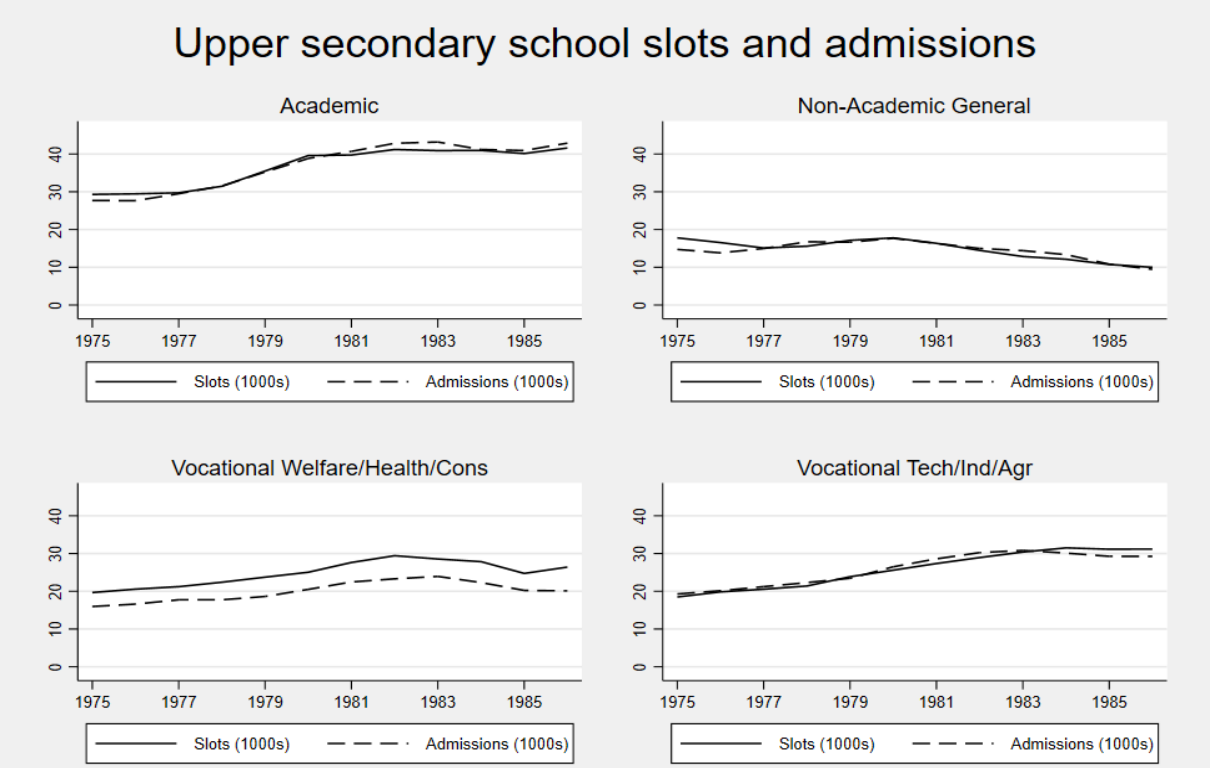
The supply of educational programs within school regions was determined by the National Board of Education, and, from the early 1980s, the process was partly decentralized to the County Boards of Education. The supply decisions were made public in December prior to each school year, in a publication that listed the coming school year's allotted number of classes per program and upper secondary school region.[12] A class encompassed a maximum of 30 students, or, for many of the vocational programs, 16 students. The supply decisions came with full funding, which was allocated to the school regions in the form of targeted grants.

After the December publication of the coming school year's supply, modifications could be made, based on proposals from the local level to either scale up programs that, during the spring application process, proved to be high in demand, or scale down programs with few applicants. These modifications imply that the supply information used in the empirical

[12] The publication, *Röda boken*, is available at the Swedish National Archives. I am grateful to Sebastian Ekberg, Malin Tallås-Ahlzén and Ellinor Edvardsson for excellent research assistance in collecting the information, as well as to Anders Stenberg for generously sharing large amounts of information on local supply and upper secondary regulation.

specification (the December decisions) will not correspond 1:1 to the de facto supplied programs. Figure 2 shows that the December-decisions still correlate strongly with the number of admitted students. The exception is the Vocational programs within Welfare/Health/Consumption, where the number of supplied slots were constantly larger than the admissions. This suggests that the modifications implemented during the spring were, at least for most programs, probably relatively minor.[13]

**Figure 2. Number of slots (December decisions) and number of admitted students per program group 1975–1986.**




Data source: Röda boken, December-decisions, and the Upper secondary application and admission registers.

As explained in the introduction, the empirical strategy builds on the idea that the supply variation from one year to another within a school region can be viewed as exogenous to students' subsequent outcomes, conditional on controls for the factors that were known to influence the Board's supply decisions. It is therefore important to know which these factors were. As described in a detailed exposé of the process in Appendix section A1.2, the decision

[13] A higher number of slots than admitted can also be a result of over-supply.

to increase, reduce, or keep constant the number of classes for a program in a school region was guided by the National government's overall funding available for upper secondary education, and by information supplied to the Board by the local and regional levels of government. In particular, the Board paid attention to the expected demand for upper secondary schooling in the form of the projected number of school age individuals in the school regions; the previous years' number of first-hand applicants per available slot; and the previous years' number of enrolled students per available slot. These factors are observed in the data available for this project, and will be flexibly controlled for in the empirical analysis.

In addition to the above-mentioned factors, the National Board received statements from the County Employment Boards and local employer/industry organizations on the need for and design of programs relevant to the local industry. One aspect of relevance for this study, is the extent to which supply expansion of a certain program reflected statements indicating higher local demand for the type of labour produced by the program. Such an impact would risk to give rise to a positive correlation between program supply and labour market outcomes driven by the demand-side rather than the program supply. While I cannot observe and control for the local statements, the empirical specification will include school-region by 2-year period fixed effects, which probably to a large extent capture local labour market chocks. A balance analysis presented in Appendix A2.2 indeed confirms that there is no association between the identifying supply variation used in the regression analysis and local labour market conditions measured by the students' parental earnings.[14] This suggests that the empirical specification successfully controls for otherwise potentially confounding effects of local labour market trends.[15]

# 3. Empirical strategy and data

This section explains the regression model, the potential types of effects that the estimates capture and the outcome variables that are used to measure these effects.

## 3.1 Estimation model

[14] The idea is that if the supply decision was a response of better labour market prospects in the form of, say, the location of a big firm to a region, then this would likely result in higher observed earnings among the parents of the students.

[15] In the earlier versions of this paper, I chose to focus on the academic programs as they are likely to have a weaker connection to the local labour market, and hence run a smaller risk for this type of omitted variable bias. However, this was probably overly prudent, and estimates for the non-academic programs are therefore now presented along with the results for the academic programs.

As explained in earlier sections, I restructure the data to a stacked 2-year format, and estimate the impact of educational school region supply changes within each school region by 2-year "round" of data (see equation 1 below for the detailed specification).

The regression equation is the following:

$$y_{igrp,t+j} = \omega_r + \tau_t + \mu_p + \sum_P \beta^P \left( \frac{Slots^P_{gt}}{Pop15_{g,t-1}} \cdot 100 \right) + C(\cdot) + X_{i,t-1}{}'\delta + \varepsilon_{grp,t+j} \quad (1),$$

where $y_{grp,t+j}$ is the average outcome of the individuals *i* of school region *g*, and school region by 2-year "round" *r*. *p* indicates if the observation is the first or the second of the two periods within a round. As indicated by the equation, the regression includes fixed effects at the level of round (note that school region fixed effects are omitted as they are captured by the round fixed effects), $\omega_r$, year, $\tau_t$ and time period (1 or 2) within round, $\mu_p$. Standard errors are clustered at the "round" level. The baseline results presented in the article are weighted by the number of students per year and school region; and results when each school region and year is given equal weight are presented in the Appendix section A4. [16] The outcome year is indicated $t + j$, where year *t* is the year the individual turns 16, and *j* denotes the number of years after this that the outcome is measured. As shall soon become clear, the analysis will cover a broad range of outcomes measured from age 16 to age 43.

$\beta^P$ measures the estimated impact of changes in the local upper secondary program supply, measured as the number of slots per 100 local school age individuals $\left( \frac{Slots^P_{gt}}{Pop15_{g,t-1}} \cdot 100 \right)$.[17] Separate coefficients are estimated for each of the groups (*P)* of academic programs; non-academic general programs; vocational welfare/health/consumption programs; vocational technical/industry/agriculture programs. (In later sections I will furthermore report separate coefficients for each of the academic programs: Natural Science, Engineering, Social Science, Humanities and Business). As previously explained, the local school age population

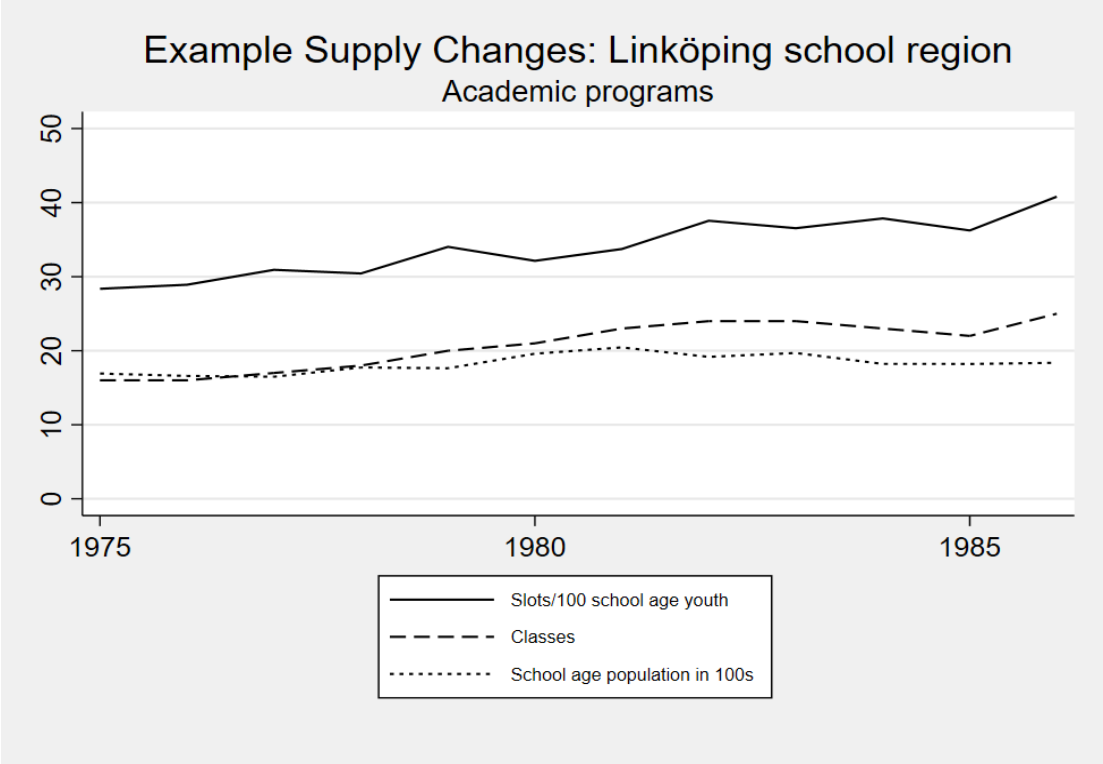
[16] The regression was run after collapsing the data to school region by year level averages, and weighting with the number of individuals, in order to speed up the estimations. The baseline results omit Stockholm school regions, since they formed a joint admission region during the studied period, which makes it cumbersome to link supply changes in specific school regions to the admission chances in the joint region. Adding them does not substantially alter results (see Appendix section A3).

[17] Appendix section A2.1 shows figures for the distribution of the supply variables for the four groups of programs, as well as the residual variation in the supply variables when all other right-hand-side variables are accounted for. The latter figure shows that the identifying supply variation is bell-shaped with few observations exceeding 2 in absolute value. Residuals of absolute value around 1 are fairly common, meaning that the supply effects are identified out of variation that is often of the magnitude of around ±0.5 to 1 more slot per 100 school age youth. Given that the supply distributions are centred around 15-25, depending on program group, the identifying variation is fairly large.

is measured as the number of 15-year-olds residing in the school region at the end of year t-1, and the number of slots is measured according to the December decisions by the Educational Board (i.e. prior to students applications to upper secondary education).

The fact that the supply variable is generated by normalizing the number of slots by the local school-age population, means that part of the identifying variation will stem from population changes over time. Figure 3 illustrates the development of both sources of variation – slots and population size – together with the constructed supply-per-school-age-population variables, for the group of academic programs in Linköping – a mid-sized school region in southern Sweden. The figure clearly shows that the development of the generated supply-per-population variable reflects changes in both the number of classes and the population size. The figure furthermore suggests that the number of available classes responds to changes in the population size – as one would expect considering that a growing/shrinking school region needs to adjust its supply.

**Figure 3. Example of the variation in supply and school age population over time in a school region.**



Let us now return to equation 1, where the component $C(\cdot)$ denotes a control function for the factors that were influential for Educational Boards' "December decisions" on the school region supply. These factors include the projected school age population size and recent trends in local demand as reflected in applications and admission, in relation to available slots, and they are measured as follows:

i. The projected number of 16-year olds is measured as the natural log of the number of 15-year old students, $ln(pop15_g)$, who resided in the region measured at December 31 the year prior to the start of the school year in question.
ii. The number of first preference applicants to each program group *P* as a share of the number of available program slots in the region; $\frac{Appl1_g^P}{Slots_g^P}$.
iii. The extent to which classes were filled, which is measured as the number of admitted students to program group *P* as share of the number of available program slots; $\frac{Adm1_g^P}{Slots_g^P}$.

These school region (*g*) level variables are added measured in years *t-1* and *t-2* in order to capture potential lagged impacts, and they are included both in levels and squared in order to allow for potential non-linear effects.[18] The control function takes the following form:

$$C(\cdot) = \sum_{j=1}^{2}\left(\sum_P \gamma_j^P\left(\frac{Appl1_{g,t-j}^P}{Slots_{g,t-j}^P}\right) + \sum_P \partial_j^P\left(\frac{Appl1_{g,t-j}^P}{Slots_{g,t-j}^P}\right)^2 + \sum_P \theta_j^P\left(\frac{Adm1_{g,t-j}^P}{Slots_{g,t-j}^P}\right) + \sum_P \rho_j^P\left(\frac{Adm1_{g,t-j}^P}{Slots_{g,t-j}^P}\right)^2 + \varphi ln(pop15_{g,t-j}) + \theta\left(ln(pop15_{g,t-j})\right)^2\right) \quad (2)$$

Finally, the regression equation includes a set of student background individual level covariates ($X_{i,t-1}$), measured at age 15; the year before entering upper secondary education. These mainly serve to increase efficiency; a balance analysis below will show that they are by large uncorrelated with program supply changes conditional on the school region controls listed above.

## 3.2 Interpretation of the regression coefficients

The estimated $\beta^P$-coefficients reflect the reduced form effect of adding one more program group slot per 100 potential students, according to the Education Board's supply decisions as

[18] Additional regressions, with the supply variables as outcomes and the school region control variables along with the fixed effects as right-hand-side variables, are available upon request. They indicate that in particular the variables for earlier years' number of admitted per available slots are relevant to include – they tend to be positively correlated with the current supply-variable. The projected number of 16-year olds, measured as last year's number of 15-year olds, is often negatively correlated with the supply per population – not unexpectedly, since the same variable is used as denominator for the supply-variables.

of December prior to each school year. As explained in earlier sections, I use the December supply decisions as they provide variation that is exogenous to students' later applications to upper secondary school. During the spring, local supply adjustments could be made, meaning that the supply variation used in the regressions is a proxy for the (unobserved) realized number of available slots.

It shall be noted that the local program supply affects not only access to the program group itself, but potentially also other aspects such as the overall access to upper secondary education in the school region; program peer composition (possibly in all programs, as students are reshuffled as a result of the changing access of some program/s/); teacher quality; class size; student motivation during the final term of lower secondary school; and students' applications to upper secondary school. Consequently, the treatment effect may comprise a long list of impacts.

Figure 4 lists the expected channels of impacts of an increase in the local supply of, say, program A, starting with the expected effects related to admission; "*Direct effects on program A*". An obvious such mechanism is that expansion of program A is likely to give more students access to the study content of the program. As admission is grade based, access is in particular expanded for students with lower grades than the earlier admission threshold. In Figure 4, expected sign of these effects is denoted as unknown, because it will likely vary across programs, and potentially also across student–program combinations. Some programs may benefit certain groups of students but not others. Admitting lower-grade students to program A will furthermore affect the students that would have been admitted to the program in absence of the supply increase, through surrounding them with on average lower-ability peers. The expected impact of this is also unknown; whereas there is plenty of evidence suggesting that being surrounded by on average higher ability peers benefits student achievement (e.g. Epple and Romano, 2011), there is also recent evidence that students can benefit from ranking academically higher than their peers (Delaney and Devereux, 2022). Expanding a program also means hiring more teachers, and will potentially result in lower average teacher quality (under the assumption that incumbent teachers are more qualified than the new hires).[19] The impact of teachers may be related to the ability of the admitted students; if program expansion means that classes become more heterogeneous with respect to academic ability, teaching may become harder. On the other hand, program expansion

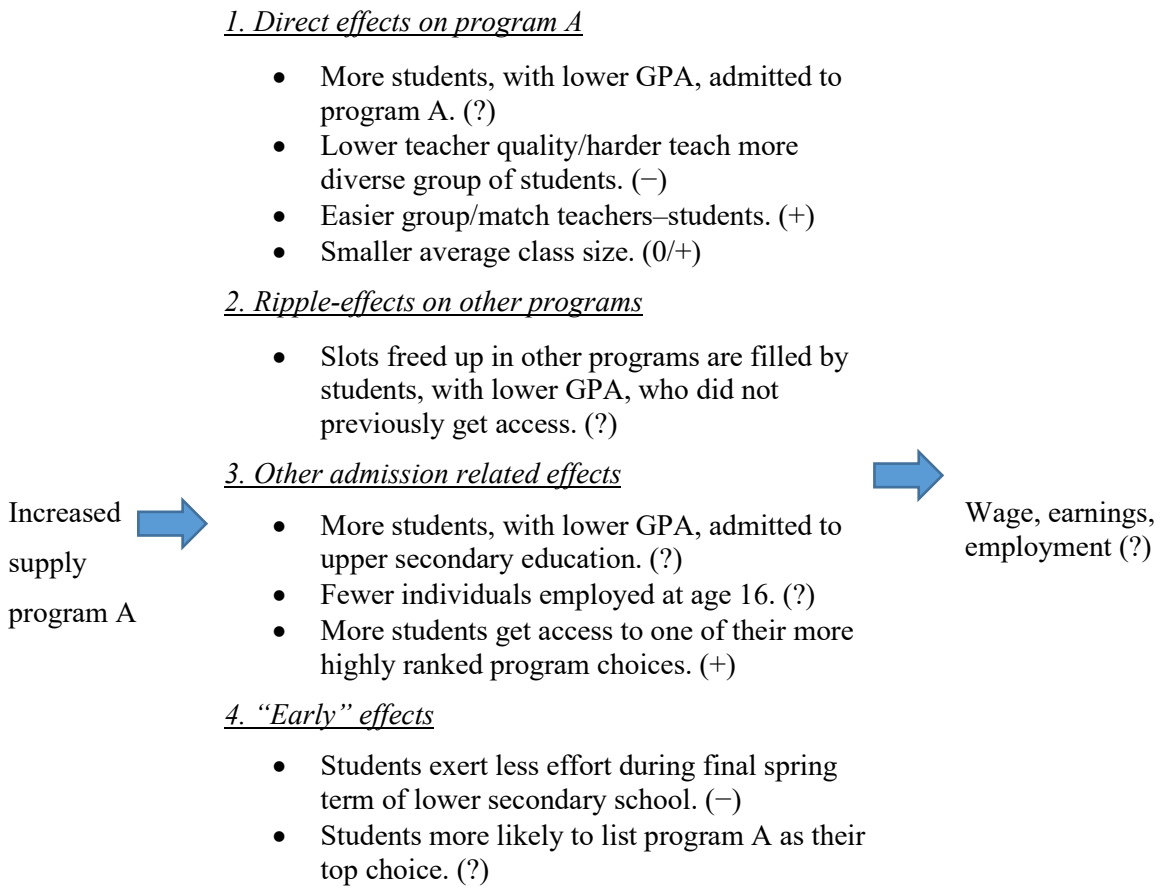
[19] Since the supply changes evaluated in this paper are rather small, compared to larger scale educational expansions, the teacher quality channel is probably rather limited.

could enable grouping teachers and students in ways that facilitate teaching and learning. Program expansion is furthermore likely to give rise to on average smaller classes, if some of the added slots remain vacant.[20] Leuven and Oosterbeck (2018) summarize the empirical estimates on reducing class size in Europe as ranging from zero to large positive effects.

Second, expansion of program A can have ripple-effects in the form of decreased competition for other programs (Gandil, 2022), making these programs accessible for students with lower grades. The expected impacts are unknown, and may very well differ across programs, students, and across student–program combinations, just as was the case for program A. The aggregate expected impact is therefore unknown.

[20] Changing supply generally took the form of adding or subtracting one or half of a class, and a full class normally comprised 30 students.

**Figure 4. Illustration of potential channels of effects of increased program supply (expected sign of effect in parenthesis)**




Third, more supply of program A implies an expansion of the total number of upper secondary education slots. More students consequently get access to upper secondary education, which, in the Swedish context of grade-based admission, lowers the average academic ability of upper secondary students, and plausibly delays labour market entry; decreasing the number of 16-year olds in employment. The aggregate expected impact of these aspects, denoted "*Other effects*" in the figure, are unknown, as they relate to the student – program match, as well as to peer, teacher and potential class size effects, and the labour market trajectory of individuals with and without upper secondary education. The expansion of upper secondary school also means that more students will get access to an educational program that they prefer more strongly, which I assume will have a beneficial impact.

Fourth, expansion of program A can impact students already during their final term of lower secondary education, denoted "*Early effects*" in the figure.[21] An announced expansion of the

[21] Recall that the supply changes for an upcoming school year were announced in December.

number of slots may induce local students to exert less effort, since it decreases competition (Fidjeland, 2023, Tilley, 2021). In Figure 4, I assume that the long-term impact of such reduced effort is negative. Expanding supply of a program may also affect students' application behaviour. A likely scenario is that more students find it worthwhile to add the program to their application list when it is more accessible. The expected long-term effects of such a mechanism are ambiguous.

In sum, Figure 4 illustrates that the aggregate impact of expansion of an upper secondary program on long-term wages, earnings and employment are ambiguous, as there are several, potentially contradicting, forces at play. In order to gain a full understanding regarding what is driving any aggregate estimated effects, it is useful to study a broad list of potential mediators. One contribution of this paper is to provide estimates on a broad range of outcomes, including many of the possible effects listed above.

## 3.3 Data, variables and sources

This section describes the outcome variables, the regression sample and covariates (more details, including a full list of the outcome variables, are presented in Appendix section A1). The program supply variables, as well as the school region covariates related to the supply decisions, were thoroughly explained in section 3.1 and are thus omitted here. The regression sample is based on the 16-year-old population residing in each school region. As previously explained, the school regions in Stockholm county are excluded from the regression sample, since they were subject to a special joint admission regulation, which weakens the link between student admissions and school region supply changes. Results when including the Stockholm school regions treated as one joint unit, are presented in the Appendix section A3.

I generate four labour market outcome variables that capture various degrees of intensive/extensive margin effects. The first is the natural log of the full-time equivalent monthly wage at age 42, from Statistics Sweden's "Structural wage register" (*Lönestrukturstatistiken*). This covers all public sector workers; all private sector workers in large firms; and a subsample of private sector workers in small firms. The wage regressions are weighted with the inverse of the response rate.[22] A second complementary variable, in the form of the natural log of a 3-year average of annual earnings above the 35$^{th}$ percentile of the

[22] In order to avoid that a small number of extremely large weights have a very strong influence on the estimates, the main results used weights after replacing values above 10 with that value, which approximately corresponds to the 99$^{th}$ percentile of the distribution. Results using no sampling probability weights, or not replacing values above 10, respectively, are shown in Appendix Section A2.3.

earnings distribution, is added in order to facilitate comparison with Dahl et al. (2023), who use that measure of earnings as their main outcome variable.[23] Third, I generate the natural log of annual earnings without excluding lowest 35% of observations. For this measure, I replace very small values, below 15 000 SEK – approx. 1500€ – with that amount before taking logs in order avoid very large jumps in the natural log-function for observations near zero. Fourth, an employment indicator capturing a reasonably strong attachment to the labour market at age 42 is added as a measure of the extensive margin effect. It is defined as having annual earnings corresponding to at least 50% of the median annual earnings among 45-year olds.[24] The earnings and employment variables are based on population level register data from Statistics Sweden.

Table 3 shows the average values of the wage, earnings and employment variables by program group. The highest wages, earnings and employment levels are found among students of the academic programs (with the highest levels within this group for students of Natural Science and Engineering, followed by Business, Social Science and Humanities; these figures are available upon request). Among the non-academic programs, the vocational technical/industry/agriculture sectors have the highest levels of wages, earnings and employment, followed by the non-academic general programs. The lowest levels of employment, earnings and wages can be found among the welfare/health/consumption sectors.

**Table 2. Average wage, earnings and employment measures by program category, among students starting upper secondary education in 1975–1986.**

| | Academic | Non-academic general | Vocational Welfare /Health/Cons | Vocational Tech/Ind/Agri |
|---|---|---|---|---|
| Wage | 37 412 | 28 490 | 25 828 | 29 386 |
| Earnings>35pctile | 457 695 | 345 660 | 298 436 | 362 396 |
| Earnings | 391 511 | 288 355 | 242 076 | 305 366 |
| Employed | 0.86 | 0.80 | 0.76 | 0.83 |
| Number of students | 442 253 | 174 127 | 239 712 | 311 333 |

*Note: Wages and earnings are measured in SEK (1 SEK approximately equals 0.1€) and in year 2018 monetary value. The wage information is available for a subsample of the population. The table shows the average wage based on the available observations.*

[23] Dahl et al. (2023) study earnings at age 37–39, whereas I measure earnings at age 41–43.
[24] This variable was inspired by Erikson et al. (2007), who propose it as a measure of a reasonably strong labour market connection. It was also used by e.g. Forslund et al. (2017).

In addition to the labour market outcomes described above, a large number of additional outcomes will be analysed. They include variables related to:

i) Admission and graduation from upper secondary educations: dummy variables for admission to and graduation from upper secondary school – over all and by program group.

ii) Youth employment: a dummy variable for having a relatively substantial amount of yearly earnings at age 16. Small yearly earnings are counted as non-employment, since the aim is to capture employment as an alternative to upper secondary education.[25]

iii) Application choices, motivation and matching: dummy variables for listing a program as top choice in the application to upper secondary school; dummy variables for being admitted to the most preferred (measured as top listed) program; and a continuous variable for students' final GPA from lower secondary school (grade 9).[26]

iv) The classroom environment: the average lower secondary (grade 9) final GPA of the students that are admitted to the same program and school region (peer effects) and the number of students admitted per class (proxied for by the number of admitted students per number of classes per program, year and school region according to the December-decisions; the actual class allocation is unobserved).

v) Long-run educational impacts: Dummy variables for the field and level of education attained by the age of 42.

Needless to say, the list of outcomes is long, which means that by chance, some of the coefficient estimates will turn up statistically significant in the regression analysis. I address this by interpreting the results with caution; focusing on the joint patterns for groups of similar outcomes rather than on isolated occurrences of statistical significance.

Finally, student background variables will be employed to test if the empirical strategy is sound in a balance-on-covariates type analysis, and will later be added as covariates to the regression analysis in order to increase the efficiency of the estimations. These variables

[25] Another alternative to upper secondary education is taking part in shorter courses, so called "special courses". Whereas I have access to some information on such course taking, the quality varies over the years, and I will therefore not make use of the data.

[26] The information on lower secondary final GPA available in the data is limited to students who have applied to upper secondary education. Data on the approximately 10 percent of individuals with missing final GPA is therefore imputed based on the observable student background characteristics, using the STATA mi command and taking the average over 20 imputed values.

include parental earned income; parental employment status; the age of the parents at the birth of the student; indicators for marriage status of the parents; indicators for being born in Sweden or not, for students and parents; and student gender. The time-varying student background variables are measured at age 15 of the student, the year prior to the normal upper secondary school start age when they are included as covariates in the regressions.

# 4. Results

The below section starts by showing evidence in support of the conditional exogeneity of the upper secondary program supply variation, and then moves on to present the estimated impacts of increased supply on students' admissions and graduations, other short-term and intermediate outcomes, and long-term wages, earnings and employment.

## 4.1 Balance-on-covariates analysis

As previously mentioned, a causal interpretation of the estimated supply effects of this paper requires that the variation in local supply of academic programs is exogenous conditional on the fixed effects and school region control variables of equation (1). While the conditional exogeneity assumption cannot be fully tested, the available data can be used to perform an informal check by replacing the outcome variable of equation (1) with pre-determined student characteristics. Precisely estimated zero supply-coefficients will be viewed as support for the exogeneity assumption, whereas non-zero estimates are a cause for worry.

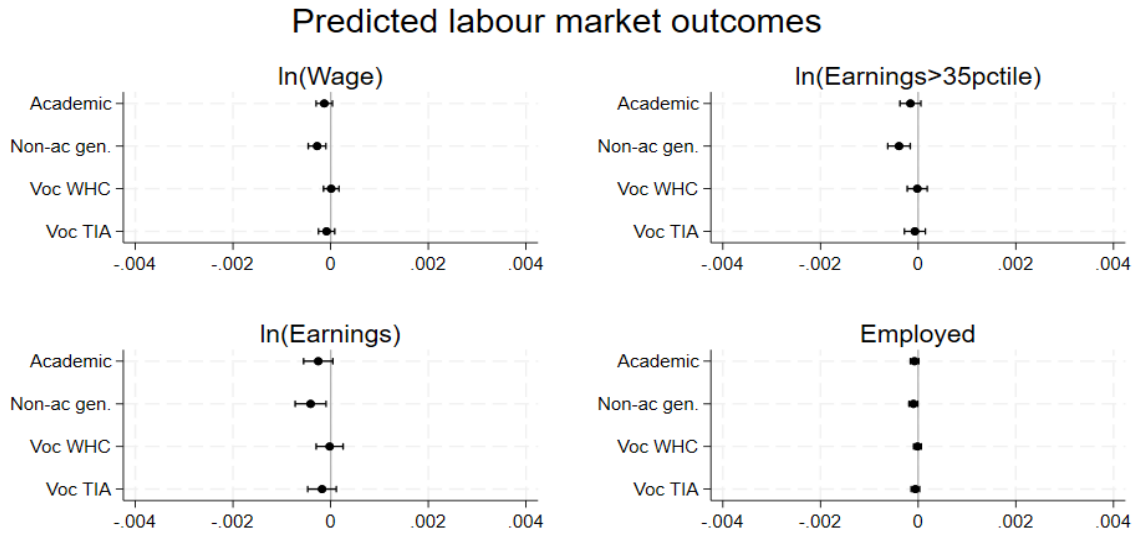
I carry out this type of "balance-on-covariates"-analysis in two ways: First, I run the above regression for each of the available student covariates separately. This yields very small and precisely estimated coefficients (results are presented in the Appendix section A2.2).[27] It can be noted that this analysis presents estimates for the parents' earnings and employment measured both as students are 15 (the year prior to starting upper secondary school), and 16 (the upper secondary school start age). If upper secondary program supply changes were correlated with local labour market changes, such as a new factory location influencing the supply of a related educational track, and this is not sufficiently controlled for by the covariates and fixed effects of the regression equation, we would expect this to show up in the earnings and employment of the local adult population – including the students' parents.

[27] Some of the coefficients are statistically significantly different from zero, but the 95% confidence intervals are always very small in relation to the average variable value.

It is therefore reassuring that these coefficients – measured both the year prior to and during the upper secondary school start age – are precisely estimated around zero.

Second, in order to aggregate all student background information in a way that is relevant for the ultimate outcomes of this study – the labour market variables – I run regressions for the *predicted values* for each of the four wage, earnings and employment measures. The predicted values are based on all student background covariates that are predetermined in relation to the treatment (i.e. measures that are either time-invariant or measured the year students turn 15 – the year prior to the regular upper secondary school start age), with the aim to generate a set of composite indices of students background that are relevant for the main outcome variables.[28]

**Figure 5. Upper secondary program supply impact on students' predicted future labour market outcomes.**




95% confidence intervals, based on standard errors clustered at admission round level. Voc WHC denotes Vocational Welfare/Health/Consumption, and Voc TIA Vocational Tech/Industry/Agriculture related programs.
School regions by year observations are weighted according to school age population size. Stockholm school regions are excluded.
The outcome variables were predicted based on the following variables: Dummy variables for parental marriage status, employment, age at birth of child, whether or not born in Sweden, dummy variables for child gender and whether or not born in Sweden, logged earnings of father, and logged joint earnings of both parents. All time-varying variables are measured at age 15 of child. The regressions include fixed effects for year, 2-year school region round, and time period within round, school region variables for lagged local school age population, lagged admissions and applications per slot.

The estimated coefficients (Figure 5) are close to zero and precisely estimated (the coefficients and their confidence intervals are presented with the same x-scale as will be used for most of the other outcomes, in order to facilitate comparison). The exception is the non-academic general program group, for which a supply increase is statistically significantly negatively associated with the labour market outcomes, although the estimated coefficients

[28] The predictions were based on linear regression models, and the list of predictors is reported in the Appendix section A2.2. The results from alternative prediction models, which for example allowed the coefficients to vary between the gender, yielded very similar results, as can be seen in the Appendix section A2.2.

are small and precisely estimated. Overall, I interpret the results as providing strong support for the conditional exogeneity assumption for the groups of academic and vocational programs, and relatively strong support in case of the non-academic general group of programs, where the estimated coefficients in Figure 5 are admittedly statistically different from zero, but still precisely estimated close to zero.

## 4.2 Impact on upper secondary admissions and graduation rates

In this section, I start by investigating how upper secondary admissions and graduations were affected by increased program supply.

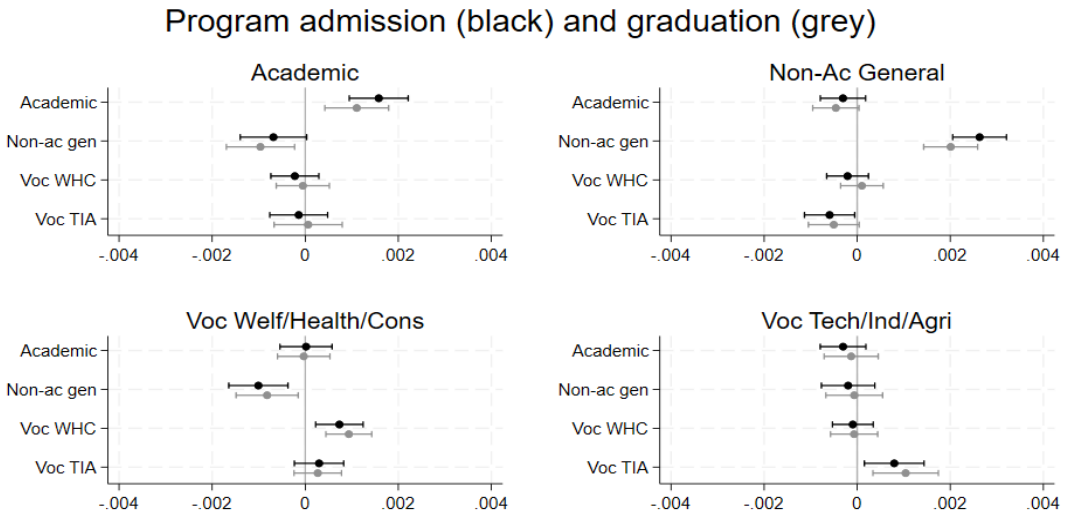
The results in Figure 6 (black markers) first of all show that the impact of supply expansion on admissions goes in the expected direction: more supply of a program increases the admission likelihood to the same program. The impact of the non-academic general program group is the strongest. It also seems to give rise of a re-shuffling of students from the academic and vocational technical/industry/agriculture sectors. For the latter group, a reverse cross-effect, in the form of a negative impact on the non-academic general program attendance, is also visible. The estimated own-program coefficients for the vocational programs are smaller, possibly due to lower demand in relation to supply for these programs (recall that Figure 2 indicated over-supply, in the form of a high number of planned slots in relation to admissions, for the vocational welfare/health/consumption program group).

Figure 6 also shows the impact on the likelihood to graduate from the program group (grey markers). The estimates are, as expected, similar to the admission coefficients – although a bit smaller in size (although not significantly different) among the non-vocational programs. Possibly, this reflects that students who were admitted to the more theoretical academic and non-academic general programs, as a result of expanding supply, did not manage to graduate in the same proportion.

Over all, the estimated effect sizes are rather small. The local supply variables are defined as number of slots per 100 prospective students, meaning that the coefficients reflect the impact of one more slot per 100 students. A 1:1 correspondence between changes in slots and admission likelihood would thus result in a 0.01-coefficient – almost four times the largest of the estimated coefficients in Figure 6. There are however plenty of reasons to expect coefficients of smaller magnitude than 0.01. First, the supply variables are likely to be measured with error, since they reflect the December-decisions and not the final allocations

(recall that the supply decisions could be modified during the spring). [29] To the extent that such measurement errors are classical they cause downward bias, resulting in smaller coefficients. Second, not all new slots may have been filled when a new class was added to a school region. Conversely, down-sizing probably tended to occur when classes could not be filled. Such patterns would also give rise to a weaker link between supply expansion and admissions. Third, attendance is measured in the fall term, after some students may have dropped out or changes tracks.

**Figure 6: Upper secondary program supply impact on admission and graduation rates.**



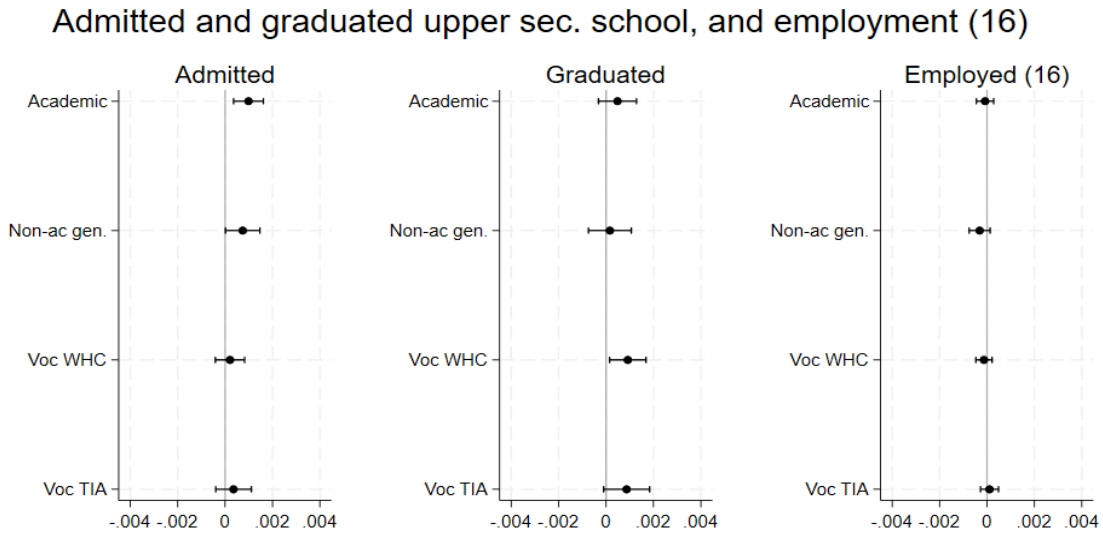

95% confidence intervals, based on standard errors clustered at admission round level. Voc WHC denotes Vocational Welfare/Health/Consumption, and Voc TIA Vocational Tech/Industry/Agriculture related programs.
School regions by year observations are weighted according to school age population size. Stockholm school regions are excluded.
The regressions include fixed effects for year, 2-year school region round, and time period within round, school region variables for lagged local school age population, lagged admissions and applications per slot, local taxable income, individual levels covariates for gender and immigrant status, and parental immigrant, employment and marital status, age at birth of child, and family income.

Figure 7 shows how increased program supply affected the chances that local youth were accepted to any upper secondary program (left-hand panel); had graduated from any upper secondary program by age 20 (mid panel); or were employed with reasonably substantial earnings at age 16 (right-hand panel). The figure shows that, whereas more supply of the academic and non-academic general groups of programs had a positive impact on upper secondary school admissions, there is no significant indication that they increased the overall upper secondary graduation rate. For the vocational programs there is on the other hand no

[29] Another cause for measurement error is that the supply variable denominator, the local student age population, is measured at the end of year t-1 and some students may move during the spring. The link between student and school region is furthermore associated with some uncertainty for students residing in small municipalities that lack own upper secondary school (see Appendix section A1.3 for details). This means that the school region-variable itself is measured with error for these programs, since these programs catered also to students in other regions. This issue is particularly relevant for the groups of vocational programs, as they included some programs that were too small to be offered in all school regions – something that may explain the smaller coefficients for these program groups.

discernable effect on overall admission rates – but a positive impact on the upper secondary graduation rate. Possibly, this reflects the lower theoretical content of the vocational programs. They are also shorter than the academic programs. None of the program types seem to have affected the employment participation among local youth (right-hand panel of Figure 7).

**Figure 7. Upper secondary program supply impact on admission and graduation from any upper secondary program.**



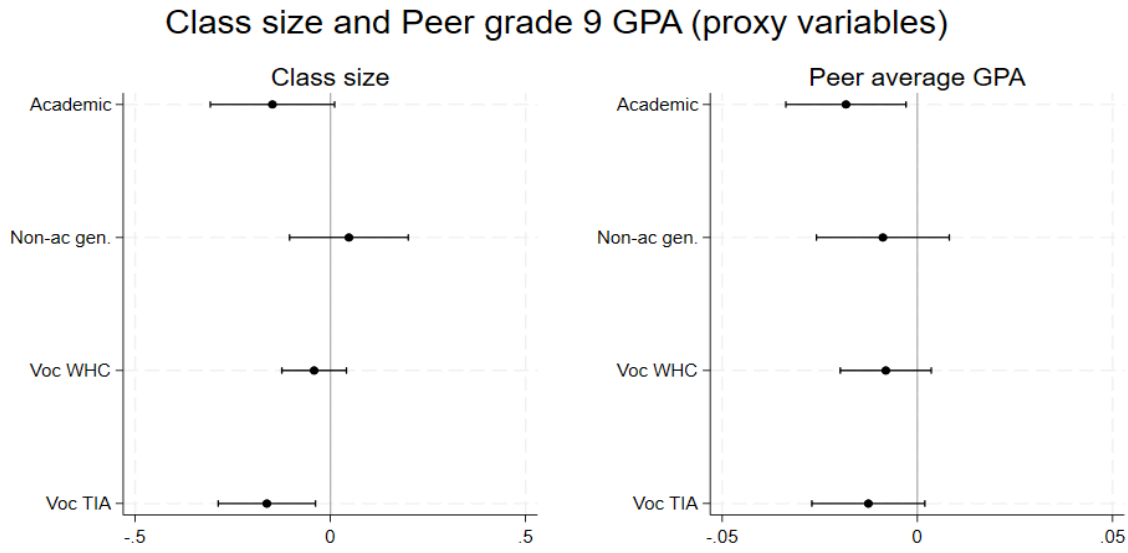

95% confidence intervals, based on standard errors clustered at admission round level. Voc WHC denotes Vocational Welfare/Health/Consumption, and Voc TIA Vocational Tech/Industry/Agriculture related programs.
School regions by year observations are weighted according to school age population size. Stockholm school regions are excluded.
The regressions include fixed effects for year, 2-year school region round, and time period within round, school region variables for lagged local school age population, lagged admissions and applications per slot, local taxable income, individual levels covariates for gender and immigrant status, and parental immigrant, employment and marital status, age at birth of child, and family income.

## 4.3 Impact on applications, lower secondary final grades, school peer composition and class sizes

As discussed around Figure 4, changing upper secondary program supply may affect aspects such as student behaviour during the final term of lower secondary education, or the school environment they meet when they enter upper secondary school. Figure 8 suggests that that adding program slots led to students on average being surrounded by fewer (smaller class sizes) and scholastically less able peers in school, as measured by their final GPA from lower secondary education (peers are defined as those admitted to the same program and school region). At least this is suggested by the coefficients in Figure 8, although most of the 95% confidence intervals cover zero. Figure 9 shows statistically significant and larger class size coefficients when separate regressions are run for the class size in each respective program

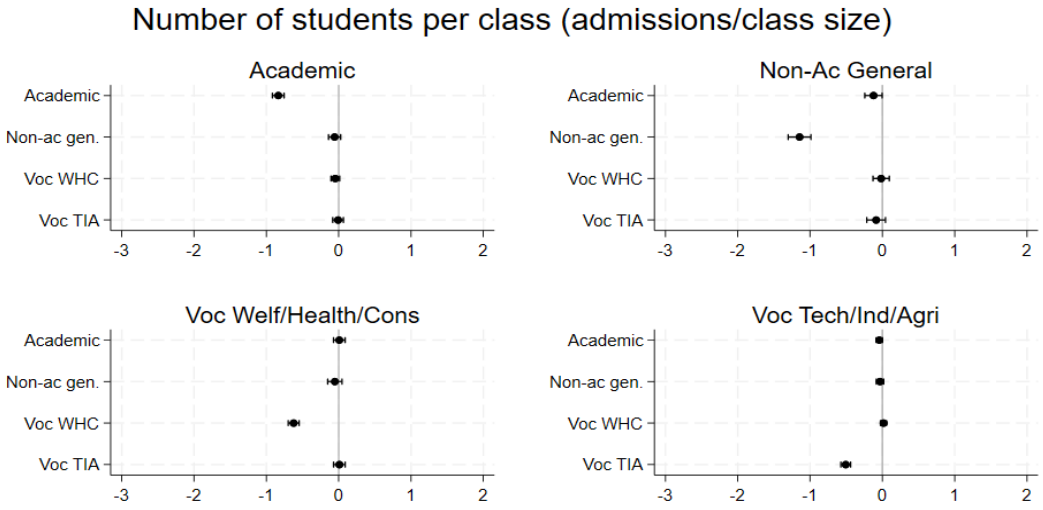
group. There is thus clear evidence that increased supply reduced average class sizes in the same program group – although the reduced form impact when averaged over all students, attending all types or programs, in Figure 8 is somewhat muted.

**Figure 8. Upper secondary program supply impact on class size (proxied for by admissions/December decision classes per program, year and school region) and school peer grade 9 GPA (proxied for by students in the same program, year and school region.**




95% confidence intervals, based on standard errors clustered at admission round level. Voc WHC denotes Vocational Welfare/Health/Consumption, and Voc TIA Vocational Tech/Industry/Agriculture related programs.
School regions by year observations are weighted according to school age population size. Stockholm school regions are excluded.
The regressions include fixed effects for year, 2-year school region round, and time period within round, school region variables for lagged local school age population, lagged admissions and applications per slot, local taxable income, individual levels covariates for gender and immigrant status, and parental immigrant, employment and marital status, age at birth of child, and family income.

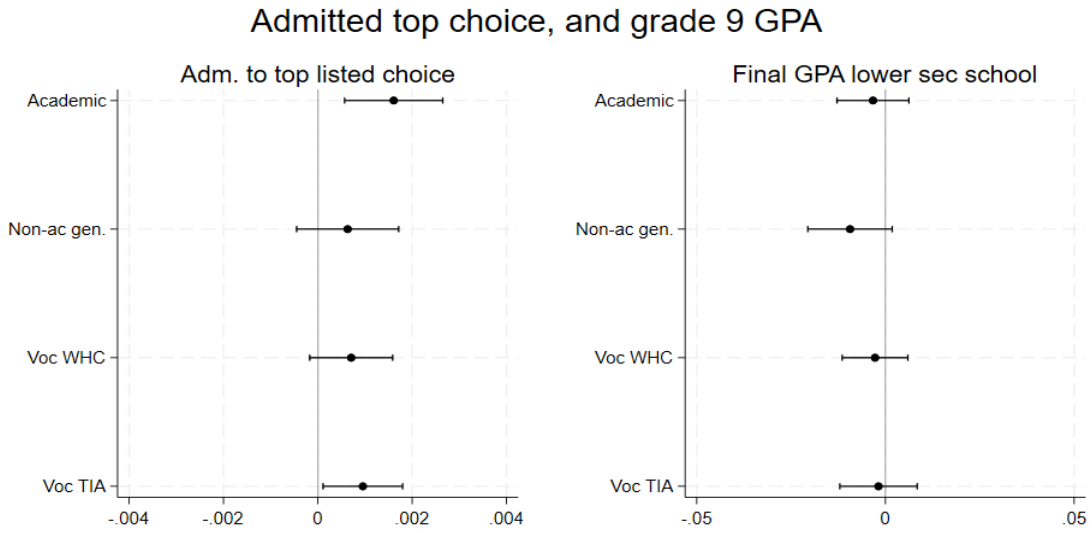
**Figure 9. Upper secondary program supply impact on class size per track type (proxied for by admissions/December decision classes per program, year and school region).**




95% confidence intervals, based on standard errors clustered at admission round level. Voc WHC denotes Vocational Welfare/Health/Consumption, and Voc TIA Vocational Tech/Industry/Agriculture related programs.
School regions by year observations are weighted according to school age population size. Stockholm school regions are excluded.
The regressions include fixed effects for year, 2-year school region round, and time period within round, school region variables for lagged local school age population, lagged admissions and applications per slot, local taxable income, individual levels covariates for gender and immigrant status, and parental immigrant, employment and marital status, age at birth of child, and family income.

Higher supply furthermore increased the share of students that were admitted to the top listed option (Figure 10), although not all coefficients are significant at the five percent level. It was however also associated with a higher likelihood of listing the program in question as the top choice, at least for the non-vocational programs (Figure 11) – something that would have dampened the impact on being admitted to the top choice.[30] There is no strong indication that a higher supply affected the students' own GPA from lower secondary school (all coefficients are negative, but not statistically significantly different from zero, see Figure 10). This is perhaps not surprising, given that many students may have been unaware about the planned supply, and only had a limited time (the spring term) to react to the December supply announcements.

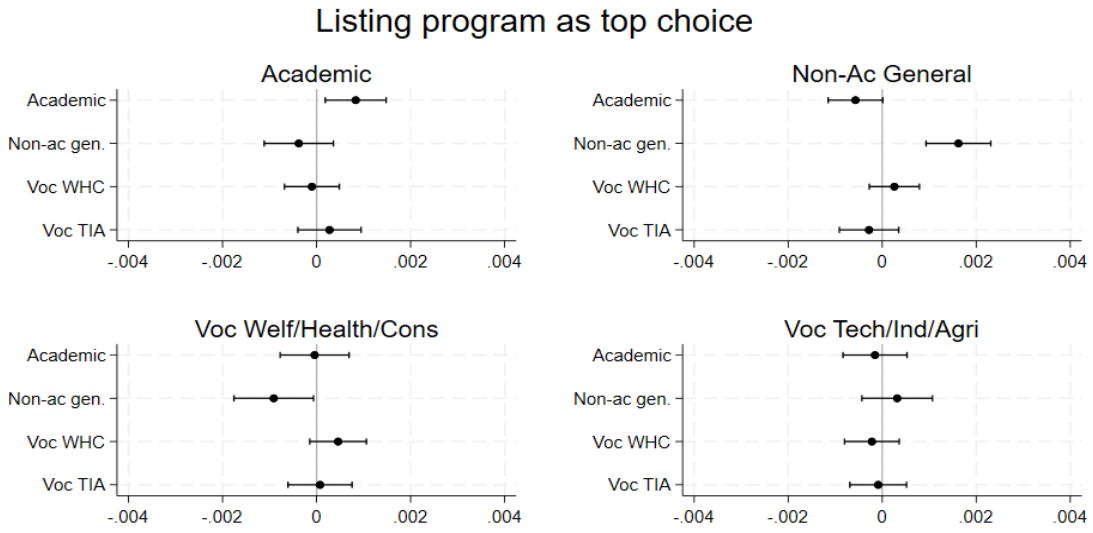
**Figure 10. Upper secondary program supply impact on being admitted to the top listed program, and students' final GPA from lower secondary school.**




95% confidence intervals, based on standard errors clustered at admission round level. Voc WHC denotes Vocational Welfare/Health/Consumption, and Voc TIA Vocational Tech/Industry/Agriculture related programs.
School regions by year observations are weighted according to school age population size. Stockholm school regions are excluded.
The regressions include fixed effects for year, 2-year school region round, and time period within round, school region variables for lagged local school age population, lagged admissions and applications per slot, local taxable income, individual levels covariates for gender and immigrant status, and parental immigrant, employment and marital status, age at birth of child, and family income.

[30] Since students choose which program to list as top choice among all programs, a multinomial choice model would in principle be a more appropriate model. Given the complicated structure of the regression model, including several fixed effects, I have chosen the simpler alternative of estimating separate regressions for each program group.

**Figure 11. Upper secondary program supply impact on listing program as top choice.**




95% confidence intervals, based on standard errors clustered at admission round level. Voc WHC denotes Vocational Welfare/Health/Consumption, and Voc TIA Vocational Tech/Industry/Agriculture related programs.
School regions by year observations are weighted according to school age population size. Stockholm school regions are excluded.
The regressions include fixed effects for year, 2-year school region round, and time period within round, school region variables for lagged local school age population, lagged admissions and applications per slot, local taxable income, individual levels covariates for gender and immigrant status, and parental immigrant, employment and marital status, age at birth of child, and family income.

## 4.4 Long run impact on long terms wages, earnings and employment, and level and field of education

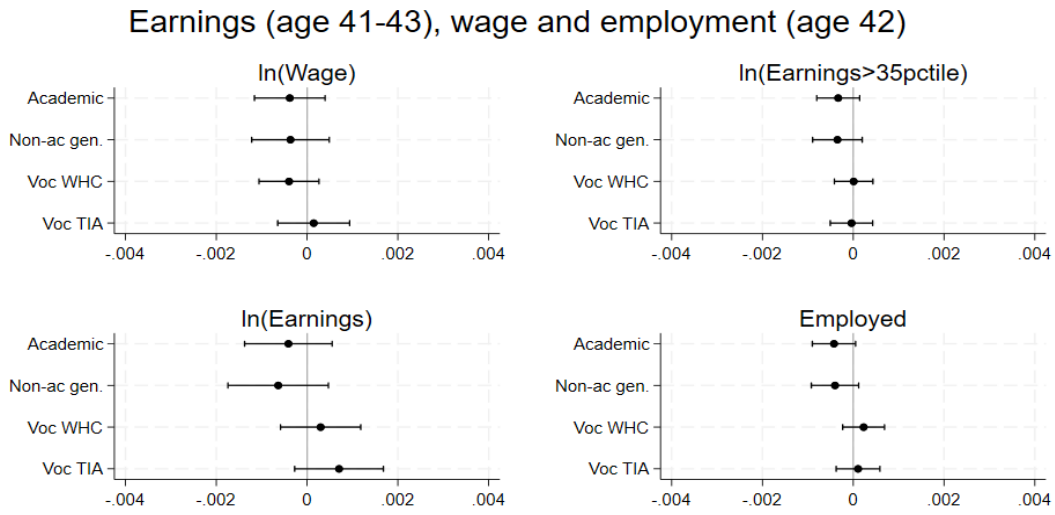
The results in previous sections suggested that that program supply changes affected not only the admission and graduation chances to the different tracks, but also aspects related to student motivation (admission to the most preferred program), class sizes and the academic ability of the school peers. In addition, vocational program supply was associated with higher overall graduation rates, whereas non-vocational program supply led to overall more admissions to upper secondary school, but not to more graduations.

The expected impacts of these aspects on the long term labour market outcomes can go in different directions (Figure 4). It is therefore perhaps not surprising that the estimated average effect of education program supply changes on the long-term labour market outcomes of local youth are statistically insignificant (Figure 12). This holds for all four outcome variables; the log of wages, the two log earnings variables, and employment. The estimates are however not precise enough to be interpreted as zero effects: the 95% confidence intervals in many cases encompass absolute values of 0.001, and sometimes approach 0.002 in absolute value. In order to illustrate what this means, let us consider the earnings effect of the vocational technical/industry/agriculture related program group, for which the confidence interval almost covers 0.002 (bottom left of Figure 12). An effect size of this magnitude

(0.002) means that adding one more slot per 100 local school age youth – an increase amounting to approximately 5% of the average supply of the program group – raises the average earnings of the school age youth of that school region cohort with 0.2 percent measured around 25 years later.[31] This may seem very small, but considering that the estimate reflects the reduced form effect averaged over all local school age youth, it is probably more reasonable to characterize it as fairly modest but non-trivial. The overall message from Figure 12 is thus that there is no evidence of any long-term labour market effects of the upper secondary program supply changes on local youth, but also that we cannot rule out non-zero effects.

Additional results available in the Appendix section A2.3 show that the same pattern holds for students' highest level or field of education by age 42; most coefficinets are insignificant but also too imprecise to rule out a zero impact.

**Figure 12. Upper secondary program supply impact on wages, earning and employment.**




95% confidence intervals, based on standard errors clustered at admission round level. Voc WHC denotes Vocational Welfare/Health/Consumption, and Voc TIA Vocational Tech/Industry/Agriculture related programs.
School regions by year observations are weighted according to school age population size. Stockholm school regions are excluded.
The regressions include fixed effects for year, 2-year school region round, and time period within round, school region variables for lagged local school age population, lagged admissions and applications per slot, local taxable income, individual levels covariates for gender and immigrant status, and parental immigrant, employment and marital status, age at birth of child, and family income.

## 4.5 Additional results

This section summarizes the results of additional estimations.

First, separate estimations by gender, available in Appendix section A2.4, show evidence of gender patterns that are in line with expectations given the strong gender divide between the

[31] The coefficients shown in the figures reflect a supply increase of 1 slot per 100 school age youth, and the average supply of the vocational technical/industry/agriculture program group was around 20 slots per 100 school age residents (see Appendix section A2.1 for the distribution)

two groups of vocational programs that was shown in Table 2. Most notably, there is a stronger admission response among male youth to increased supply in vocational technical/industry/agriculture programs than among females. The "cross-effect" that emerged from Figure 6 – that more supply of non-academic general programs reshuffled local youth away from vocational welfare/health/consumption programs – is stronger among the female youth. No strong patterns of impacts on the long-term labour market outcomes are detected for any gender; the coefficient for academic program supply is negative and statistically significant at the five percent level for employment among females in the baseline specification (weighted with school age population size), but turns insignificant in alternative specifications giving equal weight to all school regions (results available upon request).

Second, in order to investigate the impact of changing supply on earnings measured over the age-profile, I estimated separate coefficients for the program supply variables on earnings[32] for each age from 16 to 43. The results, available in Appendix section A2.5, confirm the non-significant patterns of results shown in Figure 12; the estimated coefficients are hardly ever statistically significant at the five percent level.

Third, in order to investigate the impact of each program within the academic category, I replaced the academic program group supply variable with separate supply variables for the five academic programs Natural Science, Engineering, Social Science, Humanities, and Business. As can be seen in Appendix section A2.6, the supply impacts on admissions to the same program were stronger for the Social Science, Humanities and the Business programs than for Natural Science and Engineering. Increased supply of the latter two did furthermore *not* significantly affect the likelihood to graduate from the program – possibly a combination of the small admission effect and the fact that these programs included more advanced Math and Science courses. No strong patterns of effects were found for the long-term labour market outcomes; a couple of coefficients were statistically significant at the five percent level (Business program supply on wages, and Social Science on employment), but given the large number of estimated coefficients, these shall be taken with a grain of salt. Over all, there is no strong evidence of any positive impact of increased supply of the separate groups of academic programs; possibly some, but weak, indication of a negative impact.

[32] This set of regression uses a slightly different earnings measure than the main regressions, namely one that excludes earnings relating from sickness and parental benefits, since this was not available for all ages. The earnings measure for the age-coefficients was furthermore gathered from two data sources; for outcome years until and including 1999, the IoT-register earnings variable was used, and from 2000 onwards the LISA-register earnings variable.

Finally, I investigated if the impact of supply changes differed depending on whether the change took place in a setting where the admission threshold to get into the program was high – or low. This analysis was run for each of the Academic programs.[33] This was done by, for each of the programs, generating two separate regression samples: one where the admission threshold in the first of the two years of the stacked data rounds was high (defined as above or at 3.0, i.e. approximately at the centre of the threshold distribution, see Appendix A2.6), and one where it was low (below 3.0).[34] The results are mostly insignificant. One exception is a statistically significant negative effect of increased supply of the Business program on wages and earnings in the sample where the increase took place from a low initial admission threshold. Although this result shall be taken with a grain of salt – after all, hardly any other statistically significant effects were found for the other cases – it is possible that expanding this program when admission thresholds were already low, thereby allowing students with very low grades to enter the program, had overall harmful effects on local youth's labour market outcomes.

# 5. Concluding discussion

To conclude, this study has found that changing supply of upper secondary programs in Sweden during the 1970s and -80s affected several aspects related to local youth's education: More supply of a program group increased admissions to it, and sometimes decreased admissions to other fields. This effect furthermore had a stark gender component: For female students higher supply of non-academic general programs had a particularly strong positive impact on admission rates to the same program group, and a negative cross-effect on admissions to vocational welfare/health/consumption programs. The supply effect on vocational industry/technical/agriculture programs was on the other hand only present among male students. The positive impact of supply on admissions was in general also reflected in a higher likelihood to graduate from the expanding program group.

Increased supply also raised the overall chances that local youth were admitted to, and graduated from, any upper secondary program. Whereas the overall admission effect was significant only for increased supply of the non-vocational program groups, the reverse held for the overall graduation effect; this was only present for the vocational program supply. The pattern might reflect that the vocational programs are shorter (than the academic programs)

[33] I did not run these regressions for the other program groups, as they contain many, often smaller, programs.
[34] The true admission thresholds are unobserved. I therefore use proxy variables measured as the GPA for the last admitted student.

and likely academically easier to complete than the other more theoretical programs. The result can be viewed as in line with Hall (2012), who found that increasing the duration and theoretical content of (vocational) programs led to more dropouts among low ability students.

However, the study finds no clear evidence of an impact on long-run wages, earnings and employment. This contrasts to the recent RD-based studies by Dahl et al. (2023) and Silliman and Virtanen (2022), who both find that upper secondary field of study matters for long run earnings. It shall however be underlined that the present study estimates another type of effect, and for a broader group of youth. Whereas RD-studies estimate the impact of admission to a certain program instead of another, they do not estimate the over-all effects on local youth of changing the supply of an upper secondary program. They will hence not estimate effects in the form of e.g. increasing the aggregate intake to and graduation from upper secondary school; or ripple-effects on admissions to other programs. The RD-studies are also limited to estimating the impact on students with a specific preference ordering (depending on what field combination is studied), who are near the admission threshold, and to cases where the admission threshold is binding (not all who apply are accepted).[35] In the Swedish upper secondary context, this implies relatively well- but often not top-performing students.[36]

This study, on the other hand, measures the impact of changing local program supply from one year to another, on the full local school age population. This means that the estimated effects of increased supply of, say, academic programs, on the local school age population, contains not only the effect of increased admissions to the academic track, but also potential ripple effects on other students who gain access to slots in other tracks that open up due to the expansion of academic program slots. That such effects can be important is illustrated by Gandil (2022), who shows that ripple effects account for a substantial share of the total estimated earnings impact of local college supply changes in Denmark.[37] As a result, a supply change affects not only the program group in question, but potentially all students, as a result of changing admission patterns and consequently also peer groups.

[35] Angrist and Rokkanen (2015) discuss RD identification and estimation away from the admission threshold with an application using data from Boston exam schools

[36] Figure 2 in Dahl et al. (2023) shows that the distribution of the admission cutoffs used in their regression analysis are centered a bit over 3, which is approximately equal to the average 9th grade GPA of students during the period.

[37] Dalla Zuanna et al. (2022) is another example of a study of groups of students who are "treated" in different ways: they show that introducing grade-based admission to upper secondary schools in Norway benefited students who gained access, but was detrimental for students who were crowded out of popular schools.

The non-significant long-term labour market results of this study may thus be a result of the many short-term education-related effects working in different directions. That such aspects are relevant to consider, was shown by the results of this study on e.g. school peers, class sizes and upper secondary applications. An interesting field for future studies would be to further investigate under which conditions increased access to education – in terms of level and specialization – improves student outcomes, in monetary as well as social terms.

# References


Altmejd, A., A. Barrios-Fernandez, M. Drlje, et al. (2021). “O Brother, Where Start Thou? Sibling Spillovers on College and Major Choice in Four Countries.” *Quarterly Journal of Economics* 136 (3): 1831–1886.

Altonji, J G, Arcidiacono, P and A Maurel (2016), "The Analysis of Field Choice in College and Graduate School: Determinants and Wage Effects", in vol 7 of Handbook of the Economics of Education vol 5, pp. 305-396, Editors: Eric A. Hanushek, Stephen Machin, Ludger Woessmann, Elsevier, doi.org/10.1016/B978-0-444-63459-7.00007-5.

Angrist, J and M Rokkanen (2015). “Wanna Get Away? Regression Discontinuity Estimation of Exam School Effects Away from the Cutoff”, *Journal of the American Statistical Association* 110(152): 1331–1344. https://doi.org/10.1080/01621459.2015.1012259

Card, D and A Payne (2002). "School finance reform, the distribution of school spending, and the distribution of student test scores," *Journal of Public Economics*, vol. 83(1): 49-82.

Currie, J and E Moretti (2003). “Mother's Education and the Intergenerational Transmission of Human Capital: Evidence from College Openings”, *The Quarterly Journal of Economics*: 118(4)1495–1532.

Carneiro, P, Liu, K and K G Salvanes (2018). “Supply of Skills and Endogenous Technical Change: Evidence from a College Opening Expansion Reform.” CEPR Working paper no. 13045, and forthcoming in the *Journal of the European Economic Association*.

Dahl, G., D.-O. Rooth, and A. Stenberg (2021). Intergenerational and Sibling Peer Effects in High School Majors. Working Paper 27618. National Bureau of Economic Research.

Dahl, G, Rooth, D-O and A Stenberg (2023). “High School Majors and Future Earnings”, *American Economic Journal: Applied Economics* 15(1): 351–382. https://doi.org/10.1257/app.20210292

Dalla Zuanna, A, Liu, K and K G Salvanes (2022). "Pulled-in and Crowded-out: Heterogeneous Outcomes of Merit-based School Choice" CEPR Discussion Paper DP16853.

Delaney, J M and P J Devereux (2022). “Rank Effects in Education: What Do We Know So Far?” IZA DP No. 15128.

Epple, D and Romano, R E (2011). “Peer effects in education: A survey of the theory and evidence.” In *Handbook of Social Economics* vol 1: 1053–1163. Elsevier.

Erikson, R, Nordström Skans, O, Sjögren, A and O Åslund (2007) ”Ungdomars och invandrades inträde på arbetsmarknaden 1985–2003”, IFAU-rapport 2007:18.

Falch, T, Lujala, P, and Strøm, B (2013). "Geographical constraints and educational attainment." Regional Science and Urban Economics, 43(1), 164-176.

Fidjeland, A (2023). “Using high-stakes grades to incentivize learning” *Economics of Education Review* 94, 102377.

Fischer, M, Karlsson, M, Nilsson, T and N Schwarz (2020). ”The Long–Term Effects of Long Terms – Compulsory Schooling Reforms in Sweden”. *Journal of the European Economic Association* 18(6): 2776–2823. doi.org/10.1093/jeea/jvz071

Forslund, A, Liljeberg, L and O Åslund (2017). ”Flykting- och anhöriginvandrades etablering på den svenska arbetsmarknaden”, IFAU-rapport 2017:4.

Gandil, M H (2022). “Substitution Effects in College Admissions”, Manuscript https://github.com/MikkelGandil/papers/raw/master/SubstitutionEffectsCollege.pdf

Gibbons, S, & Vignoles, A (2012). Geography, choice and participation in higher education in England. Regional science and Urban Economics, 42(1-2): 98-113.

Golsteyn B H H and A Stenberg (2017). "Earnings over the Life Course", Journal of Human Capital 11(2): 167-212.

Goodman-Bacon, A (2021). “Difference-in-differences with variation in treatment timing.” *Journal of Econometrics* 225: 254–277.

Goodman, J, Hurwitz, M and J Smith (2017). "Access to 4-Year Public Colleges and Degree Completion", Journal of Labor Economics 35(3): 829-867.

Grau, N, Hojman, D, and Mizala, A (2018). "School closure and educational attainment: Evidence from a market-based system." Economics of Education Review, 65: 1-17

Hall, C (2012). “The Effects of Reducing Tracking in Upper Secondary School”, *Journal of Human Resources* 47 (1): 237-269. https://doi.org/10.3368/jhr.47.1.237

Hall, C (2016). “Does more general education reduce the risk of future unemployment? Evidence from an expansion of vocational upper secondary education”, *Economics of Education Review* 52: 251-271. https://doi.org/10.1016/j.econedurev.2016.03.005.

Hampf, F and L Woessmann (2017). “Vocational vs. General Education and Employment over the Life Cycle: New Evidence from PIAAC.” CESifo Economic Studies 63 (3): 255–69.

Hanushek, E A, Schwerdt, G, Woessmann, L and L Zhang (2017). “General Education, Vocational Education, and Labor market Outcomes over the Lifecycle.” *Journal of Human Resources* 52 (1): 48–87.

Hämäläinen, U and R Uusitalo (2008). ”Signalling or Human Capital: Evidence from the Finnish Polytechnic School Reform”, Scandinavian Journal of Economics 110(4): 755-775.

Holmlund, H (2020). "A researcher’s guide to the Swedish compulsory school reform", *Journal of the Finnish Economic Association* 1: 25–50.

Kelchtermans, S, and Verboven, F (2010a). "Participation and study decisions in a public system of higher education." Journal of Applied Econometrics, 25(3), 355-391.

Kelchtermans, S, and Verboven, F (2010b). "Program duplication in higher education is not necessarily bad." Journal of Public Economics, 94(5-6): 397-409.

Kirkeboen, L J, Leuven, E and M Mogstad (2016). “Field of Study, Earnings, and Self-Selection.” *Quarterly Journal of Economics* 131 (3): 1057–111.

Lafortune, J, Rothstein, J and D Whitmore Schanzenbach (2018). "School Finance Reform and the Distribution of Student Achievement." *American Economic Journal: Applied Economics*, 10 (2): 1–26. https://doi.org/10.1257/app.20160567

Leuven, H and H Oosterbeek (2018) “Class size and student outcomes in Europe”, EENEE Analytical Report No. 33, Prepared for the European Commission.

Lovén, I, Hammarlund, C., and Nordin, M (2020). "Staying or leaving? The effects of university availability on educational choices and rural depopulation." *Papers in Regional Science*, 99(5).

Öckert, B (2010). "What’s the value of an acceptance letter? Using admissions data to estimate the return to college" *Economics of Education Review* 29(4): 504-516.

Rothstein, J and D W Schanzenbach (2022). “Does Money Still Matter? Attainment and Earnings Effects of Post-1990 School Finance Reforms.” *Journal of Labor Economics*, 40(S1): S141-S178. https://doi.org/10.1086/717934

Silliman, M and H Virtanen (2022) “Labour Market Returns to Vocational Secondary Education”, *American Economic Journal: Applied Economics* 14(1): 197–224. https://doi.org/10.1257/app.20190782.

Stronati, C (2023), “The design of upper secondary education across OECD countries: Managing choice, coherence and specialisation”, OECD Education Working Papers, No. 288, OECD Publishing, Paris, https://doi.org/10.1787/158101f0-en.

Tilley, L (2022). "The effect of higher-stakes grades on student achievement", Chapter in “Inputs and incentives in education”, Dissertation 2022:3, Department of Economics, Uppsala University.

# Government bills, reports and regulations referenced in the text

### Government reports (Statens offentliga utredningar SOU)

SOU 1973:48 Skolans regionala ledning.

SOU 1980:5 Förenklad skoladministration.

SOU 1989:10, SOU 1989:10 Två nya treåriga linjer i gymnasieskolan.

SOU 2014:5. Staten får inte abdikera – om kommunaliseringen av den svenska skolan.

2020:33 Gemensamt ansvar – en modell för planering och dimensionering av gymnasial utbildning.

### Regulations (Förordningar)

SFS 1971:235 Skolförordning (1971:235).

SFS 1984:618. Förordning (1984:618) om elevplatser i gymnasieskolan m.m.

### Government Bills (Propositioner)

Prop. 1973:77 KungI. Maj:ts proposition angående skolväsendets organisation i glesbygd m.m.

Prop. 1980/81:100 Prop. 1980/81:100 med förslag till statsbudget för budgetåret 1981/82.

Prop. 1980/81:107 Proposition 1980/81:107 om den statliga skoladministrationen m.m.

Prop. 1981/82:157 Proposition 1981/82:157 om flexibel skolplanering m.m.

Prop. 1985/86:10 Proposition 1985/86:10 om ny skollag m.m.

Prop. 1985/86:97 Proposition 1985/86:97 om statsbidrag till lärarlöner i gymnasieskolan.

### Documents from the National Archives mentioned in the text

Skolöverstyrelsens Dnr P 78:1566, `Planeringsunderlag för gymnasieskolan´ Skolöverstyrelsen, Planeringsavdelningen, P-avd (allm). Planeringsunderlag för gymnasieskolan 1977-1978. H IV:1.

Skolöverstyrelsens Dnr P 81:401, `Sökandetryck och platstillgång, planeringsunderlag för överväganden om gymnasieskolans dimensionering´ Skolöverstyrelsen, Planeringsavdelningen, P-avd (allm). Planeringsunderlag för gymnasieskolan 1980-1982. H IV:5.

Skolöverstyrelsen, Planeringsavdelningen, Planeringsunderlag för gymnasieskolan, SE/RA/420262/58/02/H/H IV/1.