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Abstract

We investigate how the introduction of free movement of workers affects enrolment of natives in tertiary education. In a difference-in-differences framework, we exploit a policy change that led to a significant increase in the share of cross-border commuters in local employment in border regions of Switzerland. Our results show a rise in enrolment at Universities of Applied Sciences in affected relative to non-affected regions in the post-reform period but no change in enrolment at traditional universities. Furthermore, we find that enrolment increases in non-STEM fields that build skills less transferable across national borders. This allows for complementarities with foreign workers who are more likely to hold occupations requiring STEM training. Individuals with a labor market oriented education such as vocationally trained respond to the increase in labor market competition because they have employment opportunities and access to tertiary education through Universities of Applied Sciences.

Keywords

Cross-border commuting, demand for tertiary education, study field choice, labor market conditions

JEL Classification

F22, I26, J24, J61, R23

1 Introduction

Higher education has gained momentum in the developed world with one in three people in the OECD holding a tertiary degree today. Schooling decisions have a significant impact on individual outcomes as there are substantial returns to acquiring higher education. Graduates with a tertiary degree earned on average 55% more than those with an upper-secondary degree in 2019 (OECD, 2020). Returns to education reflect the relative availability of skills in an economy and immigration can significantly alter the composition of the local labor force. Growing international mobility can be linked to immigration regulation. Migration within the EU is based on the free movement of persons principle and member countries of the EFTA have negotiated similar conditions with the EU. As the skill level of immigrants often defers from the one of natives, the induced change in the composition of the labor force is likely to have an impact on returns to education and could alter native incentives to demand schooling.

In this paper, we focus on an inflow of skilled foreign workers who could either encourage or discourage natives to enroll into tertiary education depending on how labor market outcomes are affected. This has been subject to a heated debate in the literature. The traditional view is that skill groups most affected by a migrant inflow face worse labor market conditions (Borjas, 1995; Borjas and Doran, 2012; Dustmann et al., 2012), suggesting that native incentives to accumulate human capital may be weakened. At the same time, there is evidence that skilled immigrants boost total factor productivity and innovation (Moser et al., 2014; Peri et al., 2015; Hunt, 2017), resulting in the opposite prediction. We contribute to this debate by exploring the role of labor market conditions in educational decisions. Answering this question is crucial to understand the long-run effects of rising foreign competition in the labor market.

Switzerland offers a unique setting to explore our research question. The Agreement on the Free Movement of Persons (AFMP) abolished restrictions to access the Swiss labor market for foreign workers from the EU and EFTA, including cross-border commuters. As a result, the number of frontier workers permanently increased. Since cross-border commuters reside abroad, they leave demand for goods and services in the country of work largely unaffected. Moreover, the Swiss education system enables us to isolate education demand from supply forces since fulfilling the admission requirements generally guarantees enrollment. Similar to other Western European countries, Switzerland's dual education system gives access to tertiary education to graduates from general training at Universities and from vocational training at Universities of Applied Sciences. Different educational backgrounds are linked to a different level of labor market experience and are likely to lead to different enrollment decisions in response to changes in labor market conditions. Finally, we have access to administrative data on all individuals enrolled in academic tertiary education, which allows us to precisely quantify demand by institutional type and study field.

Our empirical strategy combines the timing of the AFMP implementation with cross-sectional variation in distance to the Swiss border in a difference-in-differences framework. Motivated by the fact that commuting costs rise with distance, we define Swiss areas close to the international border as affected labor market regions and those further away as non-affected regions (Dustmann et al., 2017; Beerli et al., 2021). Indeed, approximately 90% of cross-border commuters are employed within thirty minutes of travel time from the border. We assign native students to their region of residence at the time they took their tertiary education entrance exam because local information is considered most easily accessible at the age of enrollment. There is no evidence suggesting that trends in native educational and labor market outcomes would have been different in treatment and control regions absent the reform.

Results show that the share of commuters in treated regions grew by 3.3 percentage points relative to the control regions in the post-reform period. This effect is large in magnitude compared to an average exposure in the treated regions in the pre-reform period of 14.4%. It is driven by skilled commuters with an upper-secondary or tertiary education. We find that enrollment in undergraduate degrees at Universities of Applied Sciences rises in the post-reform period in treated regions by 1.1 percentage points relative to a pre-reform average of 7.9%. University enrollment in treated relative to control regions does not change. Furthermore, we map occupations to fields of study using survey data and classify fields according to the extent to which they are affected by the presence of commuters. Subjects are considered to be affected if they are linked to occupations that frontier workers hold relatively more often than resident workers. We find that enrollment in less affected fields of study at Universities of Applied Sciences rises in the post-reform period in treated regions. These are non-STEM subjects that typically require more country-specific skills compared to STEM fields. Our findings are robust to different treatment definitions, outcome measures, and additional control variables.

The reform directly affected the composition of the workforce by raising the share of skilled foreign workers. We document a rise in the wages of natives with tertiary education and the likelihood that they hold a managerial position (Beerli et al., 2021). Moreover, we show that wages decrease for those with an upper-secondary degree. Enrollment at Universities of Applied Sciences is driven by individuals with a vocational background. They are prepared to enter the labor market, which gives them knowledge of labor market conditions, and have access to higher education. In contrast, general education prepares for entrance into tertiary education only. We show that the reform effects on native wages are heterogenous by educational attainment and occupation. Wages for native tertiary educated workers in affected regions increased for STEM and non-STEM workers, and the share of employed in management rose in particular for the latter group. Wages at the upper-secondary level increased for STEM workers and decreased for non-STEM workers. These results suggest complementarities between foreign workers, who are overrepresented in STEM professions, and high-skilled natives employed in non-STEM jobs. Consistent with rising returns to skill, the natives' response is to advance their non-STEM skills.

We contribute to the literature that links native educational outcomes to immigration, which has so far relied on evidence from the United States. Early work finds a negative effect on high school graduation rates of American-born minorities and argues that it is likely driven by competition for school resources (Betts, 1998). More recently, Hunt (2017) differentiates between adult immigrants and immigrants of school age. Results show that a higher share of low-skilled adult immigrants has a positive impact on high-school completion through its effect on labor market conditions, and no effect of school aged immigrants. In the same context, McHenry (2015) documents a rise in native educational outcomes at the secondary and post-secondary level. Overall, Llull (2018) argues that the direction of response varies across the native population depending on individual level labor market returns to education. Most of the existing work either assumes an exogenous migrant allocation or uses a shift-share instrumental variable strategy, which relies on strong assumptions (e.g., Goldsmith-Pinkham et al., 2020). In contrast, we focus on a policy experiment as an exogenous source of variation. The inflow of foreign workers we explore consists of cross-border commuters who do not compete with natives for school resources.

Our mapping between occupations and fields of study contributes to the literature on differences in occupational choices between immigrants and natives. Studies document that foreign-born workers are more often employed in scientific and technical occupations than natives (Hunt and Gauthier-Loiselle, 2010; Peri and Sparber, 2011; Hanson and Slaughter, 2017). We confirm these findings in a context where the foreign workers are culturally and linguistically similar to the natives. Few studies link immigrant occupational choices to native enrollment in specific study fields. Ransom and Winters (2020) look at STEM fields and find an outflow of native-born Americans, specifically blacks, from subjects related to occupations with more foreign workers. Cortés and Pan (2015) document a similar crowding-out effect from nursing studies. We add to this literature by considering all study fields, increasing the generalizability of this paper. Grouping fields by the intensity of expected labor market competition with foreign workers enables us to link the enrollment analysis to labor market conditions at the field level.

The education literature finds that expected earnings and employment perspectives matter in the study field choice (Beffy et al., 2012; Wiswall and Zafar, 2015; Schweri and Hartog, 2017) with some studies showing limited knowledge of labor market returns (Xia, 2016). A number of related studies exploit business cycles to evaluate the impact of opportunity costs on demand for education. There is evidence that enrollment is countercyclical at lower educational levels (Ayllon and Nollenberger, 2016), in college (Dellas and Sakellaris, 2003; Long, 2014) and in graduate school for women (Johnson, 2013). In comparison, we use an immigration reform that creates exogenous variation in local labor market conditions, leaving country-wide economic conditions unchanged. We distinguish between individuals with general and vocational background to identify the groups of individuals most responsive to the changes in local labor market conditions. This level of detail is novel in the literature.

To understand drivers of enrolment decisions, we investigate labor market effects of a migration reform. There is mixed evidence on the impact of an inflow of foreigners on native labor market outcomes (see e.g., Borjas, 2003; Ottaviano and Peri, 2012; Dustmann et al., 2016). While most of the existing literature looks at resident migrants, we focus on cross-border commuters. In an early study, Dustmann et al. (2017) investigate a temporary increase in low-skilled Czech frontier workers into Germany after the fall of the Berlin wall. They find a decline in wages and an even stronger drop in employment outcomes for natives. Looking at the same reform as we do, Beerli et al. (2021) find a positive effect on the wages of high-skilled natives due to the expansion of incumbent firms in affected regions. Cristelli and Lissoni (2020) document that natives who collaborate with cross-border inventors benefit from higher productivity. We extend this literature by examining effects on native human capital accumulation which likely have long-run impacts on the native skill composition. Ignoring such adjustments could result in misleading estimates of the labor market effects of immigration.

The remainder of the article is organized as follows. In Section 2 we discuss the regulatory framework applied to cross-border commuters and the educational system in Switzerland. In Section 3 we describe the data and outline the empirical strategy. In Section 4 we present our results on enrollment by institutional type and by field of study, while the mechanisms are discussed in Section 5. In Section 6 we conclude.

2 Context

2.1 Cross-Border Commuting

Individuals with a citizenship from a European Union (EU) or European Free Trade Association (EFTA) member state working in Switzerland are subject to the rules outlined in the Agreement on the Free Movement of Persons (AFMP). It was signed in June 1999, approved by the electorate in May 2000 and introduced on the 1st of June 2002.[1] While the agreement affects all workers from EU and EFTA countries, we focus on cross-border commuters. Commuters are non-Swiss by nationality and require a working permit to be employed in Switzerland. Since they need a working contract from a Swiss employer to receive or extend such a permit, frontier workers are by definition employed individuals.

Prior to the AFMP, cross-border commuters and firms that wanted to hire them had to fulfil several requirements. Commuters had to live in formal border zones in the neighboring countries and were only allowed to work in similarly defined zones in border regions of Switzerland. Permits were tied to a specific employer and valid for up to one year after which they had to be renewed. Commuters had to return to their place of origin on a daily basis. Furthermore, employers had to prove that the vacancy could not be filled by a native worker (local priority requirement).

The policy change was implemented in three steps. From June 2002 onwards, cross-border commuters from EU-15 and EFTA countries were free to reside outside the border zones of the home country. In addition, they were required to return to their place of residence only once a week rather than every day. The work permit was no longer bound to a specific job and its validity was extended to the length of the working contract, for a maximum of five years. In June 2004 the local priority requirement was abolished and, as a result, cross-border commuters could be hired under the same conditions as resident workers in the Swiss border zones. Full liberalization across the entire country came into force in June 2007 when commuters were allowed to work anywhere in Switzerland. Interim regulations applied for other EU member states and were relaxed over time.

The new rules on the free movement of cross-border commuters led to a large increase in the number of foreign workers. Most of them work in the Swiss border regions, where the share of commuters in total employed rose from 9.9% in 2001 to 14.2% in 2017. In the latter year, 95% of all cross-border commuters were nationals of the neighbor countries Austria,

[1] The AFMP is a bilateral agreement. Regulations for Swiss nationals were completely removed in June 2002. The removal of immigration barriers is expected to have benefited all natives. The AFMP is unlikely to have promoted commuting of Swiss nationals from border regions due to the relatively high living costs and wages in Switzerland.

France, Germany or Italy. Consistent with travel costs depending on distance, commuters generally work in regions close to their place of residence where the same language is spoken.[2]

Commuters differ from natives in their educational level. Earnings structure survey data show that in 2016 48% of cross-border commuters have an upper-secondary degree, 23% up to a lower-secondary degree, 19% an academic tertiary and 10% a professional tertiary degree. In comparison, the share of native workers with an upper-secondary education is higher (57%) and with a lower-secondary education considerably lower (15%). The share of natives with academic tertiary degrees (16%) is comparable to that among commuters. In further sections, we look at over time changes in exposure to commuters by education and occupation.

2.2 Dual Education System

We focus on enrollment in academic tertiary education in Switzerland. Two broad types of institutions exist: Universities and Federal Institutes of Technology, with roughly 60% of all students in 2017, and Universities of Applied Sciences. Universities and the Federal Institutes of Technology (UNI) are the oldest institutions with a right to grant tertiary level degrees. In 1997 the Universities of Applied Sciences (UAS) were established.[3] While Universities are committed to a combination of teaching and research, Universities of Applied Sciences impart professional skills with a practice and application oriented focus. Both offer STEM and non-STEM education. Around 69% of all University students are enrolled in a non-STEM field in 2017. This share is close to 74% at Universities of Applied Sciences.

The Swiss education system has features common to other European countries. Figure 1 shows that at the upper-secondary level one can follow a vocational or a general education track. According to the Swiss Federal Statistical Office, 68.3% of students pursued a vocational degree in 2016, while the rest enrolled in general training. At the end of upper-secondary education, a student needs to pass a matura examination to enter tertiary education. There are three types of matura that can be combined with the vocational or general education. While a general matura grants access to all tertiary education institutions, a vocational and a specialised matura target Universities of Applied Sciences. In 2016, 21.2% of the Swiss residents under the age of 25 hold a general, 15.4% a vocational, and 3% a specialised matura.

Figure 2 shows the locations of the tertiary education institutions across Switzerland

[2]Between 97 and 98% of the Austrian and German commuters work in a municipality in which German is spoken by the majority of residents. The share of Italian and French commuters that go to Italian- and French-speaking municipalities is 88% and 80% respectively.

[3]In some regions the UAS include Teacher Education while other regions have set up independent Universities of Teacher Education (UTE). We combine these institutions with the Universities of Applied Sciences.

in 2017. Most of the institutions are in the northern and western part of the country and clustered in the urban centers. There are ten cantonal Universities and two Federal Institutes of Technology spread over ten cities. In contrast, most of the Universities of Applied Sciences have several locations, which are often specific to a study field. As the expansion of UAS took place during our study period, we take this into account in our empirical specification. The high density of institutions we observe in the end of the period enables daily commuting to classes for a large share of the population lowering the costs of studying.[4]

The Swiss education system offers a unique setting as the lack of supply constraints enables us to infer demand for tertiary education from enrollment. Besides a matura, no major entry restrictions exist for Swiss nationals at the undergraduate level. A general matura typically grants access to any degree in the chosen university. As an exception, health degrees can have a cap on the number of students enrolled in a year. To enroll in a specific field, Universities of Applied Sciences can require a certain major of the vocational matura or relevant work experience. Interviews are often conducted to test the ability of candidates in social or health related fields at UAS. While there is overall little screening at entry, the pool of eligible students is already selected due to the admission requirements for upper-secondary education tracks resulting in a matura. In the analysis, we focus on enrollment but also look at differences in graduation rates.

3 Data and Methods

3.1 Data

We take the commuting zone as the unit of observation.[5] They are considered small-scale labor markets where the allocation of municipalities rests on 2000 census data and is provided by the Swiss Federal Statistical Office (FSO). For simplicity, we refer to them as "regions". We combine several data sources to conduct our analysis. Detailed information is available in the Data Appendix C.

In the enrollment analysis we use administrative data referred to as SHIS-studex, an abbreviation for the Swiss Higher Education Information System. This is an individual-level database covering all matriculated students at the academic tertiary level of education in Switzerland. It includes students at Universities since 1990 and Universities of Applied Sciences since their foundation in 1997. The variables used are age, nationality, place of

[4]Yearly study costs are estimated to be around CHF 24,000 including tuition fees that are generally below CHF 2,000 for Swiss nationals. See, e.g., the estimation by the study advisory service from the University of Zurich. On September 15th 2020 one Swiss Franc is equivalent to approximately 1.1 US Dollars.

[5]The commuting zone is called MS-region in Switzerland. MS comes from the French "mobilité spatiale".

residence prior to beginning a study, the type of matura granting access to tertiary education, type of tertiary institution and field of study. The structure of the SHIS-studex dataset allows tracking individuals from the point of enrollment up to graduation and provides information on received degrees.

We are interested in demand for undergraduate degrees and focus on first-year students enrolled in a bachelor study over the period 1997–2017. We select students who completed their matura in Switzerland in order to assign them to the region of residence at the time of receiving the certificate. We calculate our main outcome as $\textit{Share of students enrolled}_{rt} = \frac{\textit{Nr first-year students}_{rt}}{\textit{Birth cohort size}_{rt}}$. The cohort is the Swiss population in each region at the median age of first-year students. In the full sample the median age is twenty-one, in the sample of students enrolled in Universities it is twenty and in Universities of Applied Sciences twenty-two. The FSO provides information about the size of the native population at the municipality level and the age structure of the population at the cantonal level. We add to this dataset the geographic location of the tertiary institutions. A University is located in a single city, while Universities of Applied Sciences are spread over several municipalities. We collected this information from the websites of the institutions.

Additionally, we use information from the Survey of Higher Education Graduates (EHA). The survey is conducted every two years. It has a panel structure where individuals respond to questions related to their working experience and acquired skills one and five years after graduation. Our focus lies on first-wave results because we are interested in outcomes a short time after graduation. We consider the subset of Swiss graduates with a bachelor's or master's degree who have in addition a Swiss matura. We use information about place of living (current and at the time of taking the entrance exam), place of work and the mapping between fields of study and occupations.

In the labor market analysis, we rely on two surveys over the period 1996–2016. The Swiss Earnings Structure Survey (SESS) is a large-scale firm survey conducted every two years. It is a repeated cross-section of private sector firms in the secondary and tertiary sectors of the economy. We use information on the firm location at the commuting zone level, which is the most detailed geographical unit available. We limit the sample to employees 18–65 years of age. To calculate our outcome variables, we use data on native gross hourly wages, level of managerial tasks and working permit information that allows us to distinguish native from cross-border employees. To calculate the share of cross-border commuters, we divide the number of commuters by the total number of employees. In the analysis by educational level, the share of cross-border commuters is the number of commuters by education divided by the total number of employees. We differentiate three types of education based on the highest level attained – tertiary, upper-secondary and up to lower-secondary training.

Similarly, we differentiate between workers employed in STEM and non-STEM occupations. In the analysis by occupation we limit the observation period to 1996–2010 because different occupation classifications were used before and after 2010. Furthermore, we use data on the demographic characteristics of workers such as gender, age and occupational categories.

While the SESS covers only employed individuals, the Swiss Labor Force Survey (SLFS) includes individuals aged 15 years and older. We use annual data on the municipality of residence, demographic characteristics, educational attainment and employment outcomes for the household head. We limit the sample to individuals in the age group 18–65. The native unemployment rate is the number of unemployed relative to total labor force by educational category. The native employment rate is the number of employed relative to total number of individuals by educational category.

Additionally, we collected travel time data for each municipality from `www.map.search.ch`, which we accessed in December 2018. We take the travel time by car from each municipality m to the closest border crossing or border checkpoint according to the Federal Customs Office. At the regional level r we calculate the measure $\textit{Travel time}_r = \sum_{m \in r} \textit{Travel time}_{m,2018} \times \frac{\textit{Nr employed}_{m,1995}}{\textit{Nr employed}_{r,1995}}$. Regions with a border crossing or border checkpoint are assigned a value of zero minutes.

3.2 Empirical Strategy

Motivated by the nature of the policy change, the empirical analysis is based on a standard difference-in-differences strategy. We investigate the reform effects by comparing regions close to the border with those further away before and after the regulatory change. Figure 3 shows how travel time from the border relates to the share of commuters in a region. Exposure to commuters declines sharply with travel time. We add to the figure a function that approximates treatment intensity by distance to the border: $\exp(-0.05 \times \textit{travel time})$.[6] In the main part of the analysis we use a fixed threshold of thirty minutes to define treatment, which is consistent with Beerli et al. (2021). This approach assigns 35 out of the 106 regions to the treatment group and the remaining 71 regions to the control group (see map in Figure 2). As is visible in Figure 3, there is no discontinuity in exposure to cross-border commuting at the thirty minutes threshold. To take this into account, we consider different treatment assignments in alternative specifications.

[6] Figure 3 also reveals that commuters work further away from the border in 2017 than they did in 1997. The continuous function tracks well the relationship between commuter flows and travel time in both years and, therefore, takes into account the upward trend in the commuting distance.

We run the following specification in the main part of the analysis:

$$\begin{aligned} y_{rt} = \alpha + & \beta_1 \, Transition_t \times 1(Travel\ time_r \leq 30\, min) + \\ & \beta_2 Post_t \times 1(Travel\ time_r \leq 30\, min) + \mathbf{X}'_{rt}\gamma + \delta_r + \varepsilon_{rt} \end{aligned} \tag{1}$$

where r is region, and t year. In the analysis of enrollment, first-year students are allocated to their region of residence at the time of taking the matura. Our main outcome is the share of first-year students in birth cohort. In the labor market analysis, individuals are either assigned to the region of the workplace (wage outcome) or to the region of living (employment outcomes). We look at the gross hourly wage rate, likelihood of holding a managerial position, employment and unemployment rates. We estimate the reform effect by distinguishing between three periods: pre-reform (1997–2001), transition (2002–2006) and post-reform (2007–2017). The observation period for the labor market outcomes is 1996–2016 due to data availability. The coefficients of interest, β_1 and β_2, show the difference in the dependent variables between treated and control regions during and after the reform compared to pre-reform years.

In our baseline specification we include region fixed effects to capture time-invariant regional variation in the outcomes of interest. We further include NUTS II region × year fixed effects which control for changes over time occurring at the larger geographical level.[7] In the enrollment analysis, we also control for the natural log of native population that may drive changes in enrollment rates. Additional variables that could vary during the period and across regions are introduced in robustness checks. We use time invariant weights to account for the different population and employment sizes across regions, which are specified in the notes to the figures and tables. In a robustness check we confirm that the weights do not drive our results. Standard errors are clustered at the regional level.

While β_1 and β_2 are the only estimates we report in tables, graphically we present the results from an event study.

$$y_{rt} = \alpha + \sum_{t=1997}^{2017} \beta_t Year_t \times 1(Travel\ time_r \leq 30\, min) + \mathbf{X}'_{rt}\gamma + \delta_r + \varepsilon_{rt} \tag{2}$$

The event study shows how the yearly treatment effects materialize over time. The coefficients β_t capture the impact of the reform relative to the last year in the pre-reform period.

[7] Switzerland has seven NUTS II regions, each containing between one and seven cantons. Cantons are the largest administrative sub-national units, followed by districts and municipalities. The education system is organized at the cantonal level, while a tertiary institution's catchment area often extends over several cantons.

The key assumption under which our results are valid is that enrollment rates and labor market conditions would have followed the same trend in treatment and control regions absent the reform. We compare yearly coefficients in the pre-reform period to investigate whether this assumption is likely to hold. Graphical evidence shows that prior to the reform educational demand in treatment and control units follows parallel trends. Pre-trends for overall and University enrollment are shown for 1991–2001, while for the Universities of Applied Sciences they cover the period since their foundation in 1997. Similarly, results are robust to additional control variables which could have evolved differently over time in the two groups of regions. These results are reported in more detail in Section 4.

The parallel trends assumption could be violated if natives in the border regions commute abroad for study or work reasons after the introduction of the AFMP or the Bologna reform in the 2000s. We argue that both examples are not a potential threat to our identification. First, although there are few tertiary institutions in proximity to the Swiss border it is unlikely that one of the reforms increased commuting to study, because the tertiary education systems in these countries were already similar and the Swiss institutions are of relatively high quality.[8] Second, low unemployment and a high wage level make Switzerland a relatively favorable country to work. This makes the likelihood of Swiss commuting abroad low, in particular because of the high living costs in Switzerland.

The Stable Unit Treatment Value Assumption (SUTVA) is the second important identifying assumption. We are interested in local labor market conditions and their impact on demand for education.[9] We take an area approach similar to Beerli et al. (2021), but use the commuting zone as a unit of observation. This reduces concerns about geographical spillovers across regions as zones are constructed where individuals reside and work. Based on 2018 register data we calculate that on average 64% of the resident population in a commuting zone also works there (Bundesamt für Statistik, 2020a). This share is the same for the group of treated and control regions.

We argue that the labor market conditions in the place of residence at the time of receiving the matura are the relevant determinants of first-time enrollment and study field choice. Information about local conditions should be most readily available to the individual especially at a young age. The experience of immediate family members, which is arguably accrued locally, is likely to be an important information source (see Xia, 2016). Additionally, our sample consists of individuals with a Swiss nationality and a Swiss tertiary entry exam. This subgroup is likely to perceive local conditions as more important than the subgroup

[8] Universities close to the Swiss border are: University of Konstanz and Zeppelin University, Germany; University of Applied Sciences in Dornbirn and Feldkirch, Austria; University of Liechtenstein, Liechtenstein.

[9] Evidence for the importance of local compared to national labor market conditions in educational decisions is presented in Long et al. (2014) for the US context.

of foreign nationals who tend to exploit more distant economic opportunities (Basso and Peri, 2020). We compare the place where former students work and live one year after completing tertiary education to the one where they resided when they took their matura in the EHA survey. In 2017 59% of the graduates live in the same region where they resided during their upper-secondary education. 29% even work in that same commuting zone and this share is essentially the same in the treatment and control regions. This is considerable given that many high-skill jobs are not available across the country. Any violations of the SUTVA assumption would bias our estimates towards zero, so results should be considered conservative.

3.3 Treatment Intensity

To justify the treatment assignment rule, we estimate Equation 1 and compare the share of cross-border commuters in employment across treatment and control regions in the different periods. Column (1) of Table 1 shows that regions within thirty minutes of travel time from the national border experienced a large inflow of commuters relative to regions further away. While average exposure in the treatment region grew from 14.4% in the pre-reform period to 18.6% in the post-reform period, we estimate a reform effect of 3.3 percentage points after controlling for region fixed effects and broader regional trends. Magnitudes increase after the second implementation step of the AFMP in 2008 as shown in Figure 4a. The continuous rise in the exposure to commuters during the period highlights the permanent nature of the reform. Figure A1a replicates these results with administrative data. Estimates are larger in magnitude as we fix the denominator in the baseline year due to employment data availability. Results show that cross-border commuting was already slightly on the rise in the last years of the pre-reform period. This could be explained by an informal relaxation of migration regulations prior to 2002, which we take into account when discussing the timing of the enrollment results.

In Table 1, columns (2)–(4), and in Figures 4b–4d we look at exposure to cross-border commuting by educational level. We find that the rise in the share of cross-border commuters among the upper-secondary educated is 4.6 percentage points while among the tertiary educated 3.2 in the post-reform period. The positive effect on the former group is already significant during the transition period. We do not find a significant increase in commuting of lower-secondary educated workers as presented in the Table, while the positive estimates in Figure 4b are driven by the choice of the base year.

In the Appendix we present robustness checks. In Table B1 we test the sensitivity of the results to lower and higher cut-off values in treatment definition. We find that the estimated magnitude of the supply shock declines as we choose a higher threshold value. As a generalization, we confirm the rise in cross-border commuting using the continuous treatment measure. The estimated rise in cross-border commuting becomes higher in magnitude compared to the baseline results. Given that the exponential function takes the value of one at zero minutes of travel time and 0.22 at thirty minutes, the difference in magnitudes is in line with the functional specification. Another concern we address is whether resident migrants are, like commuters, more often employed in border regions. Figure A1b shows that the share of resident migrants does not evolve differently across treatment and control regions during the study period. We, therefore, focus on cross-border commuters as the relevant group of foreign workers given our empirical strategy.

4 Main Results

4.1 Enrollment by Institutional Type

Summary statistics show that during our study period, average enrollment in tertiary education is higher in regions more affected by the introduction of the free movement reform than in regions less affected (see Table 2). This difference is driven by enrollment at Universities while shares are similar for Universities of Applied Sciences. Figure A2 shows for UAS that the gap in enrollment between the two regions grew over time, while it followed the same trend in the pre-period. We next test whether these patterns are statistically significant and persist conditional on region fixed effects, population level and broader regional trends.

Results in column (1) of Table 3 show a positive but insignificant rise in overall enrollment in the post-reform period among individuals residing in affected regions prior to beginning their studies compared to non-affected regions. However, the responses differ by institutional type. Columns (2) and (3) indicate that individuals from regions close to the border enroll significantly more often at Universities of Applied Sciences. The magnitude of the effect is 1.1 percentage points. Average enrollment rates in the treated regions increased from 7.9% in the pre-reform period to 18.3% in the post-reform period. The reform effect can account for almost 10% of the enrollment growth observed during the period and is 14% of the pre-treatment enrollment level. In contrast, we find no change in entry into Universities between the treatment and the control regions.

Figure 5 shows that demand for tertiary education, overall and by institutional type, evolved similarly between the treatment and control group in the pre-reform years. This suggests that the common trend assumption is unlikely to be violated. Indeed, the timing of the increase in enrollment at Universities of Applied Sciences is in line with the intensity of the labor supply shock presented in Figure 4a. While we observe a small increase in commuting prior to 2002, we find that enrollment goes up only in the post-reform period when all barriers were abolished and the inflow of frontier workers was substantial. We take this as evidence against anticipation effects.

In the Appendix, we provide a number of robustness checks showing that our results hold in alternative specifications. Panels A and B of Table B2 show that the threshold of thirty travel minutes is not decisive for the main findings. Moreover, the estimates remain similar when using the continuous measure for travel time (Panel C). Table B3 investigates whether our main finding is sensitive to additional control variables and the weighting scheme. Changes in the supply of education and demand for labor could be confounding factors to the common trend assumption. Since our observation period coincides with the expansion of the UAS, we test whether enrollment rates are driven by the availability of new study locations and study fields.[10] Column (2) shows that results are robust to controlling for the presence of tertiary institutions as well as the number of study fields offered within a radius of 20km from the largest municipality in a region in 1990. Note that the reform estimate is larger in magnitude, suggesting that its effect is more sizeable than that of an additional institution within 20km. To mitigate labor demand concerns, we proxy labor demand with a Bartik type measure of employment, relying on the industrial composition of each region in 1995 and aggregate annual employment growth at the industry level (see Bartik, 1991, for an initial application to labor demand).[11] As shown in column (3), controlling for labor demand does not change results compared to our baseline specification. Additionally, in column (4) we confirm that weights do not drive the results. In Figure A3 we redefine our outcome variable as the natural log of the number of natives enrolled. Results are consistent with our baseline measure and mitigate concerns that the effect is driven by variation in the size of the birth cohorts over time.

4.2 Enrollment by Field of Study

The enrollment analysis has shown that natives respond to the inflow of frontier workers by demanding more tertiary education at Universities of Applied Sciences. In this section, we investigate how the free movement reform affects demand for specific study fields.

[10] Hoxby (2009) finds for the USA that university choice is less driven by distance in recent times partly due to declining transportation costs. In the context of Switzerland, Denzler and Wolter (2010) argue that the distance to university matters for both the decision to enroll and the study field choice in particular for individuals from middle and low socio-economic groups.

[11] Atkin (2016), for example, documents that expansion in export manufacturing in Mexico affected school enrollment negatively by raising the opportunity cost of education. We construct the Bartik variable as follows: $Bartik_{rt} = \sum_i Shemployed_{ir1995} \times \frac{Nr\,Employed_{it}}{Nr\,Employed_{i1995}}$, where i denotes industry, r region and t year. The industry is defined by two-digit NOGA-08 codes.

We start by linking subjects to occupations and create the variable *Sh employed*$_j$ which proxies the share of employees trained in a field j.

$$\text{Sh employed}_j = \sum_{o=1}^{O} \text{Sh employed}_o \times \text{Sh employed}_{oj}, \quad j \in [1, 22] \tag{3}$$

Sh employed$_{oj}$ is the share of employed individuals in an occupation o with a degree in field j, which we multiply with the share of employed in the same occupation *Sh employed*$_o$. Intuitively, we allocate individuals employed in an occupation to fields of study and take into account the size of the occupation.

We infer the link between study fields and occupations from their joint distribution provided by the EHA survey (2003–2017). This approach is consistent with the fact that natives do not observe the education of commuters but have some knowledge of their occupations. We use the study fields at the two-digit ISCED level as presented in column 1 of Table 4 and consider the ten occupations in ISCO-08 level 1 (managerial) and level 2 (professional occupations) as requiring high skill. We derive the distribution of cross-border commuters and residents across occupations from 1999 and 2000 administrative data, respectively. These years are the earliest available and, hence, alleviate concerns about endogenous adjustments in the commuters' occupational choices to changes in the skill levels of natives.[12]

We build a relative measure based on the values from Equation 3 for cross-border commuters and resident workers.

$$\text{Relative skill supply}_j = \frac{\text{Sh cross-border commuters}_j}{\text{Sh residents employed}_j}, \quad j \in [1, 22] \tag{4}$$

The measure *Relative skill supply*$_j$ indicates how the highly educated commuters are allocated across study fields j relative to the workers living in the country. A higher value of the measure implies that commuters are relatively more likely to have received training in this specific field than resident workers. In column 3 of Table 4 we present for each study field the skill supply of commuters relative to that of resident workers. The least affected fields, those with the lowest ratio, are listed first and the most affected fields come last. Frontier workers are more often trained in study fields which build technical and numerical skills and underrepresented in ones which build knowledge less likely to be transferable across borders

[12]FSO administrative data provide the distribution of cross-border commuters in 1999, while census data from 2000 offer information on all resident employees in Switzerland. We focus on occupations held by resident workers living in the border region to control for potential differences in the industrial structure of places where cross-border commuters and resident employees work.

and require social or high level of language skills. Comparing columns (1) and (2) in Table 4 reveals that expected labor market competition with foreign workers is higher in STEM than in non-STEM occupations. If we divide the study fields based on the variable *Relative skill supply* into affected (value above one) and non-affected (below one) we see that the former group coincides with STEM and the latter with non-STEM fields. The only exception is Arts which is a non-STEM subject while classified as affected.

In Table 5 we study the variation in the skills of the commuters over time and complement the static picture of the skill distribution presented above. Specifically, we investigate the change in exposure to cross-border commuters by both educational level and occupation. We consider upper-secondary and tertiary levels of education, while we split occupations into STEM and non-STEM. At both levels we observe a stronger inflow in STEM than in non-STEM occupations in the transition and post-reform periods. Overall, we take this as evidence in line with the static one presented in Table 4. Next, we proceed to the analysis of enrollment by field of study.

Figure A4 plots raw enrollment rates into STEM and non-STEM fields at UAS and shows that demand for non-STEM fields grew faster in treated relative to control regions. Panel C of Table 6 confirms this by showing a statistically significant rise in enrollment of 1 percentage point in the post-reform period. The reform effect can account for roughly 10% of the enrollment growth observed during the period and is almost 24% of the pre-treatment level. Figure 6 shows that the timing of the effects is in line with the implementation of the free movement reform. The evidence from the analysis of enrollment in non-affected fields provides consistent evidence. In contrast to Ransom and Winters (2020) who estimate crowding-out effects from STEM fields in regions with more foreign workers, we find no such evidence. Panel A of Table 6 shows a statistically insignificant rise in overall enrollment and Panel B no change in University enrollment.

In Table B4 we show that the overall increase in the demand for non-STEM and non-affected fields is robust to variations in the treatment definition. Enrollment in STEM fields turns significant at the threshold of twenty-five minutes and in the continuous treatment specification. Results reported in column (3) also show a rise in enrollment in affected fields, which is however of smaller magnitude than the estimate for non-affected fields. In summary, while the STEM enrollment results depend slightly on the treatment definition, the rise in non-STEM enrollment is robust and of larger magnitude. Table B5 reports results from specifications including additional control variables in columns (2)–(3) and without weighting scheme in column (4). Estimates remain very close to the ones from the main specification.

A final concern is whether enrollment in study fields is geographically concentrated (results available upon request). Switzerland is split into four language regions, where we investigate the effect of dropping the two largest regions.[13] The coefficients of enrollment in non-affected fields in the post-treatment period is of similar magnitude when dropping the German or the French speaking regions but estimates become statistically insignificant at the conventional levels. The reported results are, thus, not driven by a single region. Given that the inflow of commuters is present in all language regions, this exercise reinforces the link that we draw between local labor market conditions and enrollment.

5 Mechanisms

Results show that natives respond to the free movement reform by acquiring more schooling. When faced with stronger competition, education offers an opportunity to stay competitive by upgrading one's skills. In this section we explore mechanisms and discuss whether natives of certain types select into education.

5.1 Prior Labor Market Experience

Previous studies on the AFMP find that labor market outcomes of some natives have improved due to the reform (Cristelli and Lissoni, 2020; Beerli et al., 2021). To test if changes in such outcomes are consistent with the observed educational choices, we investigate wage effects by education level. Panel A of Table 8 reports a decrease in wages for upper-secondary educated workers and an increase in wages for tertiary educated workers in affected regions, with statistically significant effects in the post-reform period. Wage results by educational attainment also hold in the sample of workers below the worker median age of forty years (results upon request).[14] In Panel B we look at the probability of natives to hold at least middle management positions and find that the share of tertiary educated increases in the post-reform period in affected regions. We do not find any difference at the upper-secondary level. Note that in unreported event study figures, the magnitude and significance of the estimates depend on the choice of the base year. Overall, the pattern of the results is consistent with the ones reported in Beerli et al. (2021), while we look at upper-secondary educated natives separately. The authors explain the improved labor market outcomes for tertiary

[13] In 75 out of 106 regions the majority speaks German, in 23 French and in 8 either Italian or Romansh. Within the treated regions, the French speaking regions (eleven) and the Italian speaking regions (three) are overrepresented while the German speaking regions are underrepresented (twenty). There are only two regions with the main language Romansh, whereas one is treated.

[14] We additionally look at whether the native employment conditions at the educational level evolve differently during the period in treated and control regions. Results for unemployment rates in Panel A of Table B6 and for employment rates in Panel B of Table B6 do not suggest so.

degrees with an increase in the labor demand of skill-intensive incumbent and new firms. This is in contrast to a standard model, which considers solely a labor supply shock and predicts declining wages.[15]

Summary statistics in Table 2 show a high existing premium to tertiary education. Wage effects can be hard to observe especially relative to a high existing premium. While others have found that future earnings matter for major choice (Schweri and Hartog, 2017, in the Swiss context), the choice elasticity is often relatively low (Patnaik et al., 2020). However, natives with prior labor market experience are likely to have knowledge of local wages and more so of positions held by educational level. To test this, we run the enrollment analysis separately for individuals with different educational backgrounds.

Numbers from the FSO for 2012 upper-secondary graduates show that 64% of those with a vocational matura enroll in tertiary education within 42 months after graduation. This is significantly lower compared to 94% of those with a general and 84% with a specialised matura (Bundesamt für Statistik, 2018). This is not surprising given that the vocational and specialised education prepare to enter both the labor market and tertiary education, while the objective of a general training is to prepare for enrollment at University. The two groups tend to enroll in different types of institutions. The majority of students at a University have a general education while at a University of Applied Sciences students typically have a vocational training. Since individuals with a vocational, specialised and general matura can enroll at UAS, we can test which group drives our results. We take into account that a vocational matura can be completed during the vocational training (Type I), or in two to four semesters after the vocational education (Type II). Table 7 illustrates that the higher demand for tertiary education is driven by people who do their vocational matura at the same time as their vocational education or have a specialised matura.

This evidence suggests that the reform affected educational decisions of individuals with an upper-secondary degree that combines schooling and occupational training. We additionally run separate difference-in-differences regression by age at enrollment into UAS. In Figure 7 we show that individuals between 19 and 21 years of age, or close after graduating from upper-secondary education, are most responsive. Vocationally trained individuals already have at least three years of work experience at the time at which they choose whether to pursue a tertiary degree. Access to a professional network makes them more aware of changes in local labor market conditions. This link to the professional world persists during

[15] Our framework deviates from Beerli et al. (2021) in at least two respects that may explain the different magnitude of the wage effect on tertiary educated natives. First, we use 2000 as the reference year in our event study analysis, while they take 1998. Second, in our measure of tertiary educated we only include individuals with an academic degree, while they also consider individuals with professional tertiary degrees. Our analysis leads to the same qualitative results as theirs.

the studies: students at a UAS report more often to work while studying (79%) than those at a UNI (69%) (Bundesamt für Statistik, 2020b). Around 22% of all UAS students are enrolled in a part-time study. In unreported results, we test if the increase in enrollment in the post-reform period comes from full-time or part-time studies. We find that the reform effect is driven by full-time students.

5.2 Skill Complementarities

To better understand responses at the study field level, we examine native wages by education and occupation. Columns (1) and (2) in Panel A of Table 9 show that at the upper-secondary level the returns in STEM professions rise and in non-STEM professions fall in the post-reform period. Estimates for workers with a tertiary education in columns (3) and (4) are positive and not significant but comparable in magnitude to the estimates by education level (see Table 8). In Panel B we show that the increase in the probability of natives to hold managerial positions is driven by those employed in non-STEM occupations (p-value of 0.105). The chosen study field at tertiary education is typically closely linked to the major at the upper-secondary level.[16] Results therefore suggest that the increase in non-STEM enrollment can be either induced by lower opportunity costs of studying, higher returns to a tertiary degree or a combination of the two. The increase in STEM wages for upper-secondary and tertiary educated workers suggests that there may be complementarities within these occupations between native and foreign workers that could explain why we find no change in STEM enrollment despite the rise in foreign competition.

Individuals with a vocational and specialised matura enroll more often at Universities of Applied Sciences due to the reform. The rise in enrollment of vocationally educated is driven by those with a vocational matura major in business and services (results available upon request). Individuals with a specialised matura are typically trained in health, social work, pedagogy or art. Consistently, when we split the non-STEM fields into broad categories, we find that the positive post-reform effect comes from business and law, and health and welfare (see Figure A5). Subjects that fall into the area of business and law are the most popular ones with an average enrollment share of 25%, while health and welfare receives approximately 15%. In particular, the skills acquired from a business and law study could be complementary to the technical skills brought by the commuters.

The literature has established a pattern between the skill types of native and immigrant workers. For the US, Hanson and Slaughter (2017) observe that high-skilled immigrants

[16] Individuals who enroll in tertiary education generally advance their skills already developed at the upper-secondary level. For example, 92% of non-STEM vocationally educated enroll into non-STEM study fields at the tertiary level. The share for those with a STEM background is comparable at 89%.

are more likely to be employed in STEM than in non-STEM professions. The literature explains these specializations through differences in the skill transferability across countries or in the quality of training which results in foreigners having a comparative advantage in STEM occupations (Hunt and Gauthier-Loiselle, 2010; Hanson and Slaughter, 2017). In line, in Tables 4 and 5 we show that while there is a sizeable increase of cross-border commuter employment in non-STEM occupations, the inflow of cross-border commuters is concentrated in STEM occupations. In our context, differences in education quality are a less likely explanation because the largest Swiss institutions providing tertiary level STEM education are world leaders.[17] We hence document that STEM skills are more transferable even among foreign workers who have language proficiency and are culturally similar. In summary, natives respond to the reform by acquiring more non-STEM skills. This allows them to benefit from complementarities with the foreign workers and to avoid direct foreign competition.

5.3 Foreign Students

The literature on university enrollment and study field choice has established a link between the presence of foreign students and natives' decisions. Recent studies find on average no or a positive effect on native enrollment (Shih, 2017; Machin and Murphy, 2017). Earlier studies also document crowding-out effects (Borjas, 2004). At the field level, there is some evidence that foreign students reduce the likelihood that natives major in a STEM subject (Orrenius and Zavodny, 2015; Anelli et al., 2020). In our context, the share of foreign students is sizeable (16% in 1997, close to 19% in 2017), which is why we take a closer look at this group. We distinguish between international students – non-Swiss without a Swiss matura – and immigrant students – non-Swiss with a Swiss matura.

The share of international students in total enrollment at the bachelor level was approximately 12% in 2017. International students are overrepresented in Universities and in STEM fields of study, which could crowd out natives from these studies. There is generally no cap on the maximum number of students enrolled in Switzerland, which is in contrast to the US where most of the above studies are conducted. Since tuition in Switzerland is to a large degree publicly funded, cross-subsidization of natives through higher tuition fees paid by the international students is also unlikely. Additionally, there is limited knowledge about the class composition when enrolling at the bachelor level so it is unlikely that a high share of international peers crowds natives in or out of certain institutions or fields. Finally, for

[17] In the academic year 2019/2020, the ETH ranked 6th and the EPFL 18th out of 1,001 in the QS World University Ranking. In the same year, the ETH ranked 13th and the EPFL 38th out of 1,001 in the THE World University Ranking.

international students to present a challenge to the empirical strategy, they need to affect differently natives coming from the treatment and the control region and we see no convincing reason why this should be the case.

Immigrant students represent about 7% of total enrollment in 2017 and this number is similar in Universities and Universities of Applied Sciences, in STEM and non-STEM fields. In contrast to international students, immigrant students have had prior contact with natives in the place of residence and also within the educational system. To further mitigate any concerns that the differences in the composition of the peer group is driving our results, we introduce controls for the lagged share of immigrant students by institutional type (Table B3) and by field of study (Table B5).[18] Results are robust to the inclusion of these controls.

Overall, we find no evidence that enrollment results are likely to be driven by the presence of foreign students. Furthermore, we believe that our empirical strategy mitigates remaining concerns. We measure overall demand for two types of institutions and for broad groups of study fields. This alleviates the potential crowding-out or crowding-in effect at the institution $\times$ field level since switching between institutions and narrowly defined fields can help to avoid or to find more foreign peers.

5.4 Selection

In this section we test whether the enrolled natives have different characteristics across treatment and control groups. For example, if more females than males respond to the reform, the share of enrolled females in treated regions is expected to go up relative to the control regions. To explore changes in the student composition, we build new outcomes measured as the number of first-year students with a certain characteristics relative to all enrolled first-year students. Table B7 presents first results for growing up in an urban origin and whether German is the majority-spoken language in the municipality. In the last column we look at gender. Results show no significant change in enrollment by any of these characteristics.

Similarly, we compare academic achievement as a proxy for student quality. We compute the graduation rate of students as $Graduation\ rate_{rt} = \frac{Nr\ of\ graduates\ by\ 2017_{rt}}{Nr\ of\ students\ enrolled_{rt}}$ where t is the year of first enrollment. Results in Table B8 show no significant differences in graduation rates at Universities of Applied Sciences between treated and control regions (see Cortés and Pan, 2015, for a positive selection into nursing studies). The higher demand for tertiary degrees in affected regions is driven by students with an average quality similar to that in

[18] In a few instances the total number of enrolled students from a region in a year is zero turning the share variable missing. In these cases we replace the variable with zero. To control for this adjustment we also include a dummy variable equal to one for such observations, zero otherwise.

control regions. As a degree is considered a key signal for high ability, our evidence suggests that those who respond to the reform on average improve their labor market prospects (Arrow, 1973). Overall, our evidence shows no ex-ante selection into tertiary education and no differences in ex-post performance as measured by graduation rates due to the reform.

6 Conclusion

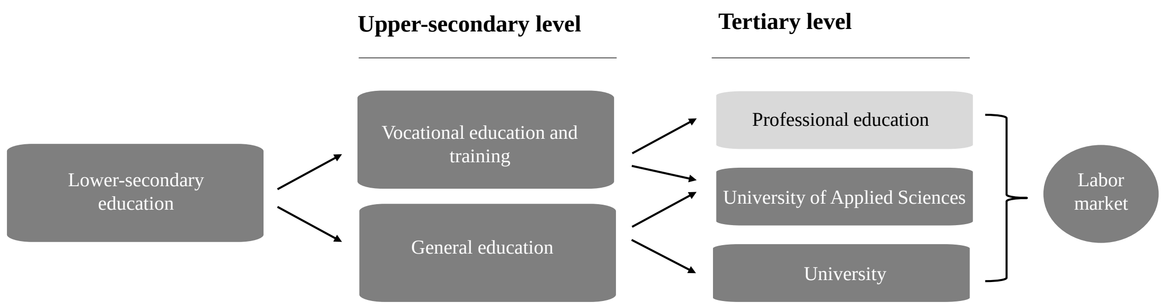
We examine the impact of the introduction of free movement of workers on native demand for tertiary education in Switzerland. We find that individuals from affected regions enroll more often at Universities of Applied Sciences and select study fields linked to non-STEM occupations. These results are driven by individuals with a vocational background at the upper-secondary level who have viable labor market options. This makes them sensitive to changes in the labor market conditions such as returns to skill. Our results suggest that natives specialize in non-STEM degrees, which are linked to occupations where foreign workers are underrepresented and complementarities between the two groups could arise.

The education system in the Swiss context, similar to other European countries, grants access to tertiary degrees to individuals with a general and a vocational background at the upper-secondary level. At the tertiary level, they usually enroll at different institutions with a focus on general or specific skills, respectively. This institutional feature contributes to a labor force with a diverse skill set. As we have shown, the dual education system gives individuals with different training an important margin to respond to changes in labor market conditions. By providing opportunities to upgrade skills, governments can facilitate the adjustment processes we observe.

The study field choice of affected natives can reinforce initial occupational specialization of high-skilled native and foreign workers. Indeed, we find support for this in the data. On the other hand, a sudden outflow of foreigners due to a more restrictive migration policy or deteriorating relative economic conditions in the host country could create a shortage of skills that foreign workers were previously supplying. Since skill acquisition is typically a long-term process, these findings should be taken into account when considering changes to immigration policies.

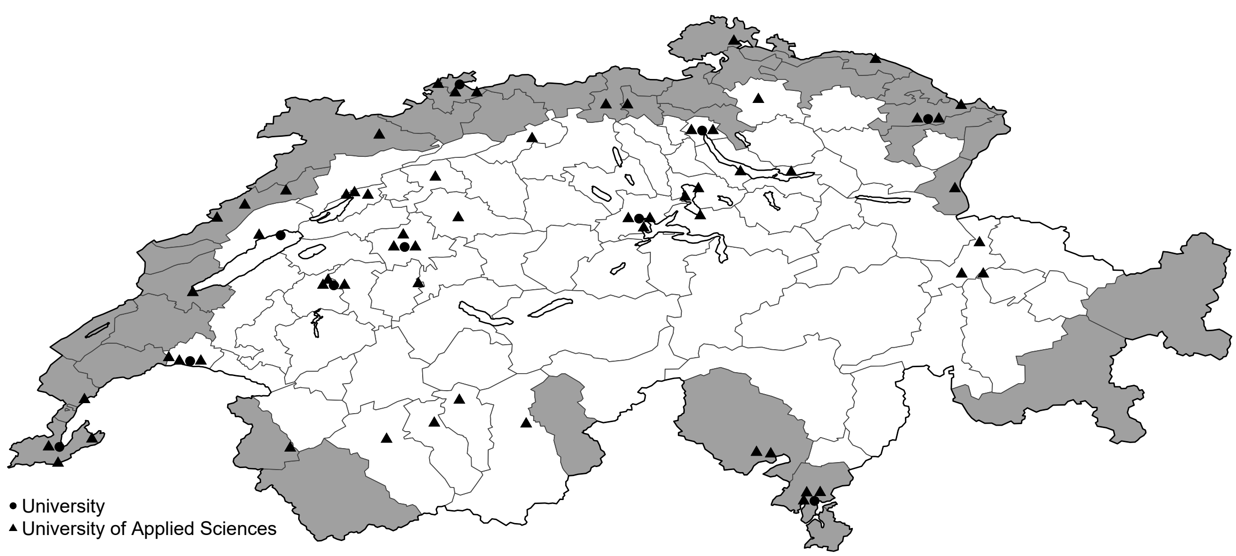
Figures

Figure 1: Swiss education system



Note: The figure presents Swiss educational tracks at the upper-secondary and tertiary level of education. Arrows show most common choices given previous educational background. Compulsory education ends at the lower-secondary level. Individuals typically enter the labor market after the upper-secondary or tertiary education.

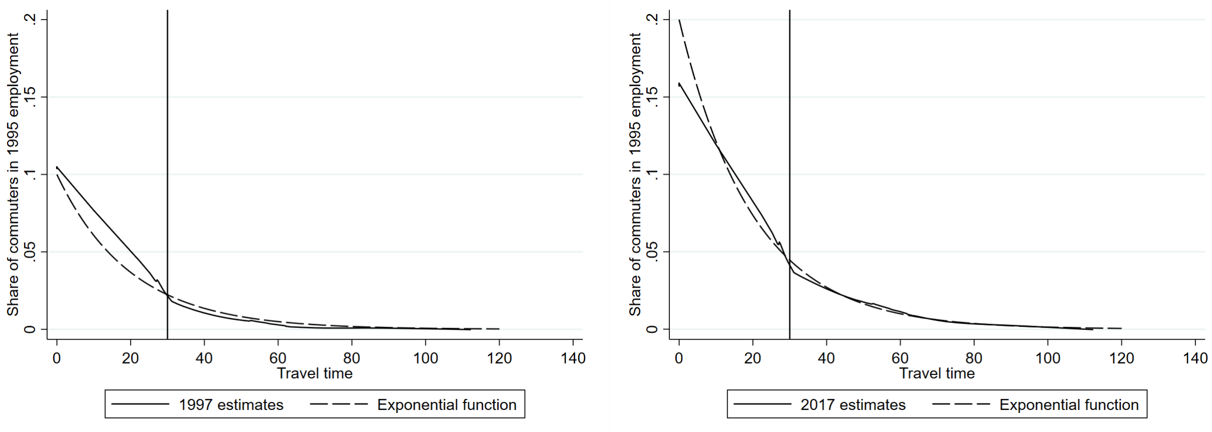
Figure 2: Tertiary institutions in treated and control regions



Note: The map shows Switzerland's 106 commuting zones split into treated (grey) and control regions (white). The locations of the tertiary institutions in 2017 are shown by institutional type.

Figure 3: Exposure to cross-border commuters and travel time

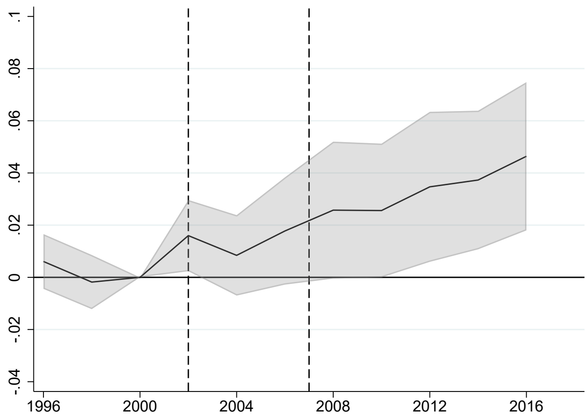
(a) 1997 (b) 2017



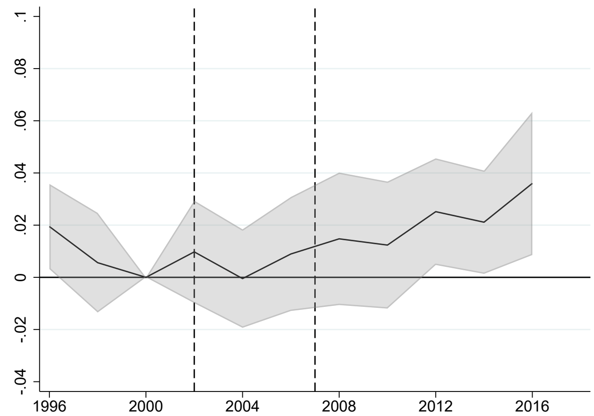
Note: The figure shows estimates from a locally weighted regression of the share of cross-border commuters in 1997 and 2017 (Panel a and Panel b, respectively) in 1995 employment, respectively, on travel time to the closest Swiss border crossing. The unit of observation is the commuting zone. The dashed line plots the function $\exp(-0.05 \times \textit{travel time})$ rescaled by ten in Panel a and five in Panel b. The vertical line is drawn at thirty minutes travel time. Source: FSO.

Figure 4: Exposure to cross-border commuters

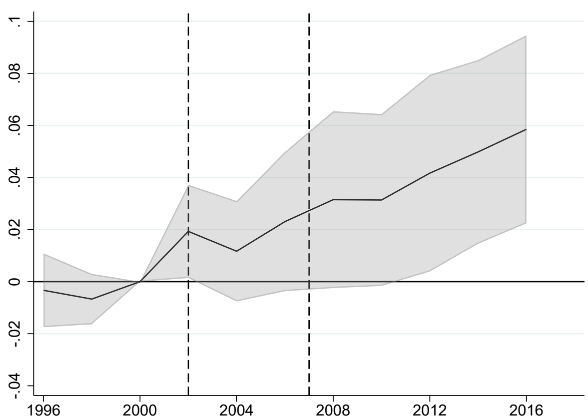
(a) All cross-border commuters



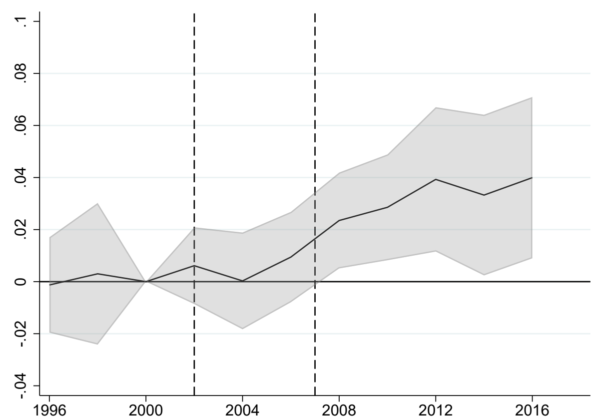
(b) Up to lower-secondary educated



(c) Upper-secondary educated



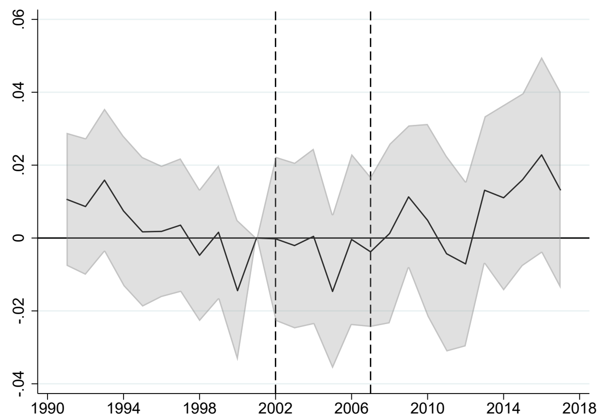
(d) Tertiary educated



Note: The figure shows difference-in-differences estimates using biennial data at the commuting zone level for the period 1996–2016. The vertical lines indicate the beginning of the transition period (2002) and of the post-reform period (2007). The dependent variable is the share of cross-border commuters in total employment. Observations are weighed by the number of total employees in 1996. Standard errors are clustered at the commuting zone level, 95% confidence intervals shown. Source: SESS.

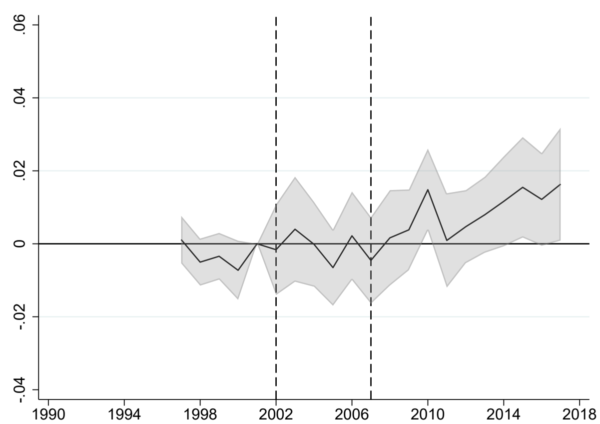
Figure 5: Native enrollment by institutional type

(a) All



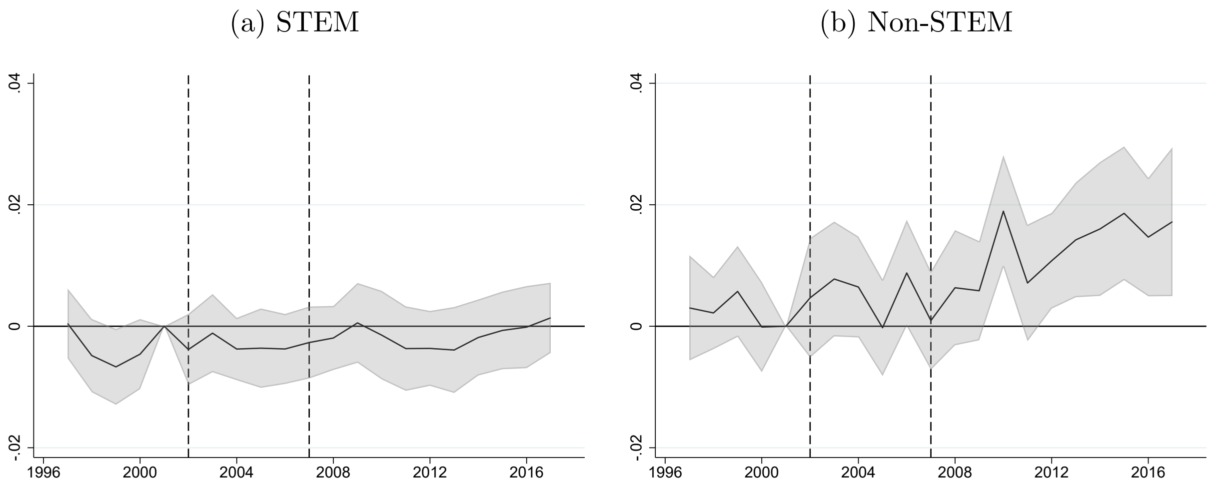
(b) University

(c) University of Applied Sciences



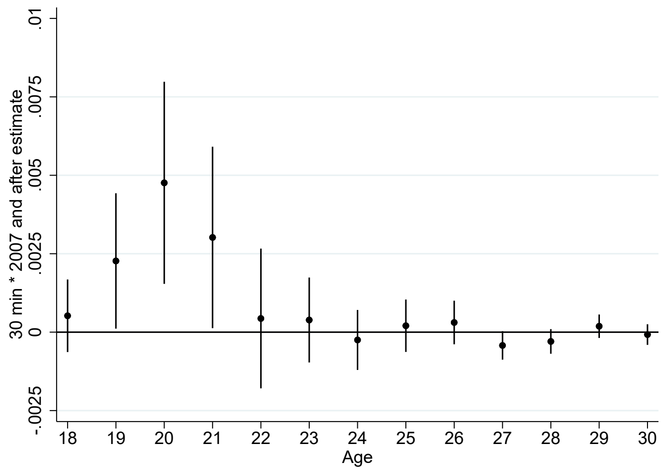
Note: The figure shows difference-in-differences estimates using annual data at the commuting zone level for the period 1991–2017. The vertical lines indicate the beginning of the transition period (2002) and of the post-reform period (2007). The dependent variable is the share of native first-year students in birth cohort. The denominator is specific to the institutional type. Observations are weighed by the cohort size in a specific institutional type in 1997. Standard errors are clustered at the commuting zone level, 95% confidence intervals shown. Source: SHIS-studex.

Figure 6: Native enrollment by type of study field at Universities of Applied Sciences



Note: The figure shows difference-in-differences estimates using annual data at the commuting zone level for the period 1997–2017. The vertical lines indicate the beginning of the transition period (2002) and of the post-reform period (2007). Affected fields are those with a supply shock measure above one as shown in Table 4. The dependent variable is the share of native first-year students enrolled in a specific group of study fields at Universities of Applied Sciences in birth cohort. Observations are weighed by the cohort size in 1997. Standard errors are clustered at the commuting zone level, 95% confidence intervals shown. Source: SHIS-studex.

Figure 7: Native enrollment by age cohort at Universities of Applied Sciences



Note: The figure shows difference-in-differences estimates of the coefficient of the "30min × 2007 and after" variable by age cohort. Each estimate is obtained from a separate regression. The dependent variable is the share of native first-year students at Universities of Applied Sciences in age-specific cohort. Observations are weighed by the age-specific cohort size in 1997. Standard errors are clustered at the commuting zone level, 95% confidence intervals shown. Source: SHIS-studex.

Tables

Table 1: Exposure to cross-border commuters by educational level

	Outcome: share of cross-border commuters			
	All	Up to lower-secondary	Upper-secondary	Tertiary
	(1)	(2)	(3)	(4)
30min * 2002-2006	0.013**	-0.002	0.021**	0.005
	(0.006)	(0.007)	(0.008)	(0.007)
30min * 2007 and after	0.033***	0.014	0.046***	0.032***
	(0.012)	(0.009)	(0.016)	(0.011)
Mean outcome	0.072	0.070	0.069	0.069
Sd outcome	0.109	0.129	0.103	0.098
Commuting zones	106	106	106	106
within 30 min	35	35	35	35
N	1166	1166	1166	1160

Note: The table shows difference-in-differences estimates using biennial data at the commuting zone level for the period 1996–2016. The dependent variable is the share of cross-border commuters in total employment. Observations are weighed by the number of total employees in 1996. Standard errors in parentheses are clustered at the commuting zone level. * p<0.1; ** p<0.05; *** p<0.01. Source: SESS.

Table 2: Summary statistics

	Treatment group			Control group		
	N	Mean	Sd	N	Mean	Sd
Share of cross-border commuters	385	0.167	0.122	781	0.010	0.015
... with lower-secondary education	385	0.165	0.164	781	0.008	0.020
... with upper-secondary education	385	0.161	0.113	781	0.009	0.014
... with tertiary education	385	0.155	0.107	775	0.013	0.019
Share enrolled	735	0.356	0.093	1491	0.313	0.083
... at UNI	735	0.208	0.085	1491	0.171	0.061
... at UAS	735	0.150	0.053	1491	0.143	0.049
... in agriculture	735	0.003	0.002	1491	0.004	0.003
... in arts and humanities	735	0.039	0.017	1491	0.031	0.014
... in business and law	735	0.093	0.029	1491	0.082	0.027
... in education	735	0.037	0.017	1491	0.036	0.018
... in engineering	735	0.050	0.015	1491	0.048	0.014
... in health	735	0.046	0.028	1491	0.035	0.022
... in ICT	735	0.012	0.007	1491	0.011	0.006
... in math and sciences	735	0.033	0.012	1491	0.029	0.011
... in services	735	0.004	0.005	1491	0.004	0.004
... in social sciences	735	0.038	0.020	1491	0.031	0.015
Mean ln gross hourly wage	385	3.573	0.098	781	3.564	0.109
... of lower-secondary educated	385	3.298	0.082	781	3.297	0.083
... of upper-secondary educated	385	3.519	0.081	781	3.496	0.081
... of tertiary educated	385	3.934	0.088	774	3.937	0.085
Share employed in management	385	0.144	0.031	781	0.141	0.029
... with lower-secondary education	385	0.027	0.023	780	0.025	0.023
... with upper-secondary education	385	0.107	0.026	781	0.102	0.025
... with tertiary education	385	0.439	0.093	774	0.439	0.097
Share unemployed	735	0.034	0.022	1491	0.027	0.018
... with lower-secondary education	730	0.070	0.082	1354	0.055	0.077
... with upper-secondary education	735	0.035	0.026	1491	0.028	0.023
... with tertiary education	692	0.025	0.027	1445	0.017	0.023
Share employed	735	0.758	0.051	1491	0.786	0.046
... with lower-secondary education	735	0.445	0.117	1433	0.467	0.129
... with upper-secondary education	735	0.768	0.063	1491	0.799	0.057
... with tertiary education	711	0.889	0.057	1446	0.917	0.051

Note: The observation period for the enrollment outcomes is 1997–2017 and for the other outcome variables 1996–2016. Data is at the commuting zone level. Share of cross-border commuters is in total employment. Lower-secondary level of education is compulsory education as highest degree, upper-secondary is an apprenticeship or a matura, tertiary is a degree from a University or University of Applied Sciences. Share enrolled is the share of first-year students in birth cohort. UNI is short for University and UAS for University of Applied Sciences. One-digit ISCED fields of studies are considered. Share unemployed is the number of unemployed divided by the labor force. Share employed is the number of employed divided by the number of respondents. Weights assigned to the observations reflect the number of native employees in 1996, native cohort size in 1997, number of total employees in 1996, native labor force in 1996, and number of native respondents in 1996. Sources: SESS, SLFS, SHIS-studex.

Table 3: Native enrollment by institutional type

	Outcome: share of enrolled native first-year students		
	All	University	University of Applied Sciences
	(1)	(2)	(3)
30min * 2002-2006	-0.000	-0.004	0.003
	(0.007)	(0.004)	(0.004)
30min * 2007 and after	0.010	-0.002	0.011**
	(0.007)	(0.005)	(0.004)
Mean outcome	0.326	0.183	0.144
Sd outcome	0.089	0.072	0.050
Commuting zones	106	106	106
within 30 min	35	35	35
N	2226	2226	2226

Note: The table shows difference-in-differences estimates using annual data at the commuting zone level for the period 1997–2017. The dependent variable is the share of native first-year students in birth cohort. The denominator is specific to the institutional type. Observations are weighed by the cohort size in a specific institutional type. Standard errors in parentheses are clustered at the commuting zone level. * p<0.1; ** p<0.05; *** p<0.01. Source: SHIS-studex.

Table 4: Cross-border commuters relative to resident workers by field of study

Field of study (1)	STEM field (2)	Skill supply of commuters relative to residents (3)
Education	0	0.495
Languages	0	0.596
Law	0	0.653
Welfare	0	0.663
Journalism and information	0	0.670
Personal services	0	0.719
Humanities (except languages)	0	0.728
Social and behavioral sciences	0	0.764
Health	0	0.800
Veterinary	0	0.819
Business and administration	0	0.883
Arts	0	1.179
Mathematics and statistics	1	1.318
Biological and related sciences	1	1.384
Agriculture	1	1.547
Manufacturing and processing	1	1.549
Environment	1	1.613
Physical sciences	1	1.652
Engineering and engineering trades	1	1.948
Forestry	1	1.968
Information and communication technologies (ICT)	1	2.304
Architecture and construction	1	2.470

Note: Column (1) lists two-digit ISCED study fields. Column (2) distinguishes between STEM and non-STEM fields. Column (3) shows the ratio of the share of commuters trained in a study field relative to the share of residents trained in the same field according to Equation 4. Sources: EHA (2003–2017), FSO (1999, 2000).

Table 5: Exposure to cross-border commuting by education and occupation

	Outcome: share of cross-border commuters			
	Upper-secondary		Tertiary	
	STEM (1)	non-STEM (2)	STEM (3)	non-STEM (4)
30min * 2002-2006	0.027***	0.009	0.038**	0.001
	(0.010)	(0.006)	(0.017)	(0.006)
30min * 2007 and after	0.036**	0.018*	0.053**	0.023**
	(0.015)	(0.010)	(0.022)	(0.010)
Mean outcome	0.086	0.040	0.101	0.051
Sd outcome	0.133	0.064	0.136	0.069
Commuting zones	106	106	105	106
within 30 min	35	35	35	35
N	848	848	814	840

Note: The table shows difference-in-differences estimates using biennial data at the commuting zone level for the period 1996–2010. The dependent variable is the share of cross-border commuters in total employment by educational level and occupation. Observations are weighed by the number of total employees in 1996. Standard errors in parentheses are clustered at the commuting zone level. * $p<0.1$; ** $p<0.05$; *** $p<0.01$. Source: SESS.

Table 6: Native enrollment by type of study field

	Outcome: share of enrolled native first-year students			
	STEM (1)	Non-STEM (2)	Affected (3)	Non-affected (4)
Panel A: All institutions				
30min * 2002-2006	-0.001	0.000	-0.001	-0.001
	(0.003)	(0.006)	(0.003)	(0.005)
30min * 2007 and after	-0.000	0.008	0.001	0.007
	(0.003)	(0.006)	(0.003)	(0.006)
Mean outcome	0.092	0.240	0.103	0.229
Sd outcome	0.023	0.072	0.025	0.069
Commuting zones	106	106	106	106
within 30 min	35	35	35	35
N	2226	3975	2226	3975
Panel B: Universities				
30min * 2002-2006	-0.001	-0.004	-0.002	-0.003
	(0.002)	(0.003)	(0.002)	(0.003)
30min * 2007 and after	-0.002	-0.003	-0.002	-0.002
	(0.002)	(0.004)	(0.002)	(0.004)
Mean outcome	0.049	0.133	0.051	0.131
Sd outcome	0.019	0.058	0.019	0.057
Commuting zones	106	106	106	106
within 30 min	35	35	35	35
N	2226	3975	2226	3975
Panel C: Universities of Applied Sciences				
30min * 2002-2006	-0.000	0.004	0.001	0.002
	(0.002)	(0.003)	(0.002)	(0.003)
30min * 2007 and after	0.001	0.010***	0.003*	0.008**
	(0.002)	(0.003)	(0.002)	(0.003)
Mean outcome	0.043	0.108	0.053	0.098
Sd outcome	0.014	0.041	0.014	0.039
Commuting zones	106	106	106	106
within 30 min	35	35	35	35
N	2226	3975	2226	3975

Note: This table shows difference-in-differences estimates using annual data at the commuting zone level for the period 1997–2017. Affected fields are those with a supply shock measure above one as shown in Table 4. The dependent variable is the share of native first-year students enrolled in a specific group of study fields in birth cohort. Observations are weighed by the cohort size in 1997. Standard errors in parentheses are clustered at the commuting zone level. * p<0.1; ** p<0.05; *** p<0.01. Source: SHIS-studex.

Table 7: Native enrollment at Universities of Applied Sciences by type of matura

	Outcome: share of enrolled native first-year students			
	Vocational (during)	Vocational (after)	Specialised	General
	(1)	(2)	(3)	(4)
30min * 2002-2006	-0.000	0.001	0.004*	-0.002
	(0.002)	(0.001)	(0.002)	(0.002)
30min * 2007 and after	0.006*	-0.001	0.007***	-0.002
	(0.003)	(0.002)	(0.002)	(0.002)
Mean outcome	0.043	0.033	0.016	0.033
Sd outcome	0.021	0.020	0.016	0.018
Commuting zones	106	106	106	106
within 30 min	35	35	35	35
N	2226	2226	2226	2226

Note: The table shows difference-in-differences estimates using annual data at the commuting zone level for the period 1997–2017. The dependent variable is the share of native first-year students at Universities of Applied Sciences in birth cohort. Observations are weighed by the cohort size in 1997. Column (1) shows first-year students with a vocational matura completed during the apprenticeship, column (2) first-year students with a vocational matura completed after the apprenticeship. Standard errors in parentheses are clustered at the commuting zone level. * p<0.1; ** p<0.05; *** p<0.01. Source: SHIS-studex.

Table 8: Native labor market outcomes by educational level

	All	Up to lower-secondary	Upper-secondary	Tertiary
	(1)	(2)	(3)	(4)
Panel A: ln gross hourly wage rate of natives				
30min * 2002-2006	-0.007	-0.018	-0.011	0.018
	(0.008)	(0.012)	(0.008)	(0.011)
30min * 2007 and after	-0.010	-0.011	-0.012*	0.035**
	(0.007)	(0.016)	(0.006)	(0.016)
Mean outcome	3.567	3.297	3.504	3.936
Sd outcome	0.106	0.083	0.082	0.086
Commuting zones	106	106	106	106
within 30 min	35	35	35	35
N	1166	1166	1166	1159
Panel B: Share of natives in a managerial position				
30min * 2002-2006	0.006	-0.002	0.003	0.032**
	(0.004)	(0.003)	(0.005)	(0.014)
30min * 2007 and after	0.003	-0.001	0.000	0.039*
	(0.005)	(0.003)	(0.005)	(0.020)
Mean outcome	0.142	0.025	0.104	0.439
Sd outcome	0.030	0.023	0.025	0.096
Commuting zones	106	106	106	106
within 30 min	35	35	35	35
N	1166	1165	1166	1159

Note: The table shows difference-in-differences estimates using biennial data at the commuting zone level for the period 1996–2016. The dependent variable in Panel A is the mean natural log of gross hourly wage of natives in an education category and in Panel B the share of natives holding at least a middle management position in an education category. Observations are weighed by the number of native employees in a specific education category in 1996. Standard errors in parentheses are clustered at the commuting zone level. * p<0.1; ** p<0.05; *** p<0.01. Source: SESS.

Table 9: Native labor market outcomes by education and occupation

	Upper-secondary		Tertiary	
	STEM (1)	non-STEM (2)	STEM (3)	non-STEM (4)
Panel A: ln gross hourly wage rate of natives				
30min * 2002-2006	0.006	-0.013	0.021	0.009
	(0.006)	(0.008)	(0.019)	(0.020)
30min * 2007 and after	0.013**	-0.017*	0.037	0.035
	(0.007)	(0.010)	(0.025)	(0.030)
Mean outcome	3.498	3.469	3.894	3.994
Sd outcome	0.073	0.085	0.093	0.110
Commuting zones	106	106	101	105
within 30 min	35	35	35	35
N	848	848	790	832
Panel B: Share of natives in a managerial position				
30min * 2002-2006	0.006	-0.002	0.011	0.033*
	(0.007)	(0.006)	(0.025)	(0.018)
30min * 2007 and after	0.002	-0.007	0.016	0.040
	(0.008)	(0.007)	(0.032)	(0.024)
Mean outcome	0.075	0.124	0.367	0.510
Sd outcome	0.031	0.033	0.135	0.106
Commuting zones	106	106	101	105
within 30 min	35	35	35	35
N	848	848	790	832

Note: The table shows difference-in-differences estimates using biennial data at the commuting zone level for the period 1996–2010. The dependent variable in Panel A is the mean natural log of gross hourly wage of natives by educational level and occupation and in Panel B the share of natives holding at least a middle management position by educational level and occupation. Observations are weighed by the number of upper-secondary educated native employees in 1996 in columns (1)–(2) and tertiary educated native employees in 1996 in columns (3)–(4). Standard errors in parentheses are clustered at the commuting zone level. * p<0.1; ** p<0.05; *** p<0.01. Source: SESS.

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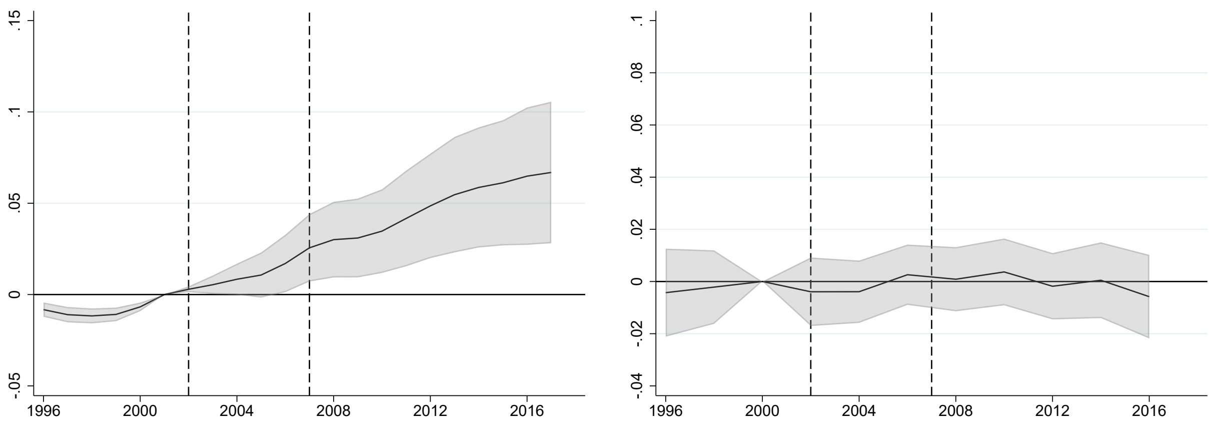
Appendix

A Figures

Figure A1: Exposure to cross-border commuters and resident migrant workers

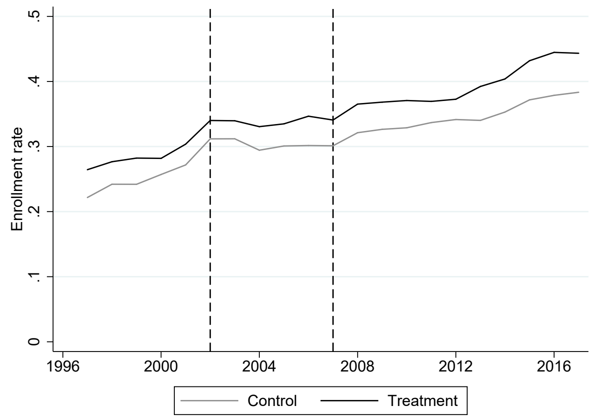
(a) Cross-border commuters (b) Resident migrant workers



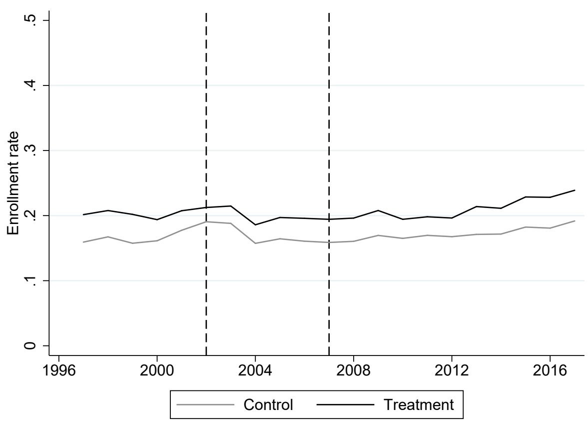
Note: The figure shows difference-in-differences estimates using annual (biennial) data at the commuting zone level for the period 1996–2017 (1996–2016) in Panel a (b). The vertical lines indicate the beginning of the transition period (2002) and the beginning of the post-reform period (2007). The dependent variable is the number of cross-border commuters divided by total employment in 1995 in Panel a and the number of resident migrant workers (excluding cross-border commuters) divided by total employment in Panel b. Weights assigned to observations equal total employment in 1995 in Panel a and total employment in 1996 in Panel b. Standard errors are clustered at the commuting zone level, 95% confidence intervals shown. Sources: FSO in Panel a and SESS in Panel b.

Figure A2: Raw trends in native enrollment by institutional type

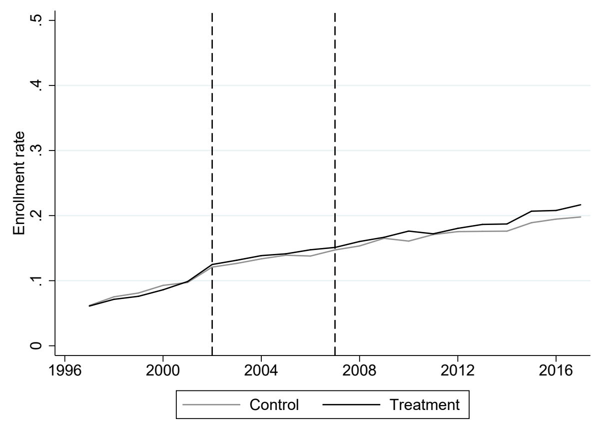
(a) All



(b) University

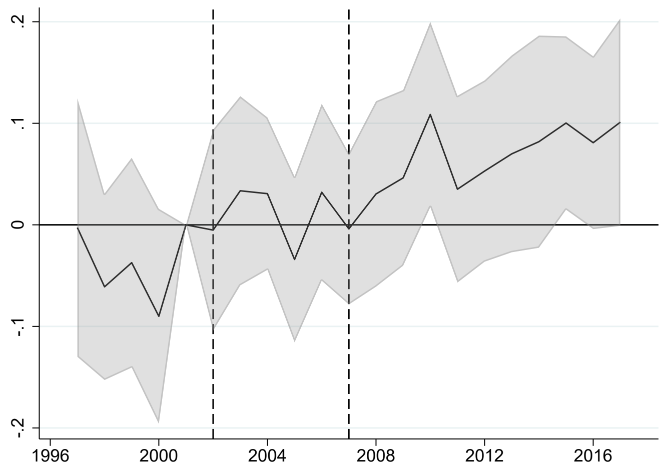


(c) University of Applied Sciences



Note: The figure shows raw enrollment rates by institutional type in treatment and control regions for the period 1997–2017. The vertical lines indicate the beginning of the transition period (2002) and of the post-reform period (2007). The y-axis variable is the share of native first-year students in birth cohort. The denominator is specific to the institutional type. Source: SHIS-studex.

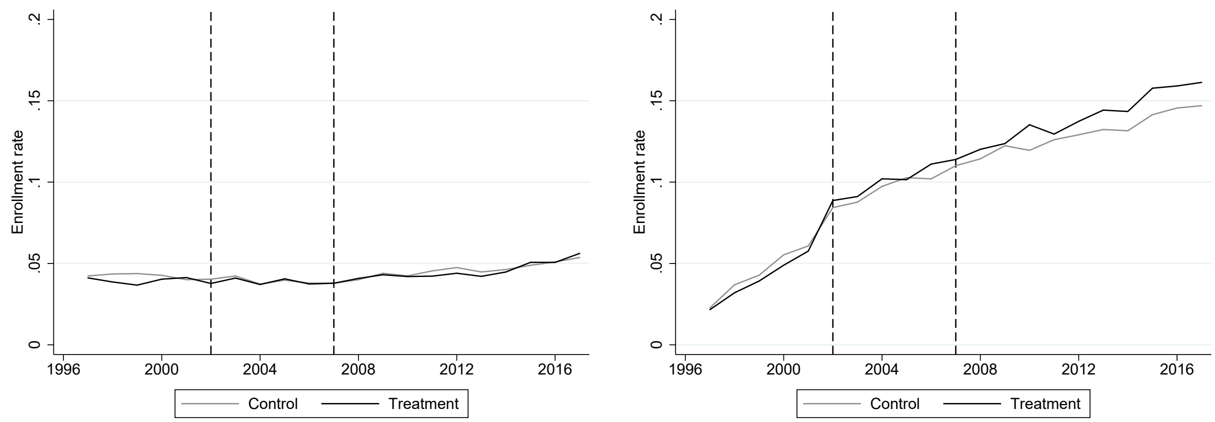
Figure A3: *Ln* number first-year native students at Universities of Applied Sciences (robustness check to outcome measure)



Note: The figure shows difference-in-differences estimates using annual data at the commuting zone level for the period 1997–2017. The vertical lines indicate the beginning of the transition period (2002) and of the post-reform period (2007). The dependent variable is the *ln* of native first-year students. Observations are weighed by the cohort size in 1997. Standard errors are clustered at the commuting zone level, 95% confidence intervals shown. Source: SHIS-studex.

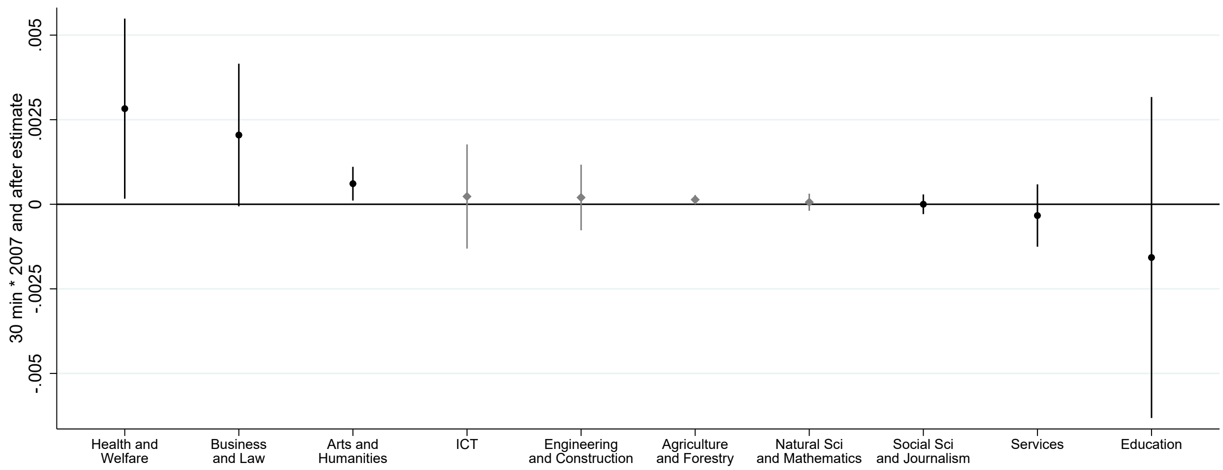
Figure A4: Raw trends in native enrollment by field of study at Universities of Applied Sciences

(a) STEM (b) Non-STEM



Note: The figure shows raw enrollment rates by field of study in treatment and control regions for the period 1997–2017. The vertical lines indicate the beginning of the transition period (2002) and of the post-reform period (2007). The y-axis variable is the share of native first-year students in birth cohort. Source: SHIS-studex.

Figure A5: Native enrollment by detailed field of study at Universities of Applied Sciences



Note: The figure shows difference-in-differences estimates using annual data at the commuting zone level for the period 1997–2017. The coefficient of the "30min × 2007 and after" variable analogous to Panel C of Table 6 is plotted. Each estimate is obtained from a separate regression. ISCED-F 2013 classification is used for the study fields. The coefficients marked with black dots relate to non-STEM fields, and those with grey diamond markers relate to STEM fields. Observations are weighed by the cohort size in 1997. Standard errors are clustered at the commuting zone level, 95% confidence intervals shown. Source: SHIS-studex.

B Tables

Table B1: Exposure to cross-border commuters by educational level (robustness checks to treatment definition)

	Outcome: share of cross-border commuters			
	All	Up to lower-secondary	Upper-secondary	Tertiary
	(1)	(2)	(3)	(4)
Panel A: 25 min threshold value				
25min * 2002-2006	0.014*	-0.003	0.021**	0.013
	(0.007)	(0.009)	(0.010)	(0.009)
25min * 2007 and after	0.037***	0.017	0.049***	0.041***
	(0.014)	(0.011)	(0.018)	(0.013)
Mean outcome	0.072	0.070	0.069	0.069
Sd outcome	0.109	0.129	0.103	0.098
Commuting zones	106	106	106	106
within 25 min	28	28	28	28
N	1166	1166	1166	1160
Panel B: 35 min threshold value				
35min * 2002-2006	0.012**	-0.001	0.019**	0.006
	(0.005)	(0.007)	(0.007)	(0.006)
35min * 2007 and after	0.029***	0.012	0.040***	0.029***
	(0.010)	(0.008)	(0.014)	(0.010)
Mean outcome	0.072	0.070	0.069	0.069
Sd outcome	0.109	0.129	0.103	0.098
Commuting zones	106	106	106	106
within 35 min	41	41	41	41
N	1166	1166	1166	1160
Panel C: Continuous treatment				
Travel time * 2002-2006	0.016*	-0.003	0.026**	0.012
	(0.009)	(0.011)	(0.012)	(0.010)
Travel time * 2007 and after	0.044***	0.020	0.060***	0.048***
	(0.017)	(0.014)	(0.021)	(0.015)
Mean outcome	0.072	0.070	0.069	0.069
Sd outcome	0.109	0.129	0.103	0.098
Commuting zones	106	106	106	106
N	1166	1166	1166	1160

Note: The table shows difference-in-differences estimates using biennial data at the commuting zone level for the period 1996–2016. The continuous measure applies the function $\exp(-0.05 \times \mathit{travel\ time})$. The dependent variable is the share of cross-border commuters in total employed. Observations are weighed by the total workforce in 1996. Standard errors in parentheses are clustered at the commuting zone level. * p<0.1; ** p<0.05; *** p<0.01. Source: SESS.

Table B2: Native enrollment by institutional type (robustness checks to treatment definition)

	Outcome: share of enrolled native first-year students		
	All	University	University of Applied Sciences
	(1)	(2)	(3)
Panel A: 25 min threshold value			
25min * 2002-2006	0.003	-0.005	0.007
	(0.007)	(0.005)	(0.005)
25min * 2007 and after	0.011	-0.005	0.015***
	(0.007)	(0.006)	(0.004)
Mean outcome	0.326	0.183	0.144
Sd outcome	0.089	0.072	0.050
Commuting zones	106	106	106
within 25 min	28	28	28
N	2226	2226	2226
Panel B: 35 min threshold value			
35min * 2002-2006	0.008	-0.001	0.008*
	(0.007)	(0.004)	(0.005)
35min * 2007 and after	0.020***	0.003	0.016***
	(0.007)	(0.005)	(0.005)
Mean outcome	0.326	0.183	0.144
Sd outcome	0.089	0.072	0.050
Commuting zones	106	106	106
within 35 min	41	41	41
N	2226	2226	2226
Panel C: Continuous treatment			
Travel time * 2002-2006	0.005	-0.005	0.010*
	(0.008)	(0.006)	(0.006)
Travel time * 2007 and after	0.014*	-0.004	0.017***
	(0.009)	(0.007)	(0.004)
Mean outcome	0.326	0.183	0.144
Sd outcome	0.089	0.072	0.050
Commuting zones	106	106	106
N	2226	2226	2226

Note: The table shows difference-in-differences estimates using annual data at the commuting zone level for the period 1997–2017. The continuous measure applies the function $\exp(-0.05 \times travel\ time)$. The dependent variable is the share of native first-year students in birth cohort. The denominator is specific to the institutional type. Observations are weighed by the cohort size in a specific institutional type in 1997. Standard errors in parentheses are clustered at the commuting zone level. * $p<0.1$; ** $p<0.05$; *** $p<0.01$. Source: SHIS-studex.

Table B3: Native enrollment at Universities of Applied Sciences (robustness checks)

	Outcome: share of enrolled native first-year students				
	Baseline	+ Education supply	+ Labor demand	No weights	+ Immigrant students
	(1)	(2)	(3)	(4)	(5)
30min * 2002-2006	0.003	0.003	0.003	0.007	0.002
	(0.004)	(0.005)	(0.005)	(0.005)	(0.005)
30min * 2007 and after	0.011**	0.010**	0.012***	0.011**	0.010**
	(0.004)	(0.004)	(0.004)	(0.005)	(0.004)
UAS within 20km		0.008**			
		(0.003)			
Number of fields within 20km		0.001			
		(0.001)			
Bartik control			-0.038		
			(0.037)		
L Sh. immigrant students UNI					0.015
					(0.017)
L Sh. immigrant students UAS					-0.088***
					(0.016)
Mean outcome	0.144	0.144	0.144	0.141	0.144
Sd outcome	0.050	0.050	0.050	0.053	0.050
Commuting zones	106	106	106	106	106
within 30 min	35	35	35	35	35
N	2226	2226	2226	2226	2226

Note: The table shows difference-in-differences estimates using annual data at the commuting zone level for the period 1997–2017. The dependent variable is the share of native first-year students in birth cohort. The denominator is specific to the institutional type. Observations are weighed by the cohort size in a specific institutional type in 1997. Column (1) is the baseline specification from Table 3, columns (2) and (3) include additional control variables. We use two education supply controls – a dummy variable for an institution and the number of study fields at the ISCED level available within a 20km radius of the main city of the region. The Bartik control predicts employment growth with shares fixed in 1995. Column (4) is unweighed. Column (5) includes two additional controls for the lagged share of immigrant students from the same commuting zone. Standard errors in parentheses are clustered at the commuting zone level. * p<0.1; ** p<0.05; *** p<0.01. Source: SHIS-studex.

Table B4: Native enrollment by study field at Universities of Applied Sciences (robustness checks to treatment definition)

	Outcome: share of enrolled native first-year students			
	STEM	Non-STEM	Affected	Non-affected
	(1)	(2)	(3)	(4)
Panel A: 25 min threshold value				
25min * 2002-2006	0.001	0.006	0.003	0.004
	(0.002)	(0.004)	(0.002)	(0.004)
25min * 2007 and after	0.004**	0.011***	0.006***	0.009***
	(0.002)	(0.003)	(0.002)	(0.003)
Mean outcome	0.043	0.101	0.053	0.091
Sd outcome	0.014	0.045	0.014	0.043
Commuting zones	106	106	106	106
within 25 min	28	28	28	28
N	2226	2226	2226	2226
Panel B: 35 min threshold value				
35min * 2002-2006	0.001	0.007*	0.003	0.006
	(0.002)	(0.004)	(0.002)	(0.004)
35min * 2007 and after	0.002	0.013***	0.004**	0.011***
	(0.002)	(0.004)	(0.002)	(0.004)
Mean outcome	0.043	0.101	0.053	0.091
Sd outcome	0.014	0.045	0.014	0.043
Commuting zones	106	106	106	106
within 35 min	41	41	41	41
N	2226	2226	2226	2226
Panel C: Continuous treatment				
Travel time * 2002-2006	0.002	0.008*	0.004	0.006
	(0.002)	(0.005)	(0.002)	(0.005)
Travel time * 2007 and after	0.004*	0.013***	0.006***	0.010***
	(0.002)	(0.003)	(0.002)	(0.003)
Mean outcome	0.043	0.101	0.053	0.091
Sd outcome	0.014	0.045	0.014	0.043
Commuting zones	106	106	106	106
N	2226	2226	2226	2226

Note: The table shows difference-in-differences estimates using annual data at the commuting zone level for the period 1997–2017. The continuous measure applies the function $\exp(-0.05 \times \textit{travel time})$. The dependent variable is the share of native first-year students in birth cohort. Observations are weighed by the cohort size in a specific study field in 1997. Standard errors in parentheses are clustered at the commuting zone level. * p<0.1; ** p<0.05; *** p<0.01. Source: SHIS-studex.

Table B5: Native enrollment in non-STEM fields at Universities of Applied Sciences (robustness checks)

	Outcome: share of enrolled native first-year students				
	Baseline	+ Education supply	+ Labor demand	No weights	+ Immigrant students
	(1)	(2)	(3)	(4)	(5)
30min * 2002-2006	0.003	0.003	0.003	0.008**	0.003
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
30min * 2007 and after	0.010***	0.010***	0.010***	0.009***	0.010***
	(0.003)	(0.003)	(0.004)	(0.003)	(0.004)
UAS within 20km		0.004			
		(0.003)			
Number of fields within 20km		0.002**			
		(0.001)			
Bartik control			-0.020		
			(0.031)		
L Sh. immigrant students Non-STEM					0.015**
					(0.008)
L Sh. immigrant students STEM					0.005
					(0.010)
Mean outcome	0.101	0.101	0.101	0.096	0.101
Sd outcome	0.045	0.045	0.045	0.048	0.045
Commuting zones	106	106	106	106	106
within 30 min	35	35	35	35	35
N	2226	2226	2226	2226	2226

Note: The table shows difference-in-differences estimates using annual data at the commuting zone level for the period 1997–2017. The dependent variable is the share of native first-year students in birth cohort in non-affected fields. The denominator is specific to the institutional type. Observations are weighed by the cohort size in a specific institutional type in 1997. Column (1) is the baseline specification from Table 6, columns (2) and (3) include additional control variables. We use two education supply controls – a dummy variable for an institution and the number of study fields at the ISCED level available within a 20km radius of the main city of the region. The Bartik control predicts employment growth with shares fixed in 1995. Column (4) is unweighed. Column (5) includes two additional controls for the lagged share of immigrant students from the same commuting zone. Standard errors in parentheses are clustered at the commuting zone level. * p<0.1; ** p<0.05; *** p<0.01. Source: SHIS-studex.

Table B6: Native unemployment and employment rates by educational level

	Outcome: native unemployment or employment rate			
	All	Up to lower-secondary	Upper-secondary	Tertiary
	(1)	(2)	(3)	(4)
Panel A: Unemployment rate				
30min * 2002-2006	0.000	-0.025	0.004	-0.003
	(0.003)	(0.016)	(0.004)	(0.006)
30min * 2007 and after	0.003	-0.005	0.003	0.004
	(0.003)	(0.014)	(0.003)	(0.005)
Mean outcome	0.030	0.060	0.031	0.020
Sd outcome	0.020	0.079	0.024	0.024
Commuting zones	106	101	106	102
within 30 min	35	35	35	33
N	2226	2084	2226	2137
Panel B: Employment rate				
30min * 2002-2006	0.010	0.040	0.007	-0.004
	(0.008)	(0.027)	(0.010)	(0.009)
30min * 2007 and after	-0.002	-0.009	0.004	-0.005
	(0.007)	(0.023)	(0.010)	(0.012)
Mean outcome	0.776	0.459	0.788	0.907
Sd outcome	0.050	0.126	0.061	0.055
Commuting zones	106	104	106	103
within 30 min	35	35	35	34
N	2226	2168	2226	2157

Note: The table shows difference-in-differences estimates using annual data at the commuting zone level for the period 1996–2016. In Panel A, the dependent variable is the share of native unemployed in total labor force in an education category. In Panel B, the dependent variable is the share of native employed in total number of respondents in an education category. Observations are weighed by the labor force in a specific education category in Panel A and by the total number of respondents in a specific education category in Panel B in 1996. Standard errors in parentheses are clustered at the commuting zone level. * p<0.1; ** p<0.05; *** p<0.01. Source: SLFS.

Table B7: Individual characteristics of native students at Universities of Applied Sciences

	Outcome: mean of individual level characteristics		
	Urban origin (1)	German speaking origin (2)	Female (3)
30min * 2002-2006	-0.003	-0.000	0.002
	(0.008)	(0.002)	(0.016)
30min * 2007 and after	-0.000	0.000	-0.010
	(0.009)	(0.001)	(0.018)
Mean outcome	0.610	0.721	0.490
Sd outcome	0.293	0.444	0.074
Commuting zones	106	106	106
within 30 min	35	35	35
N	2,224	2,224	2,224

Note: The table shows difference-in-differences estimates using annual data at the commuting zone level for the period 1997–2017. The dependent variable is the mean value of different characteristics among first-year students at Universities of Applied Sciences. Origin refers to the municipality of growing up. Municipalities are split into urban, rural or intermediate municipalities. German speaking origin refers to individuals who come from the German speaking part of Switzerland. Observations are weighed by the cohort size in 1997. Standard errors in parentheses are clustered at the commuting zone level. * p<0.1; ** p<0.05; *** p<0.01. Sources: FSO, SHIS-studex.

Table B8: Graduation rates of native students by institutional type

	Outcome: graduation rate		
	University of Applied Sciences	STEM	Non-STEM
	(1)	(2)	(3)
30min * 2002-2006	0.009	-0.003	0.025*
	(0.009)	(0.012)	(0.014)
30min * 2007 and after	0.004	-0.001	0.018
	(0.008)	(0.011)	(0.015)
Mean outcome	0.689	0.669	0.696
Sd outcome	0.298	0.298	0.305
Commuting zones	106	106	106
within 30 min	35	35	35
N	2224	2210	2208

Note: The table shows difference-in-differences estimates using annual data at the commuting zone level for the period 1997–2017. The dependent variable is the share of native first-year students who graduated within 1997–2017 relative to the number enrolled in Universities of Applied Sciences. Observations are weighed by the number enrolled in Universities of Applied Sciences in 1997. Standard errors in parentheses are clustered at the commuting zone level. * p<0.1; ** p<0.05; *** p<0.01. Source: SHIS-studex.

C Data

This appendix provides an overview of the main datasets obtained from the Swiss Federal Statistical Office (FSO) and the sample construction. We aggregate up data series available at the municipality level to commuting zones according to a concordance table provided by the FSO. We take the municipality definitions from April 2018. We use the survey weights provided where such are available.

Swiss Higher Education Information System (SHIS-studex)

The SHIS-studex dataset records all persons enrolled in tertiary education. Tertiary education includes a study at a Swiss University or Federal Institute of Technology (UNI) or at a University of Applied Sciences (UAS). Our dataset starts in 1990 for UNI and 1997 for UAS. Information on received degrees are available for UNI since 1990 and for UAS since 2000. The data on enrollment is reported yearly in the fall semester while degrees are shown by the date of graduation.

We take the following steps to build the relevant sample for our analysis. We only keep first-year students in a diploma and diploma/licentiate study before the Bologna reform and in a bachelor study in the period after because of our focus on undergraduate studies.[19] Furthermore, we take first time enrollments and disregard from subsequent decisions. The place of residence at the time of obtaining the certificate granting access to tertiary education must be in Switzerland in order to allocate students to a commuting zone. We drop non-Swiss nationals and first-year students younger than eighteen and older than thirty years (Shih, 2017). 18 years is the minimum age of entering the tertiary level when following the ordinary path of education. We exclude students above 30 years of age at entry because of our focus on Bachelor's degrees and due to the long time gap between obtaining the matura and enrollment. University of Applied Sciences students are on average older than University students. Thus, more of the former are dropped by this limitation (6.3% of UAS students versus 3% of UNI students). We disregard from institutions that are specialized on distance learning (Universitäre Fernstudien Schweiz and Fernfachhochschule Schweiz). To define study fields, we use the ISCED-F 2013 codes (International Standard Classification of Education: Fields of Education and Training) from the UNESCO and merge them to the Swiss-specific study field definitions based on a matching scheme provided by the FSO. Out of the available 25 ISCED 2-digit fields, we do not observe students pursuing a degree

[19]The structure of tertiary education changed after the implementation of the Bologna Agreement in 1999. The aim of this declaration was to have a European higher education area with unified rules. The system changed from a comprehensive one-tier (diploma or licentiate) to a two-tier degree structure with separate undergraduate (bachelor) and graduate (master) levels.

in hygiene and occupational health services, and transport services or fisheries. We further split health into health and welfare degrees. This leaves us with twenty-three categories.

Teacher education has belonged to the tertiary level since 2001. Cantons, which are responsible for this type of education, have either set up independent Universities of Teacher Education or integrated the study field into the Universities of Applied Sciences. The difference between the two types of institutions is only organizational. Throughout our study, we subsume all students enrolled in Teacher Education under UAS. This re-allocation also affects study fields at the University of Bern.

Survey of Higher Education Graduates (EHA)

The EHA survey looks at graduates with a focus on their work and educational outcomes one and five years after graduating. It is conducted every second year in autumn since 1981 and since 2009 mainly online. We have access to data from 2003 on. The first-wave survey covers the years up to 2017 while the second-wave survey goes from 2007–2017. In the first-wave all graduates from a Swiss higher education (undergraduates, graduates, PhDs) receive the questionnaire. The response rate is around 60%. Only respondents in the first-wave can participate in the second-wave four years later with a response rate of around 65%. The survey is representative at the level of study fields and institutions.

We pool all first-wave survey data from 2003 onwards to derive the mapping from study fields to occupations. Compared to the SHIS-studex dataset where we only look at first-year students in undergraduate degrees, we include master graduates as well. The reason is that the majority of bachelor students at Universities continue on to master's study. We take the sample of Swiss by nationality and with place of residence in Switzerland when obtaining the certificate granting access to tertiary education. In addition, we only keep graduates with an occupation and place of living in Switzerland at the time of the survey. We keep graduate students between 21 and 35 years of age in order to reflect the first-year students' age that we limit to 18–30 and the approximative length of a study. Since the first-wave survey is conducted one year after graduation, the respondents of interest are between 22 and 36 years. For our analysis we merge the FSO-specific study fields to the ISCED-F 2013 codes analogous to the SHIS dataset. The subject security services is part of the SHIS-studex dataset but it does not appear in the EHA. We are thus left with twenty-two categories that we use in our analysis of study field enrollment. The occupations are reported according to the ISCO-08 classification. We take a concordance table provided by the FSO to receive the older ISCO-88 occupation labels. This is a necessary step to make results comparable to the occupation data from other FSO sources, which are reported according to ISCO-88.

In the Swiss context occupations in levels 1 and 2 of ISCO-08 typically require a bachelor degree or graduate level education. There are four occupations in level 1 (Chief Executives, Senior Officials and Legislators; Administrative and Commercial Managers; Production and Specialized Services Managers; Hospitality, Retail and Other Services Managers) and six occupations in level 2 (Science and Engineering Professionals; Health Professionals; Teaching Professionals; Business and Administration Professionals; Information and Communications Technology Professionals; Legal, Social and Cultural Professionals).

Swiss Earnings Structure Survey (SESS)

The SESS is conducted at the firm-level in the month of October every second year since 1994. It covers the secondary and tertiary sectors. The population includes firms with at least three employees and also the public sector (the cantonal public sector was added in 2000, the municipal public sector was added in 2006). Participation in the survey is mandatory. Companies provide information on a random subset of employees. The number of workers covered depends on the firm size, with data for at least one third of all workers. In 2016, around 37,000 firms with 1.7 million employees were surveyed. We identify cross-border commuters by their G-permit. Natives are defined as Swiss by nationality. When splitting the data by highest education attained, we disregard from professional degrees that are also considered tertiary. This is a necessary step in order to relate the relevant wage changes to the academic tertiary degrees we focus on.

We restrict the sample to employees of private sector establishments aged between 18 and 65, with available region of work, permit type, gender, education and wage. The industry classification follows the NOGA (General Classification of Economic Activity) framework. We use the standards defined in 2008 and use concordance tables for the survey years that report NOGA 2002.

We construct the gross hourly wage rate in CHF based on the variable called standardized gross wage. The gross wage includes social contributions and Sunday or night work compensation. Additionally, 1/12 of the 13th salary and other non-periodic payments are added while excluding overtime pay. This sum is divided by weekly working hours and multiplied by 40, which is the standardized number of working hours per month. We take this standardized gross wage to derive the gross hourly wage rate. Last, we calculate the real values using CPI data from the FSO that is indexed to December 2015.

We investigate wages for different education levels and types of occupations. Occupations are reported in a Swiss specific classification up to 2010 and from 2012–2016 it follows ISCO-08. For the first period, we split the occupations into STEM and non-STEM based on the broad descriptions in the handbook.[20] Since the Swiss specific classification is not directly related to ISCO, we conduct the wage analysis by occupation only up to 2010.

Swiss Labor Force Survey (SLFS)

The SLFS is an individual-level survey. It was conducted annually in the second quarter of the year from 1991 to 2009 and quarterly afterwards. Since 2010 around 125,000 interviews are conducted yearly, whereas one person is interviewed four times within six consecutive quarters.

The SLFS covers individuals aged 15 years and older but we limit the sample to individuals in the age group 18–65. We use annual data. To construct the native employment and unemployment rates, we only keep Swiss by nationality. Definitions follow standards from the International Labor Organization. Employment is defined as employed for a salary, by a family member or self-employed. Unemployment is defined as not being employed, but searching and being available for a job. Students, retired individuals and people inactive for other reasons are considered to be out of the labor force.

[20]STEM occupations: manufacturing and processing of product; construction activities; installation, operating and maintaining; restoration, handicrafts; research and development; analysing, programming, operating; planning, constructing, drawing, and realizing. Non-STEM occupations: strategic management; accounting, personnel management; secretarial, clerical work; other commercial and administrative act; logistics, staff tasks; assessing, advising, certifying; purchase and sale of commodities and capital goods ; sale of consumer goods and retail services; transport of people and goods, communication; security and surveillance services; medical, social and care activities; personal and clothing care; educational activities; accommodation, food and domestic activities; culture, information, entertainment, sports; cleaning and public hygiene.