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Free Movement of Workers and Native Demand for Tertiary Education[a]

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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 Codes: F22, I26, J24, J61, R23

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1 Introduction

Governments play an important role in shaping access to education and often aim to achieve specific national educational targets. Other factors are also relevant in the individual decision to accumulate human capital. For example, working conditions such as relative wages are likely to have an impact on demand for schooling. Understanding how education decisions respond to changes in these factors is crucial given that the skill composition of the workforce is key for the economy's growth potential (Lucas, 1988). We investigate the importance of labor market conditions in enrolment and study field choices of natives at the tertiary level. We link changes occurring in the labor market to increasing foreign worker mobility. Given recent trends in advanced education and international mobility the topic is especially relevant for developed countries.

Free movement of persons is the corner stone of the European Union (EU). Switzerland, a non-EU country, has negotiated similar conditions in the Agreement on the Free Movement of Persons (AFMP) with the EU and the other members of the European Free Trade Association (EFTA). The AFMP was signed in 1999 and approved by the electorate in 2000. We study this major migration reform that removed quotas and introduced free movement of workers. The proposed changes were in particular important for cross-border commuters, i.e. individuals who work in Switzerland but reside abroad. Restrictions on commuting were gradually relaxed between 2002 and 2007, when they were completely abolished. As a result, the number of frontier workers substantially increased. Their share relative to total employed rose from 4% in 2001 to 5.8% in 2015. These values understate the commuters' importance for border regions where their share was 13.7% in 2015.

Switzerland offers a unique setting to evaluate the effect of a free movement reform on demand for tertiary education. Since cross-border commuters reside abroad, they leave demand for goods and services in the country of work largely unaffected. Importantly, they are unlikely to demand publicly provided services such as education. The inflow of commuters can, therefore, be regarded as an almost pure labor supply shock. The country'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. These two groups of students are interesting to compare because they differ in their labor market experience and opportunity costs of studying. Importantly, the Swiss education system enables us to isolate education demand from supply forces since fulfilling the admission requirements generally guarantees enrolment. Finally, we have access to administrative data on all individuals enrolled in academic tertiary education which allows us to precisely quantify demand.

Since cross-border commuters work in areas close to the national border, we define affected and non-affected Swiss labor market regions based on driving distance to the border. We combine this cross-sectional variation in exposure with the timing of the reform implementation in a difference-in-differences framework. The analysis of the policy change reveals an increase in the share of cross-border commuters of 5.9 percentage points in the treated relative to the control regions in the post-reform period. This is driven by upper-secondary and tertiary educated commuters. Therefore, labor market competition increases in particular for natives who are at the point of deciding whether to join the labor market or enrol in tertiary education.

Our main outcome of interest is native educational enrolment at the tertiary level by institutional type and study field. The results show that natives in regions affected by cross-border commuting respond by demanding more tertiary education relative to natives from regions less affected. Enrolment in undergraduate degrees from Universities of Applied Sciences rises in the post-reform period in treated regions by 1.6 percentage points. This effect is economically large relative to average enrolment rates in the treated regions of 7.6% in the pre-reform period and 18.4% in the post-reform period. University enrolment in treated relative to control regions does not change due to the immigration reform. Furthermore, we map occupations to fields of study using survey data and measure the extent to which specific fields are affected by the inflow of foreign workers. Subjects are considered to be affected if they are linked to occupations that commuters hold relatively more often than resident workers. We find that enrolment in less affected fields of study 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.

We link these enrolment results to conditions in the labor market. Since commuters are more likely employed in STEM occupations, the natives' response to the reform points at an attempt to avoid foreign competition in the labor market. This response is driven by individuals with a particular type of upper-secondary education. Generally and vocationally educated upper-secondary graduates differ in their labor market prospects. Vocationally trained have viable employment opportunities but the rise in competition may tighten the available vacancies or even deteriorate the working conditions in the short run. Their on-the-job education raises awareness of current labor market conditions that may explain their responsiveness. This is exactly what we see in the data. A complementary channel for which we find suggestive evidence is one of higher returns to studying. We estimate a small drop in wages at the upper-secondary level and an increase at the tertiary level.

Overall, we show that individuals respond to the signals sent by the labor market by adjusting their demand for education. Our findings are conditional on having access to learning

opportunities. By providing those, governments can facilitate the adjustment processes we document. As such adjustments are in response to changes in migration regulation, the paper addresses the need to consider policies in different areas such as education and migration jointly.

In this paper we present comprehensive evidence on how educational decisions at the tertiary level respond to changes in labor market conditions. The literature on educational choice finds that expected earnings and employment perspectives matter (Beffy *et al.*, 2012; Wiswall and Zafar, 2015) with some studies showing limited knowledge of returns (Xia, 2016). A closely related literature exploits business cycles to evaluate the impact of opportunity costs. There is evidence that enrolment is countercyclical in 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 labor market conditions. We study tertiary enrolment decisions separately for individuals with general and vocational educational backgrounds, where the latter has been to a large extent ignored in the literature. Their different experience on the labor market allows a better understanding of the motives to acquire tertiary education in the general population.

A number of studies link native demand for education to immigration. An inflow of foreign students can affect school resources while foreign workers may change labor market returns to education. Betts (1998) reports an overall negative effect of immigrant inflows on high school graduation rates of American-born minorities. Hunt (2017) finds that a higher share of low-skilled adult immigrants has a positive impact on high-school completion, while immigrants of school age have no significant effect. Similarly for college enrolment, Jackson (2018) shows a significant positive impact of labor immigrants but no effect of foreign students in the cohort. Focusing on foreign workers, McHenry (2015) documents an increase in native post-secondary degree attainment. Llull (2018) considers education, participation and occupation as margins of adjustments to immigration. Educational attainment depends on relative changes in wages, which in turn depend on capital adjustments in the economy. Our empirical strategy exploits the inflow of foreign workers, who do not compete with natives for school resources. We, thus, contribute to the literature by directly linking educational decisions with labor market conditions.

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, 2016). We confirm these findings in a context where the foreign workers are culturally and linguistically similar to the natives. Few studies link migrant occupational choices to native enrolment in specific study fields. Ransom and Winters (2020)

find an outflow of native-born Americans, specifically blacks, from STEM 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 taking a wholistic approach. We consider all study fields and, thus, capture the complete set of available choices. Moreover, we group subjects by the intensity of the labor market competition with foreign workers and map the result to the STEM classification in order to identify the most likely mechanism.

We further build on the migration literature which finds 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). A number of studies investigate specifically the role of high-skilled immigrants, reporting mostly positive results. The literature has found an increase in innovation and total factor productivity (Hunt and Gauthier-Loiselle, 2010; Moser *et al.*, 2014; Peri *et al.*, 2015). Mayda *et al.* (2018) show that a restriction on the number of H-1B visa did not affect native employment, while Mayda *et al.* (2020) document a negative effect on firm level outcomes. Crown *et al.* (2020) find that the inflow of skilled migrants to Australia affects low-skilled native wages positively. On the other hand, studies using historic events which triggered an inflow or an outflow of scientists from a country have found mixed effects on scientific output (Borjas and Doran, 2012; Waldinger, 2012, 2016). We similarly look at an inflow of high-skilled foreign workers, but focus on cross-border commuters who have not been extensively studied. Looking at the same reform as we do, Beerli *et al.* (2018) find a positive effect on the wages of high-skilled natives and no employment effects. Dustmann *et al.* (2017) investigate a temporary increase in low-skilled Czech cross-border commuters 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. We complement this literature by examining how policy induced changes to labor market conditions affect incentives for human capital accumulation. Education shapes the skill set of the labor force and has long-term implications for the individual and the country.

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 enrolment 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. While the agreement affects all foreign workers from EU and EFTA countries, we focus on cross-border commuters. Cross-border commuters are non-Swiss by nationality and require a G-permit to work 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. Within Switzerland, they were only allowed to work in defined border zones. 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. The majority of them works in the Swiss border regions, where the share of commuters in total employed rose from 9.9% in 2001 to 13.7% in 2015. In 2017, 95% of all cross-border commuters are nationals of France, Germany, Italy or Austria. Consistent with travel costs depending on distance, they generally commute to regions near their place of residence. Therefore, frontier workers tend to work in places where their native

language is spoken.[1]

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 a lower-secondary education is considerably lower (11%) and the share with an upper-secondary education is higher (59%). These differences persist during the study period. The share of tertiary educated workers has been rising for both native and frontier workers since 1996 but the trend is stronger for the latter group.

We additionally compare occupational outcomes among natives and cross-border commuters, as such could be more informative than educational attainment if there is skill downgrading. We use administrative data from 1999 and 2000 and calculate the share of commuters in an occupation relative to the share of resident workers in Table B1. Managerial and Professional occupations typically require tertiary education in Switzerland.[2] In the Professional occupations, it is in Science and Engineering, Information and Communications Technology that commuters are more likely to be employed than natives. On the other hand, they are underrepresented among Health, Teaching, Business, Legal, Social and Cultural professionals as well as in Managerial positions. A similar picture emerges when looking at occupations where typically a secondary educational background is required: frontier workers are overrepresented in positions which need more technical and numerical skills and underrepresented in occupations which require institutional or cultural knowledge, social or high level of language skills. The same conclusion is reached when we focus on the 2012–2016 period using the earnings structure survey data. Additionally, in contrast to 1999 and 2000, commuters become underrepresented in Elementary Occupations.

2.2 Dual Education System

We focus on enrolment in academic tertiary education in our analysis. Three types of institutions exist in Switzerland: Universities and Federal Institutes of Technology, Universities of Applied Sciences and Universities of Teacher Education. 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. While Universities are committed to a combination of teaching and research, Universities of Applied

[1] 97–98% 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.

[2] The earnings structure survey data from the period 2012–2016 show that the share of tertiary educated employees is highest for ISCO-08 level 1 and 2 occupations – 39% and 55%, respectively. This share is only 12% for level 3 occupations (technicians and associate professionals).

Sciences impart professional skills with a practice and application oriented focus. Both offer STEM and non-STEM education. Around 69% of all University students in the academic year 2017/2018 are enrolled in a non-STEM field. At Universities of Applied Sciences this share is almost 74%. Teacher education has belonged to the tertiary level since 2001 and is predominantly taught at Universities of Teacher Education (UTE). Of all tertiary students in the academic year 2017/2018, 61% are enrolled in Universities, followed by 31% in Universities of Applied Sciences and the remaining 8% in Universities of Teacher Education.

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 in upper-secondary education pursued a vocational degree in 2016, while the rest were enrolled in general education. There are three types of matura that grant access to tertiary education. A vocational education, which is tailored for joining the labor market, can be combined with a vocational matura. Such a matura can be obtained during or after the vocational training and is required for admission to a University of Applied Sciences. A general education results in either a general or a specialised matura. The general matura grants access to Universities and Universities of Teacher Education, but can also be used to enter a University of Applied Sciences. The specialised matura has both general and vocational education components. Individuals with this type of matura can enrol in Universities of Applied Sciences and Universities of Teacher Education. 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 in 2017. Most of the institutions are in the northern and western part of the country and clustered in the main centres. There are ten cantonal Universities and two Federal Institutes of Technology spread over ten cities. In contrast, most of the nine Universities of Applied Sciences have several locations, which are often specific to a study field. Finally, there are twenty institutions that offer teacher education. The high density of institutions enables daily commuting to classes for a large share of the population. Yearly study costs are estimated to be around CHF 24,000 including tuition fees that are generally below CHF 2,000 for Swiss nationals.[3] These costs can be financed through stipends, financial support from the family or paid work. According to a survey conducted by the FSO, around 75% of the enrolled students have a paid job (FSO, 2016).

The Swiss education system offers a unique setting because the lack of supply constraints enables us to infer demand for tertiary education from enrolment. Besides a matura, no

[3]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.

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 enrol 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 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. Furthermore, graduation rates are generally below unity with a 85% completion rate among those who enrolled in a bachelor program in 2007. In the analysis we will look at both enrolment and graduation rates.

3 Data and Methods

3.1 Data

We combine several data sources to conduct our analysis. Detailed information is available in the Data Appendix C. We take the commuting zone as the unit of observation in all parts of the analysis.[4] For simplicity, we refer to them as "regions". 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).

In the enrolment analysis we use administrative data referred to as SHIS-studex, an abbreviation for the Swiss Higher Education Information System. The data is provided by the FSO. 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, Universities of Applied Sciences since 1997, and Universities of Teacher Education since 2001. The variables used are age, nationality, place of residence prior to beginning a study, certificate 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 enrolment 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. Additionally, we focus on Swiss nationals because they are likely to be more familiar with the choice set in a dual tertiary education system compared to

[4]The commuting zone is called MS-region in Switzerland. MS comes from the French "mobilité spatiale". According to commuting data from the FSO, 63% of employees work and live in the same commuting zone in 2014.

non-Swiss. To calculate the share of students enrolled we divide the number of first-year students by the birth cohort size in 1997. 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 and Universities of Teacher Education 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 canton level.

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. In the first-wave survey, all graduates who have successfully completed a degree in a Swiss institution of tertiary education in the previous year are asked to fill out a questionnaire. Only graduates who participated in the first-wave survey are asked to take part in a second-wave survey four years later. Our focus lies on first-wave results because we are interested in information collected 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, 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 in the month of October. It is a repeated cross-section of private sector firms in the secondary and tertiary sectors of the economy. We use information on the region in which the firm is located. The sample is limited to employees 18–65 years of age. Working permit information distinguishes native from cross-border employees. We differentiate three types of education based on the highest level attained – tertiary, upper-secondary and up to lower-secondary training. We use data on native gross hourly wages and on the share of cross-border commuters. For the latter measure we divide the number of commuters by the total number of employees in 1996. 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 in 1996. 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. The survey has been conducted annually in the second quarter of the year from 1996 to 2009 and quarterly from 2010. For consistency, we use annual data. Information about municipality of residence, demographic characteristics, educational attainment and employment outcomes for the household head is available. 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 obtain 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 $travel\ time_r = \sum_{m \in r} travel\ time_{m,2018} \times \frac{nr\ employed_{m,1995}}{nr\ employed_{r,1995}}$. 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 continuous measure of treatment intensity. Treatment level is defined as $\exp(-0.05 \times travel\ time)$ where the functional form is motivated by the observed commuting patterns. As the Figure shows, it mimics well the variation we see in the data. In the main part of the analysis we use a fixed threshold of thirty minutes to define treatment. This is consistent with Beerli *et al.* (2018) and assigns 35 out of the 106 regions to the treatment group and the remaining 71 regions to the control group. Figure 2 shows the geographical location of the treatment and control regions. As is visible in Figure 3, there is no discontinuity in exposure to cross-border commuting at the thirty minutes threshold. We, therefore, consider different treatment assignments in alternative specifications.

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 enrolment, first-year students are allocated to their region of residence at the time of taking the matura. 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 measure the reform effects over all available data

points and split them into three periods: pre-reform (1997–2001), transition (2002–2006) and post-reform (2007–2017). 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 and we limit the control variables to NUTS II region $\times$ year fixed effects. The latter control for changes over time occurring at the larger geographical level.[5] In the enrolment analysis, we also control for the natural log of native population that may drive changes in enrolment rates. Further variables that could vary during the period and across regions are introduced in robustness checks. We use weights to account for the different population and employment sizes across regions. In the regressions on enrolment we weigh by native cohort size in 1997, in the wage analysis by the number of native employees in 1996, in the regressions on unemployment rates by the labor force in 1996, and in the case of employment rates by the total number of individuals in 1996. Finally, commuter exposure regressions are weighed by total employment in 1996. 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. We expect that the free movement reform effect persists until the end of the observation period due to the permanent rise in cross-border commuting that we observe in the raw data.

The key assumption under which our results are valid is that enrolment rates and labor market conditions would have followed the same trend in treatment and control regions absent the reform. We compare yearly coefficients as visualized in the figures to investigate whether this assumption is likely to hold. Graphical evidence shows that prior to the reform treatment and control units follow parallel trends. We expect no deviation from this trend

[5] 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 on a cantonal level, while a tertiary institution's catchment area often extends over several cantons.

in the years prior to 1997 since we are not aware of other reforms with a comparable scope. 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 Stable Unit Treatment Value Assumption (SUTVA) is the second important precondition to be fulfilled. We are interested in changes in local labor market conditions and their impact on demand for education. Commuting zones, the unit of observation, are constructed as regions where individuals reside and work.[6] This itself mitigates any potential violation of the SUTVA. We know from the EHA survey where former students work and live and can compare these locations with the one where they grew up. In 2017 59% of the students live in the same region where they resided during their upper-secondary education one year after graduating. 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 throughout the country. We consider local labor market conditions as the information most readily available to the individual. This is especially true at a young age when information frictions are likely to be largest. Lastly, our sample consists of natives with a Swiss entry exam. Natives are likely to perceive the local labor market conditions as more important than foreign residents, who may also consider opportunities abroad or be internally more mobile (Schündeln, 2014). Any violations of the SUTVA assumption would bias our estimates of the reform effects 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 1996 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 positive labor supply shock relative to regions further away. While average exposure grew from 12.2% in the pre-reform to 20.1% in the post-reform period, we estimate a reform effect of 6 percentage points after controlling for region fixed effects and broader regional trends. Figure 4a presents the size and timing of the inflow of commuters for each year. Magnitudes increase after the second implementation step of the AFMP in 2004 from 0.8 to 8.3 percentage points in 2016. This 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. In line with survey results, we

[6] 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.

find increasing effects from the transition period onwards. Administrative data shows that cross-border commuting was already slightly on the rise in the last years of the pre-treatment period. This could be explained by the informal relaxation of migration regulations prior to 2002. We take this into account when discussing the timing of the enrolment 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 inflow of foreign workers consists of upper-secondary and tertiary educated commuters. More than half of the total increase of 6 percentage points reflects a rise in upper-secondary educated commuters. The share of tertiary educated commuters grows by 1.8 percentage points in the post-reform period. Table 1 shows no significant increase in commuting of lower-secondary educated workers, while Figure 4b indicates a rise after 2012 but also a violation of the parallel pre-trend assumption.

In the Appendix we present robustness checks. In Table B2 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 exponential function takes the value of one at zero minutes of travel time and 0.05 at sixty minutes. As expected, the estimated rise in cross-border commuting turns slightly higher in magnitude compared to the dummy treatment results. Overall, results are robust to the use of alternative definitions of the treatment variable. 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.[7]

4 Demand for Tertiary Education

4.1 Enrolment by Institutional Type

During our study period average enrolment in tertiary education is higher in regions more affected by the introduction of the free movement reform than in regions less affected (see the summary statistics in Table 2). This difference is driven by enrolment at Universities while shares are similar for Universities of Applied Sciences and Universities of Teacher

[7] According to individual level migration data (ZEMIS) provided by the State Secretariat of Migration, the share of cross-border commuters that switched from a G-permit to a resident permit between 2002 and 2018 is 15.5%. The robustness test performed alleviates concerns about a potentially determining role of former cross-border commuters in the distribution of resident migrants across treatment and control regions.

Education. Figures A2a – A2d also show that the gap in enrolment between the two regions grew over time. We next test whether these differences are statistically significant and persist conditional on region fixed effects, population level and broader regional trends.

Results in Table 3 show a rise in overall enrolment in the post-reform period among individuals residing in an affected region prior to beginning their studies compared to non-affected regions. The magnitude of the effect is 2.4 percentage points. The analysis by institutional type in columns (2)–(4) indicates that individuals from regions close to the border enrol more often in enrolment at Universities of Applied Sciences. The magnitude of the effect is 1.6 percentage points. Average enrolment rates in the treated regions increased from 7.6% in the pre-reform period to 18.4% in the post-reform period. The reform effect is economically meaningful compared to the overall enrolment growth of 10.8 percentage points that the treatment group experienced during the period. In contrast, we find no change in entry into Universities and Universities of Teacher Education between the treatment and the control regions in any of the periods.[8]

Figure 5 shows that demand for tertiary education evolved similarly between the treatment and control group in the pre-reform years. The lack of a significant difference in enrolment rates does not indicate a violation of the common trend assumption. Indeed, the timing of the increase in enrolment 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 enrolment goes up only in the post-reform period when all barriers were abolished and the inflow of frontier workers was substantial.

In the Appendix we provide a number of robustness checks showing that our results hold in alternative specifications. Panels A and B of Table B3 show that the threshold of thirty travel minutes is not decisive for the main results. Moreover, the estimates remain similar when using the continuous measure for travel time (Panel C). Table B4 investigates whether our results are 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 if they vary over time and across regions. Since our observation period coincides with the expansion of the UAS, we test whether enrolment rates are driven by the availability of new study locations and study fields.[9] Column (2) shows that results are robust to controlling for the presence of tertiary institutions as well as the number of study

[8]For University enrolment as an exception, data is available from the early 1990s. In a setting with an extended pre-reform window from 1992–2001, we find no statistical differences between treatment and control regions over all years.

[9]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 enrol and the study field choice in particular for individuals from middle and low socio-economic groups.

fields offered within a radius of 20km from the largest municipality in a region in 1990. Labor demand could confound the results if regions closer to the international market face a different trend in their labor demand than regions in the inner part of Switzerland. To mitigate such 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).[10] 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.

4.2 Enrolment by Field of Study

The enrolment analysis has shown that natives respond to the inflow of frontier workers by demanding more tertiary education. In this section we investigate the extent to which specific study fields are affected by the free movement reform. Summary statistics in Table 2 indicate that average enrolment rates vary across study fields during the period but that their relative attractiveness is similar among the two groups of regions.

We start by linking subjects to occupations and create the variable *Sh employed*$_j$ which reflects 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 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 as high-skilled the ten occupations in ISCO-08 level 1 (managerial) and level 2 (professional occupations). We derive the distribution of cross-border commuters and residents across occupations from 1999 and 2000 administrative data, respectively. These years

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

are the earliest available and, hence, alleviate concerns about endogenous adjustments in the commuters' occupational choices to changes in the skill levels of natives.[11]

We build a relative measure based on the values from Equation 3 for cross-border commuters ($Sh\ commuters_j$) and resident workers ($Sh\ residents_j$).

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

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 and require social or high level of language skills. Comparing columns (1) and (2) in Table 4 makes clear that there is a strong link between expected labor market competition with foreign workers and STEM fields.

We divide the study fields into those with a value of the variable $Relative\ skill\ supply_j$ above and below one, where the former are referred to as "affected" and the latter as "non-affected". Figures A2e and A2f plot enrolment rates into affected and non-affected fields and show that demand for non-affected fields grew faster in treated relative to control regions. Panel A of Table 5 confirms this by showing a statistically significant rise in enrolment of 1.8 percentage points. Average enrolment rates in non-affected fields increased from 18.7% in the pre-reform period to 33.5% in the post-reform period. The reform effect is sizeable compared to the overall enrolment growth in non-affected subjects of 14.8 percentage points during the period. The increase in enrolment in non-STEM fields is also statistically significant and of similar magnitude. Figure 6 shows that the timing of the effects is in line with the implementation of the free movement reform. 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. Panels B and C present institution-specific evidence. Individuals enrolled at Universities of Applied Sciences choose more often non-affected fields due to

[11] 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.

the reform. There is again no evidence that University enrolment is affected by the free movement of workers.

In Table B5 we show that the overall increase in the demand for non-affected fields is robust to variations in the treatment definition. Enrolment in affected fields turns significant at the threshold of thirty-five minutes while the continuous function specification, the most general treatment definition, confirms the validity of our baseline results. Table B6 reports results from specifications including additional control variables in columns (2)–(3) and without weighting scheme in column (4). We replicate the baseline findings presented in column (1), while the magnitude of the coefficient slightly decreases when weights are removed.

Finally, we are concerned whether enrolment 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.[12] The coefficients of enrolment 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 enrolment.

5 Mechanism

Our analysis has shown that individuals from affected regions are more likely to enrol in tertiary education and to select study fields linked to occupations less favored by commuters. In this section we explore potential mechanisms.

5.1 Competition

Enrolment in tertiary education The free movement reform directly affects the labor market conditions through a large inflow of cross-border commuters. We investigate whether this in turn affects native employment opportunities. Our analysis shows in Panel A of Table B7 that unemployment rates do not statistically differ over time between treated and control regions for any of the three educational levels. We also look at native employment rates across affected and non-affected regions. Results in Panel B of Table B7 do not show

[12] 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.

statistically significant effects. Despite the continuous influx, we find no evidence that the native employment opportunities are negatively affected. This suggests skill complementarity between native and foreign employees.

The inflow of cross-border commuters is concentrated in certain occupations. Descriptive statistics shown in Section 2 reveal that commuters are typically overrepresented in STEM occupations. Similarly for the US, Hanson and Slaughter (2016) observe that high-skilled immigrants 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 STEM training (Hunt and Gauthier-Loiselle, 2010; Hanson and Slaughter, 2016). In our context, the latter argument is less of a concern because the largest Swiss institutions providing tertiary level STEM education are world leaders.[13] We hence document that STEM skills are more transferable even among foreign workers who have language proficiency and are culturally similar. Consequently, students pursuing non-STEM education are less likely to face foreign competition when they enter the labor market. Our results indeed show that the reform induces natives to build skills that are complementary to the ones brought by cross-border commuters. In practice, such educational adjustments reinforce the existing occupational specialization.

Enrolment at Universities of Applied Sciences Why does enrolment only increases in Universities of Applied Sciences and not in Universities? Students pursuing tertiary education at different institutions come from different educational backgrounds. The majority of students at a University have a general education while at a University of Applied Sciences students typically have a vocational training. Numbers from the FSO for 2012 graduates show that 64% of those with a vocational matura enrol 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 (Strubi *et al.*, 2018). The labor market is thus relevant as an outside option for the vocationally trained, while the objective of a general training is to prepare for enrolment at University. Consistently, there are around 3% natives with a matura on the labor market in 2016, while the share of those with an apprenticeship is around 58%. Furthermore, vocationally trained individuals 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. Moreover, a study at a University of Applied Sciences has typically a stronger link to an industry or even an occupation compared to the more general degrees at a University. This

[13] 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.

is likely to make demand for education in specific fields at a UAS more responsive to changes in labor market conditions.

Since at Universities of Applied Sciences, individuals with a vocational, specialised or general matura can enrol, we test our hypothesis by grouping the first-year students by their certificate granting access to tertiary education. A vocational matura can be completed during the vocational training (Type I), or in two to four semesters after the vocational education (Type II). A smaller number of first-year students has either a general or a specialised matura. The three kinds of matura have distinct curricula, resulting in different labor market experiences and opportunity costs of studying. Table 6 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. The rise in enrolment shown in column (1) is driven by individuals having a vocational matura major in business and services, a field where labor market concepts are likely to be taught at school (results available upon request). A higher awareness of labor market competition combined with own labor market experience is the explanation for which we find most support in the data. The increase in enrolment of individuals with a specialised matura shown in column (3) is likely due to similar reasons. Individuals with a specialised matura are educated to either join the labor market or enrol in tertiary education. However, they are typically trained in health, social work, pedagogy or art. In summary, our evidence suggests that the reform affected educational decisions of individuals with an upper-secondary degree preparing them for labor market entry.

5.2 Alternative Explanations

Returns to education Since the cross-border commuters' consumption is concentrated in the country of residence, we consider the inflow of commuters as an almost pure labor supply shock. Following a classic labor market model with perfectly substitutable native and foreign labor and a downward sloping labor demand curve, wages decrease as the competition from foreign workers rises. This mechanism can affect the wage premium for tertiary degrees (see the summary statistics in Table 2) and raise incentives to pursue a tertiary level education.

We estimate the impact of the free movement of workers on native wages. Table 7 reports a small 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-treatment period. Unreported yearly estimates show that these trends are imprecisely estimated but in line with the results in Beerli *et al.* (2018). The authors explain the rise in wages for tertiary degrees with an increase in the labor demand of skill-intensive incumbent

and new firms. This can lead to higher innovation, productivity or capital formation in a setting with increasing returns to high-skilled labor.[14]

Next, we examine native wages by occupation. Table 8 shows that the returns to STEM degrees rise in the transition and post-reform period, while returns to non-STEM degrees do not change significantly. While others have found that future earnings matter for major choice, the choice elasticity is often relatively low (Patnaik *et al.*, 2020). In Switzerland, information on wages associated with different study fields is sparse, making an informed response to changes in returns to education difficult. It is, therefore, not surprising that we find no evidence that tertiary wages play an important role in the choice of the study field.

International students The literature on university enrolment and study field choice links the presence of foreign students to natives' decisions. Recent studies presenting evidence at the university level find on average no or a positive effect on native enrolment (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 (Anelli *et al.*, 2018; Orrenius and Zavodny, 2015). These findings are relevant for us, in particular because in Switzerland the share of international students – non-Swiss without a Swiss matura – is sizeable.

Our empirical strategy allocates native students to the region where they grew up and not where they enrol. Within this framework, we are not able to link enrolment decisions with exposure to foreign peers in tertiary education. Instead of a data driven analysis of the potential impact of international students, we present the following arguments. Unlike in the US where most of the above studies are conducted, Swiss institutions have generally no cap on the maximum number of students enrolled at the institution level. Since a certificate granting access to tertiary education generally guarantees enrolment, a rise in demand for Swiss education by international students is unlikely to crowd natives out of tertiary education. Tuition in Switzerland is to a large degree publicly funded. Although some institutions demand higher fees for international students, they do not cover the costs of education. Cross-subsidization of natives through higher tuition fees paid by the international students, and thus crowding-in, turns out to not be a relevant argument in our context. Preferences over studying with international students or higher returns to education due to intensive student competition are other possible reasons that would predict crowding-in effects (Shih, 2017). We do not believe that these arguments play a major role at the bachelor level,

[14]Our framework deviates from Beerli *et al.* (2018) 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.

while becoming more important at the master or PhD level where classes are smaller and hence interaction more intensive. The studies at the field level assume that natives were in touch with foreign-born peers prior to enrolment, i.e. in an introductory university class or in high-school cohorts. Since international students migrate to pursue tertiary education, natives do not interact with them prior to enrolling. This sequential timing mitigates the likelihood that our field results are affected by international students. Finally, by measuring overall demand for an aggregate study field we alleviate the potential crowd-out effect at the institution $\times$ field level since switching between institutions and narrowly defined fields can help to avoid international peers. Overall, we find no confirming evidence that enrolment results are driven by rising returns to higher education or competition from international students. We conclude that the increase in observed foreign competition is the most plausible mechanism.

5.3 Selection

Individuals who are induced to enrol in tertiary education by the reform can be positively or negatively selected. One way to explore this question is to compare enrolled students from affected and non-affected regions before and after the reform. Table B8 presents this for a set of geographic and individual characteristics. We first consider features of the municipality of residence at the time at which the individual took the entrance exam such as whether it is urban and whether German is the majority-spoken language. Second, we consider individual characteristics such as age and gender. Results show no significant differences between the regions over time. In unreported regressions, we perform the same exercise by institutional type and replicate this finding.

Similarly, we compare academic achievement as an indicator for student quality. We compute the graduation rate of students allocating them to the first year of enrolment. In Table B9 we find no significant differences between treated and control regions and therefore no evidence of selection (see Cortés and Pan, 2015, for a positive selection into the nursing studies). The higher demand for tertiary degrees in affected regions is driven by students with an average quality similar to that in control regions. Hence, the increase in enrolment leads to a higher share of graduates coming from affected regions. As a degree is considered to be 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.

6 Conclusion

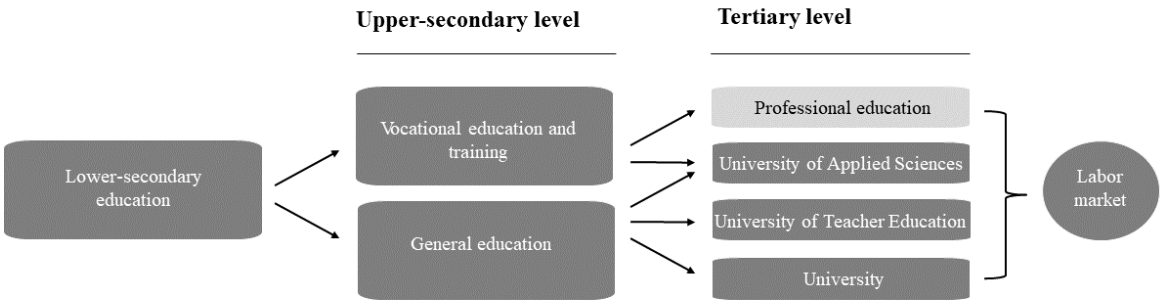
We examine the impact of the introduction of free movement of workers on native demand for tertiary education in Switzerland. We find that individuals from affected regions enrol more often in tertiary education and select study fields linked to non-STEM occupations. These results are driven by individuals with viable labor market options such as the vocationally trained students who attend classes at Universities of Applied Sciences. They, compared to the generally educated, are more aware of changes in labor market conditions triggered by migration reforms due to their labor market oriented education. Our results suggest that they respond by enrolling into degrees linked to occupations with little foreign competition. This shows that natives indeed take into account the signals sent by the labor market which may not necessarily be in line with educational policies pursued by governments.

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

The study field choice of affected natives can enforce initial occupational specialization of high-skilled native and foreign workers. Indeed, this is what we observe. Changes towards a more restrictive migration policy or deteriorating relative economic conditions in the host country can lead to a sudden outflow of foreigners. Such reversals 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.

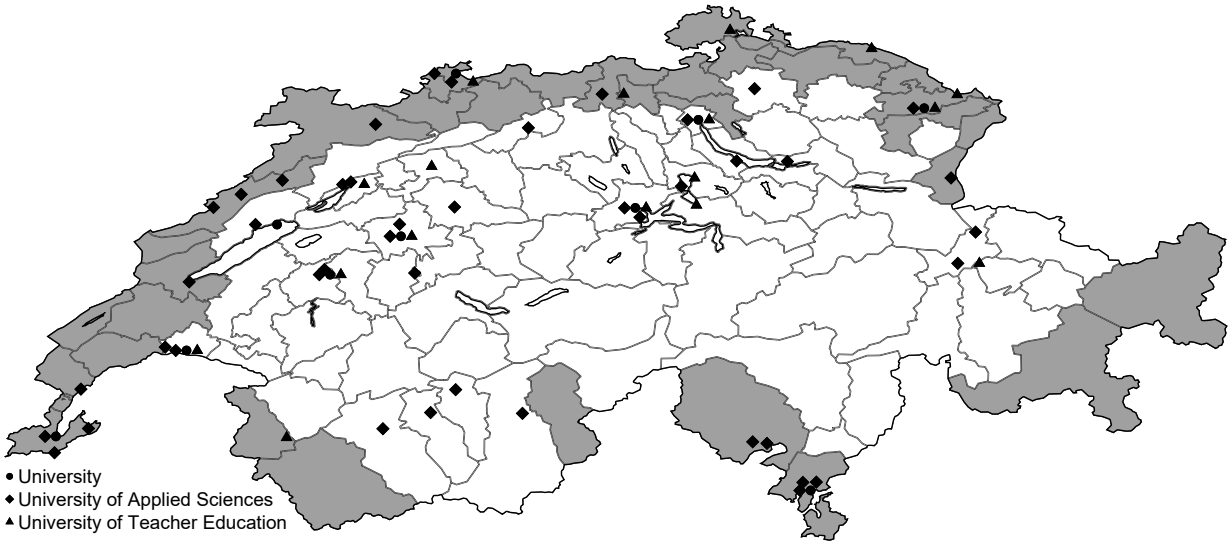
Figures

Figure 1: Swiss education system



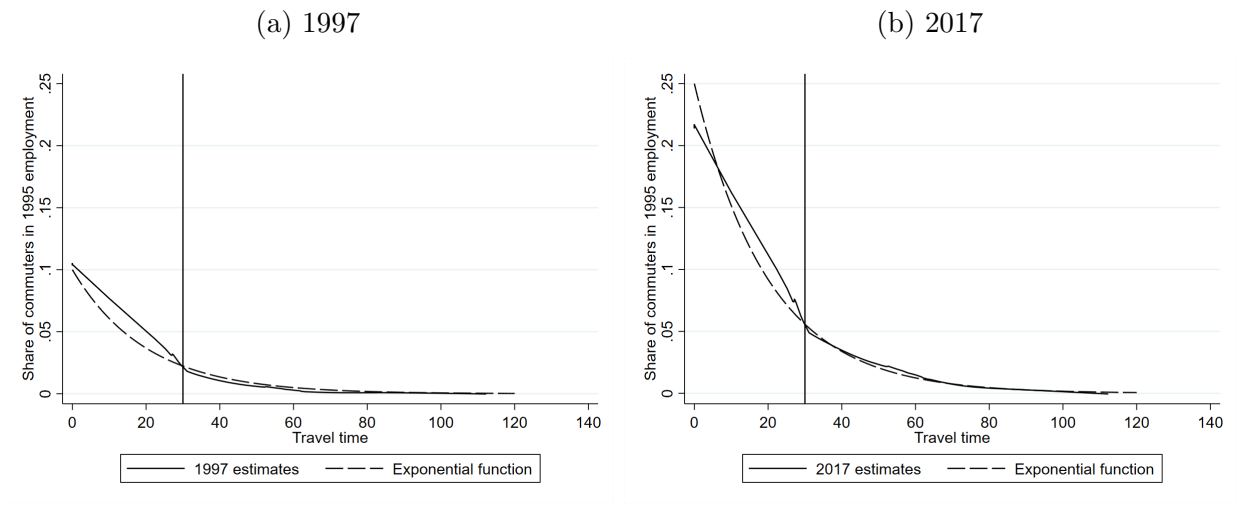
Note: The figure presents Swiss educational tracks at the upper-secondary and tertiary level of education. Arrows show most common choices given previous educational background. Compulsory education ends at the lower-secondary level. Individuals typically enter the labor market after the upper-secondary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

Figure 2: Locations of tertiary institutions



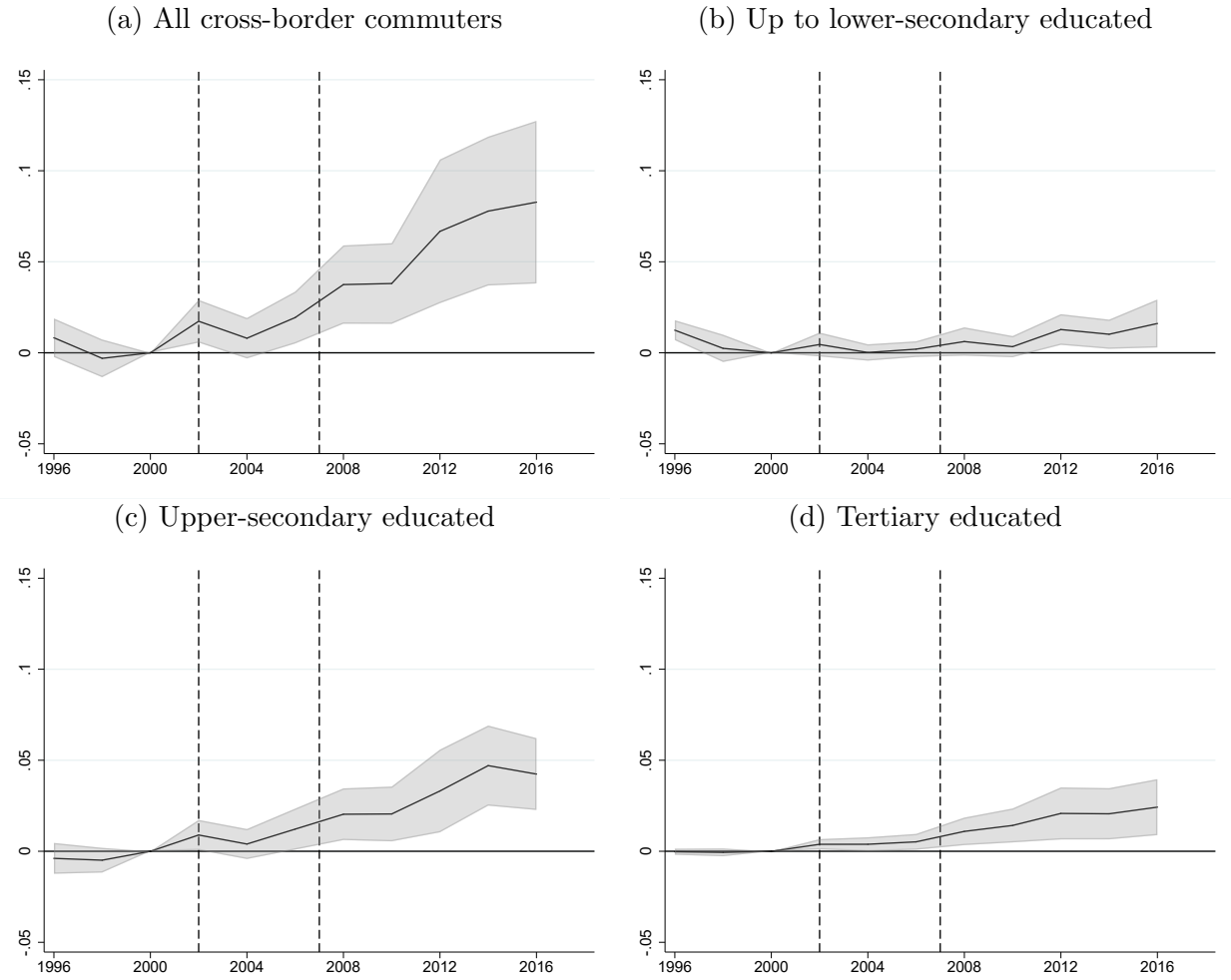
Note: The map shows Switzerland's 106 commuting zones split into treated (grey) and control regions (white). The locations of the tertiary institutions in 2017 are shown by institutional type.

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



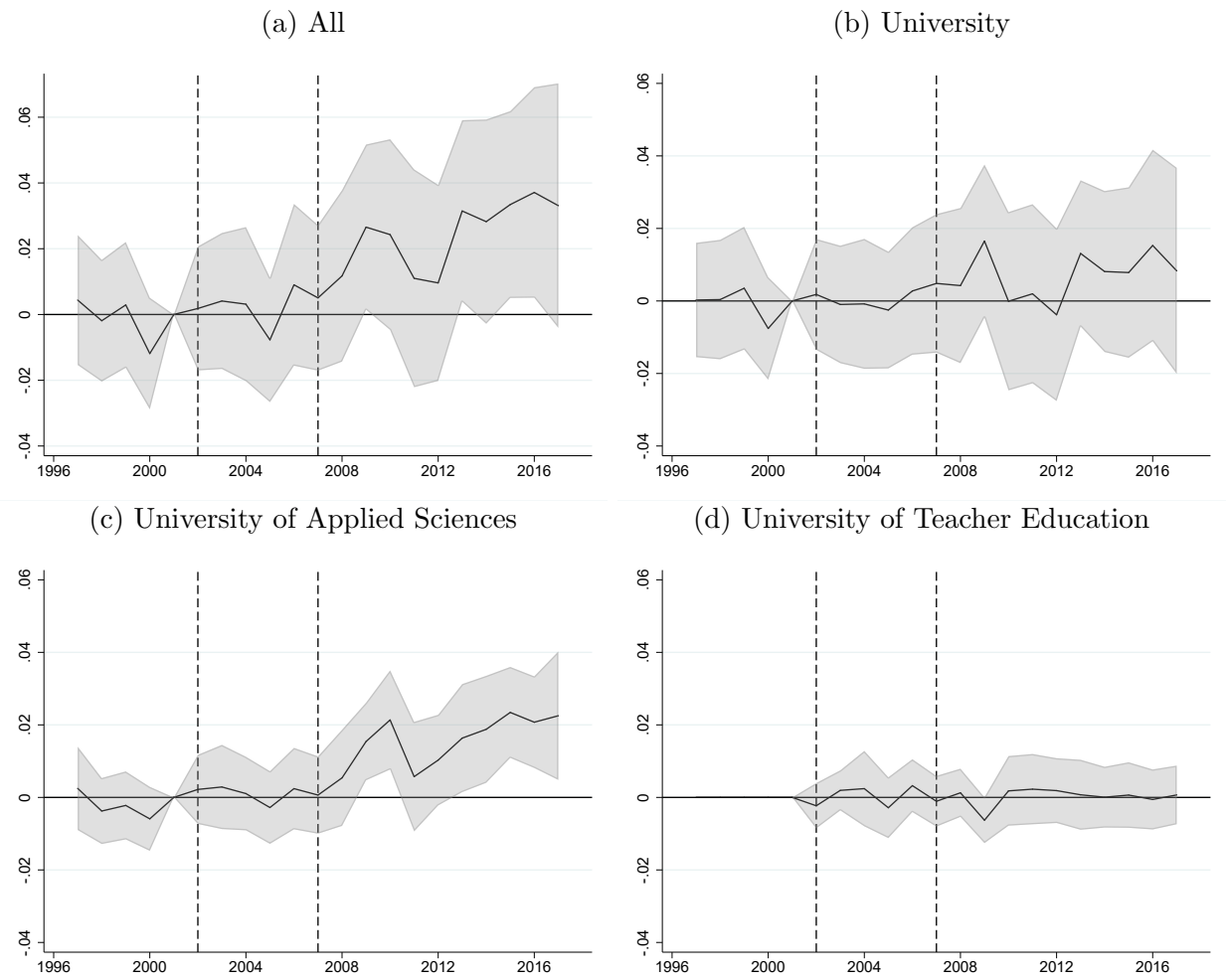
Note: The figure shows estimates from a locally weighted regression of the share of cross-border commuters in 1997 and 2017 (Panel a and Panel b, respectively) in 1995 employment on travel time to the Swiss border crossings. The unit of observation is the commuting zone. The dashed line plots the function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

Figure 4: Exposure to cross-border commuters



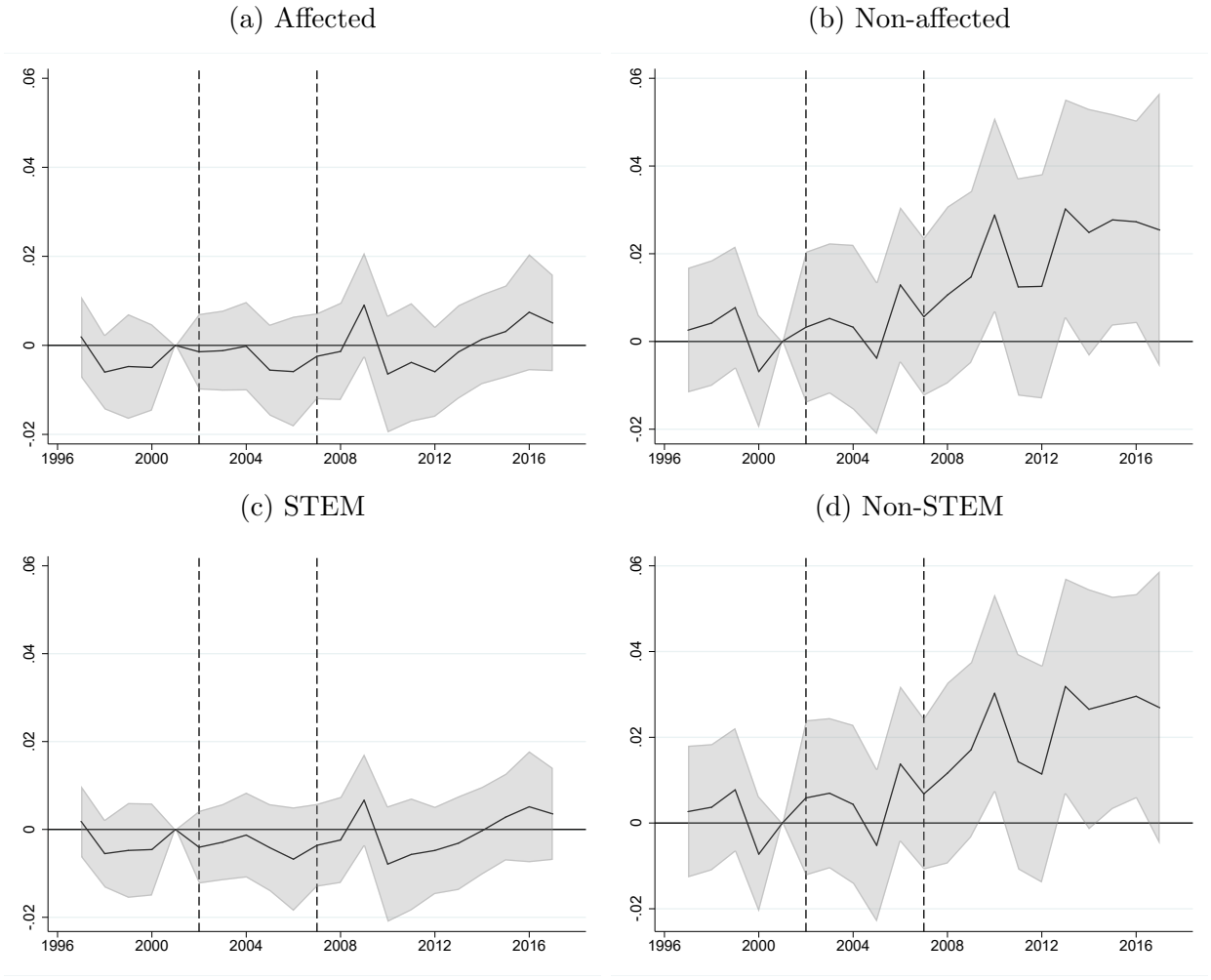
Note: The figure shows difference-in-differences estimates using biennial data at the commuting zone level for the period 1996–2016. The vertical lines indicate the beginning of the transition period (2002) and of the post-reform period (2007). The dependent variable is the share of cross-border commuters in total employment. The denominator is fixed in 1996. 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 enrolment by institutional type



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 share of native first-year students in birth cohort. The denominator is fixed in 1997 and 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 enrolment by type of study field



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 in birth cohort. The denominator is fixed in 1997. 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.

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**	-0.003	0.011***	0.005**
	(0.006)	(0.002)	(0.004)	(0.002)
30min * 2007 and after	0.059***	0.005	0.036***	0.018***
	(0.017)	(0.004)	(0.009)	(0.006)
Mean outcome	0.070	0.020	0.038	0.012
Sd outcome	0.115	0.053	0.056	0.021
Commuting zones	106	106	106	106
within 30 min	35	35	35	35
N	1166	1166	1166	1166

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. The denominator is fixed in 1996. 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	0.162	0.138	781	0.010	0.016
... with lower-secondary education	385	0.048	0.076	781	0.002	0.007
... with upper-secondary education	385	0.088	0.062	781	0.005	0.008
... with tertiary education	385	0.026	0.028	781	0.002	0.004
Share enrolled	735	0.411	0.127	1491	0.355	0.109
... at UNI	735	0.237	0.103	1491	0.191	0.071
... at UAS	735	0.145	0.056	1491	0.134	0.050
... at UTE	625	0.032	0.023	1236	0.035	0.019
... in agriculture	735	0.004	0.003	1491	0.004	0.003
... in arts and humanities	735	0.044	0.020	1491	0.035	0.015
... in business and law	735	0.108	0.039	1491	0.093	0.033
... in education	735	0.043	0.021	1491	0.042	0.022
... in engineering	735	0.057	0.019	1491	0.054	0.018
... in health	735	0.054	0.036	1491	0.040	0.027
... in ICT	735	0.013	0.007	1491	0.013	0.007
... in math and sciences	735	0.037	0.014	1491	0.033	0.013
... in services	735	0.005	0.006	1491	0.004	0.005
... in social sciences	735	0.043	0.023	1491	0.035	0.017
Mean ln gross hourly wage	385	3.574	0.102	781	3.563	0.109
... of lower-secondary educated	385	3.295	0.087	781	3.298	0.086
... of upper-secondary educated	385	3.522	0.083	781	3.498	0.081
... of tertiary educated	385	3.935	0.086	774	3.936	0.086
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 enrolment 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 1996 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, university of applied sciences or teacher education. Share enrolled is the share of first-year students in birth cohort in 1997. UNI is short for University, UAS for University of Applied Sciences and UTE for University of Teacher Education. 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 enrolment by institutional type

	Outcome: share of enrolled native first-year students			
	All	University	University of Applied Sciences	University of Teacher Education
	(1)	(2)	(3)	(4)
30min * 2002-2006	0.003	0.001	0.003	0.000
	(0.007)	(0.005)	(0.004)	(0.003)
30min * 2007 and after	0.024**	0.008	0.016***	0.000
	(0.011)	(0.008)	(0.005)	(0.004)
Mean outcome	0.372	0.207	0.136	0.035
Sd outcome	0.119	0.086	0.052	0.020
Commuting zones	106	106	106	106
within 30 min	35	35	35	35
N	2226	2226	2226	1802

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 fixed in 1997 and 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 4: Cross-border commuters relative to resident workers by field of study

Field of study	STEM field	Skill supply of commuters relative to residents
(1)	(2)	(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: Native enrolment by type of study field

	Outcome: share of enrolled native first-year students			
	Affected (1)	Non-affected (2)	STEM (3)	Non-STEM (4)
Panel A: All institutions				
30min * 2002-2006	-0.000	0.003	-0.001	0.004
	(0.003)	(0.006)	(0.002)	(0.006)
30min * 2007 and after	0.003	0.018**	0.002	0.020**
	(0.003)	(0.008)	(0.003)	(0.008)
Mean outcome	0.117	0.254	0.104	0.267
Sd outcome	0.032	0.093	0.029	0.098
Commuting zones	106	106	106	106
within 30 min	35	35	35	35
N	2226	2226	2226	2226
Panel B: Universities				
30min * 2002-2006	-0.001	0.001	-0.000	0.001
	(0.002)	(0.004)	(0.002)	(0.004)
30min * 2007 and after	-0.001	0.006	0.000	0.006
	(0.002)	(0.007)	(0.002)	(0.006)
Mean outcome	0.057	0.148	0.056	0.149
Sd outcome	0.023	0.068	0.023	0.068
Commuting zones	106	106	106	106
within 30 min	35	35	35	35
N	2226	2226	2226	2226
Panel C: Universities of Applied Sciences				
30min * 2002-2006	0.000	0.003	-0.001	0.004
	(0.002)	(0.003)	(0.002)	(0.003)
30min * 2007 and after	0.004*	0.013***	0.002	0.015***
	(0.002)	(0.004)	(0.002)	(0.004)
Mean outcome	0.059	0.077	0.048	0.088
Sd outcome	0.018	0.040	0.017	0.044
Commuting zones	106	106	106	106
within 30 min	35	35	35	35
N	2226	2226	2226	2226

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. The denominator is fixed in 1997. 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 6: Native enrolment at UAS by type of entry exam

	Outcome: share of enrolled native first-year students			
	Vocational matura (during)	Vocational matura (after)	Specialised matura	General matura
	(1)	(2)	(3)	(4)
30min * 2002-2006	0.000	0.001	0.002	-0.000
	(0.002)	(0.001)	(0.002)	(0.001)
30min * 2007 and after	0.008**	-0.000	0.008***	-0.002
	(0.004)	(0.003)	(0.002)	(0.002)
Mean outcome	0.049	0.037	0.012	0.023
Sd outcome	0.026	0.023	0.015	0.014
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. The denominator is fixed in 1997. 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 7: Native wages by educational level

	Outcome: ln **gross hourly wage rate of natives**			
	All	Up to lower-secondary	Upper-secondary	Tertiary
	(1)	(2)	(3)	(4)
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

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 mean natural log of gross hourly wage of natives 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 8: Native wages of tertiary educated by occupation

	Outcome: ln **gross hourly wage rate of natives**	
	STEM	Non-STEM
	(1)	(2)
30min * 2002-2006	0.040**	0.015
	(0.018)	(0.020)
30min * 2007 and after	0.038*	0.034
	(0.022)	(0.023)
Mean outcome	3.909	4.026
Sd outcome	0.086	0.108
Commuting zones	94	105
within 30 min	34	35
N	1001	1144

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 mean natural log of gross hourly wage of tertiary educated natives. Observations are weighed by the number of tertiary educated native 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.

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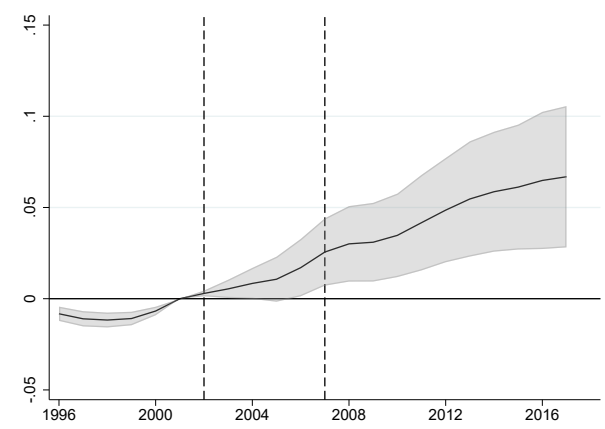
Appendix

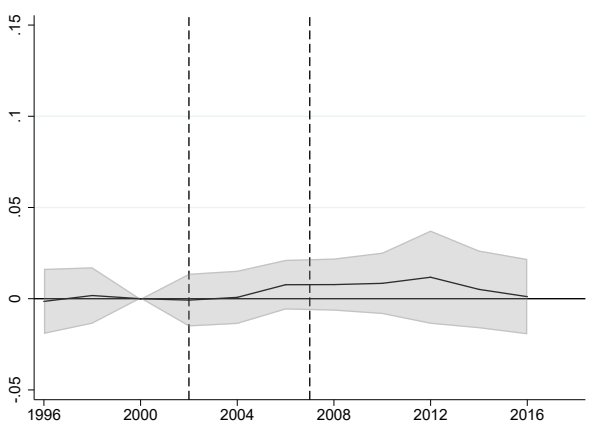
A Figures

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

(a) Cross-border commuters

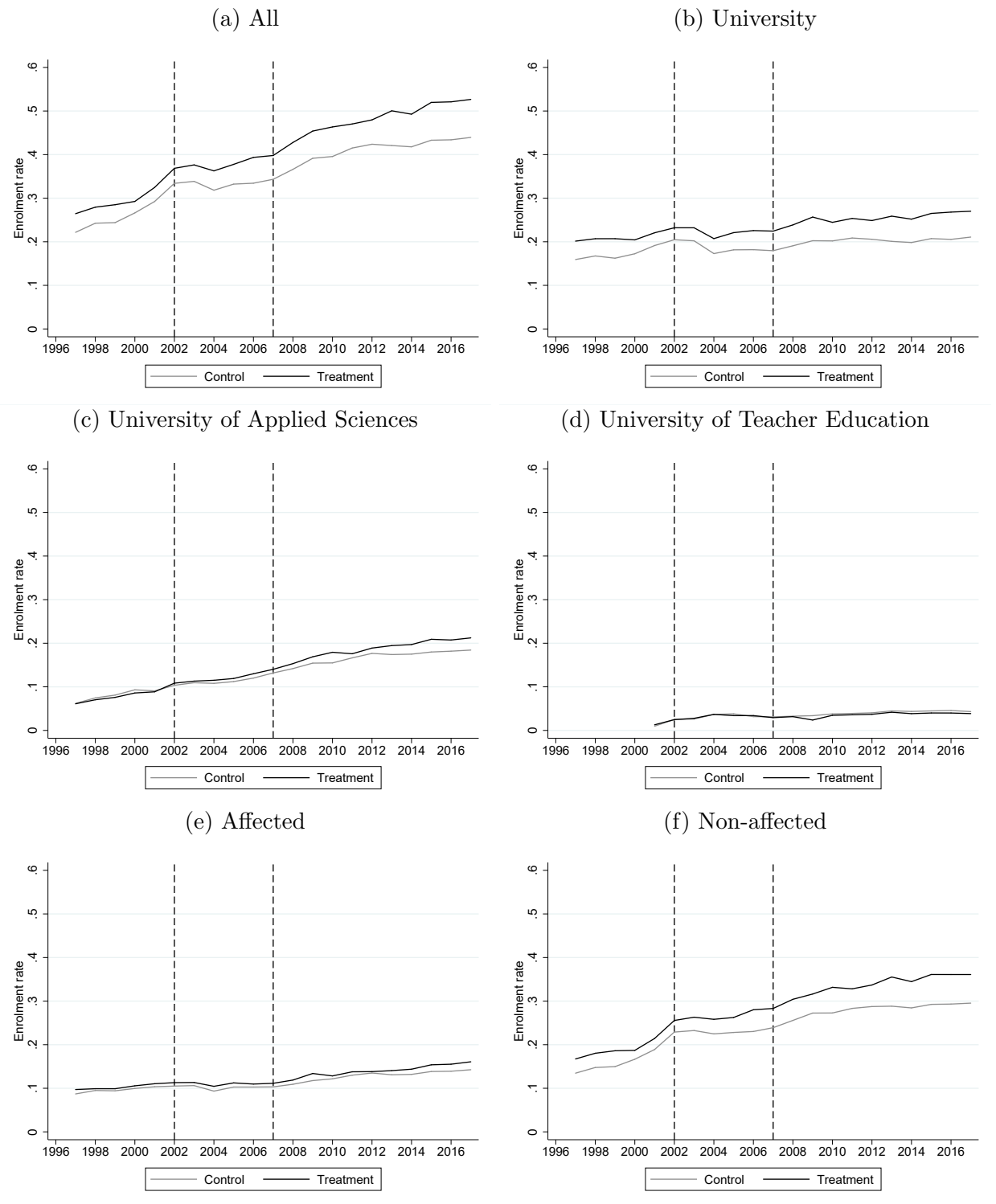


(b) Resident migrant workers



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 1996 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: Native enrolment by institutional type and field of study



Note: The figure shows enrolment rates by institutional type and 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 dependent variable is the share of native first-year students in birth cohort. The denominator is fixed in 1997 and specific to the institutional type. Source: SHIS-studex.

B Tables

Table B1: Cross-border commuters relative to resident workers by occupation

ISCO-08 code	ISCO-08 title	Share of commuters rel. to residents
(1)	(2)	(3)
44	Other Clerical Support Workers	0.116
54	Protective Services Workers	0.161
95	Street and Related Sales and Services Workers	0.195
61	Market-oriented Skilled Agricultural Workers	0.206
12	Administrative and Commercial Managers	0.228
23	Teaching Professionals	0.230
26	Legal, Social and Cultural Professionals	0.288
42	Customer Services Clerks	0.303
24	Business and Administration Professionals	0.312
33	Business and Administration Associate Professionals	0.320
14	Hospitality, Retail and Other Services Managers	0.355
22	Health Professionals	0.417
13	Production and Specialized Services Managers	0.440
34	Legal, Social and Cultural and Related Associate Professionals	0.497
96	Refuse Workers and Other Elementary Workers	0.585
62	Market-oriented Skilled Forestry, Fishery and Hunting Workers	0.598
53	Personal Care Workers	0.613
11	Chief Executives, Senior Officials and Legislators	0.650
41	General and Keyboard Clerks	0.672
92	Agricultural, Forestry and Fishery Labourers	0.790
52	Sales Workers	0.882
43	Numerical and Material Recording Clerks	1.007
35	Information and Communications Technicians	1.137
32	Health Associate Professionals	1.249
83	Drivers and Mobile Plant Operators	1.334
51	Personal Services Workers	1.349
31	Science and Engineering Associate Professionals	1.365
25	Information and Communications Technology Professionals	1.442
21	Science and Engineering Professionals	1.492
91	Cleaners and Helpers	1.693
71	Building and Related Trades Workers (excluding Electricians)	1.845
72	Metal, Machinery and Related Trades Workers	2.037
74	Electrical and Electronic Trades Workers	2.105
75	Food Processing, Woodworking, Garment and Other Craft and Related Trades Workers	2.204
73	Handicraft and Printing Workers	2.366
82	Assemblers	2.651
93	Labourers in Mining, Construction, Manufacturing and Transport	2.960
81	Stationary Plant and Machine Operators	3.288
94	Food Preparation Assistants	4.097

Note: Columns (1) and (2) show the two-digit ISCO-08 occupation codes and names. Column (3) shows the ratio of the share of commuters in an occupation relative to the share of resident workers in the same occupation. Source: FSO (1999, 2000).

Table B2: 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	0.015**	-0.002	0.011**	0.006***
	(0.007)	(0.002)	(0.005)	(0.002)
25min * 2007 and after	0.067***	0.007*	0.038***	0.023***
	(0.019)	(0.004)	(0.011)	(0.007)
Mean outcome	0.070	0.020	0.038	0.012
Sd outcome	0.115	0.053	0.056	0.021
Commuting zones	106	106	106	106
within 25 min	28	28	28	28
N	1166	1166	1166	1166
Panel B: 35 min threshold value				
35min * 2002-2006	0.012**	-0.002	0.010***	0.004**
	(0.005)	(0.002)	(0.004)	(0.002)
35min * 2007 and after	0.050***	0.004	0.031***	0.016***
	(0.015)	(0.003)	(0.008)	(0.005)
Mean outcome	0.070	0.020	0.038	0.012
Sd outcome	0.115	0.053	0.056	0.021
Commuting zones	106	106	106	106
within 35 min	41	41	41	41
N	1166	1166	1166	1166
Panel C: Continuous treatment				
Travel time * 2002-2006	0.017**	-0.003	0.013**	0.007***
	(0.008)	(0.002)	(0.006)	(0.003)
Travel time * 2007 and after	0.079***	0.007	0.045***	0.027***
	(0.022)	(0.005)	(0.013)	(0.008)
Mean outcome	0.070	0.020	0.038	0.012
Sd outcome	0.115	0.053	0.056	0.021
Commuting zones	106	106	106	106
N	1166	1166	1166	1166

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 $\exp(-0.05 \times \textit{travel time})$. The dependent variable is the share of cross-border commuters in total employed. The denominator is fixed in 1996. 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 B3: Native enrolment by institutional type (robustness checks to treatment definition)

	Outcome: share of enrolled native first-year students			
	All	University	University of Applied Sciences	University of Teacher Education
	(1)	(2)	(3)	(4)
Panel A: 25 min threshold value				
25min * 2002-2006	0.004	-0.002	0.006	0.001
	(0.007)	(0.005)	(0.004)	(0.004)
25min * 2007 and after	0.021*	0.003	0.020***	-0.002
	(0.011)	(0.009)	(0.005)	(0.004)
Mean outcome	0.372	0.207	0.136	0.035
Sd outcome	0.119	0.086	0.052	0.020
Commuting zones	106	106	106	106
within 25 min	28	28	28	28
N	2226	2226	2226	1802
Panel B: 35 min threshold value				
35min * 2002-2006	0.008	0.001	0.007*	0.001
	(0.006)	(0.005)	(0.003)	(0.003)
35min * 2007 and after	0.036***	0.014*	0.022***	0.000
	(0.010)	(0.008)	(0.005)	(0.003)
Mean outcome	0.372	0.207	0.136	0.035
Sd outcome	0.119	0.086	0.052	0.020
Commuting zones	106	106	106	106
within 35 min	41	41	41	41
N	2226	2226	2226	1802
Panel C: Continuous treatment				
Travel time * 2002-2006	0.007	-0.001	0.009*	0.000
	(0.009)	(0.007)	(0.005)	(0.004)
Travel time * 2007 and after	0.026**	0.007	0.023***	-0.004
	(0.013)	(0.011)	(0.005)	(0.005)
Mean outcome	0.372	0.207	0.136	0.035
Sd outcome	0.119	0.086	0.052	0.020
Commuting zones	106	106	106	106
N	2226	2226	2226	1802

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 fixed in 1997 and 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 B4: Native enrolment at UAS (robustness checks)

	Outcome: share of enrolled native first-year students			
	Baseline	+ Education supply	+ Labor demand	No weights
	(1)	(2)	(3)	(4)
30min * 2002-2006	0.003	0.002	0.003	0.003
	(0.004)	(0.004)	(0.004)	(0.004)
30min * 2007 and after	0.016***	0.016***	0.016***	0.013***
	(0.005)	(0.005)	(0.005)	(0.005)
UAS within 20km		0.004		
		(0.004)		
Number of fields within 20km		0.003**		
		(0.001)		
Bartik control			0.039	
			(0.048)	
Mean outcome	0.136	0.136	0.136	0.130
Sd outcome	0.052	0.052	0.052	0.054
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 in birth cohort. The denominator is fixed in 1997 and 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. 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 enrolment by type of study field (robustness checks to treatment definition)

	Outcome: share of enrolled native first-year students			
	Affected (1)	Non-affected (2)	STEM (3)	Non-STEM (4)
Panel A: 25 min threshold value				
25min * 2002-2006	0.002	0.002	0.001	0.003
	(0.003)	(0.006)	(0.003)	(0.006)
25min * 2007 and after	0.004	0.015*	0.003	0.016*
	(0.004)	(0.009)	(0.003)	(0.009)
Mean outcome	0.117	0.254	0.104	0.267
Sd outcome	0.032	0.093	0.029	0.098
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	0.002	0.006	0.001	0.007
	(0.002)	(0.005)	(0.002)	(0.005)
35min * 2007 and after	0.008**	0.026***	0.006**	0.028***
	(0.003)	(0.008)	(0.003)	(0.008)
Mean outcome	0.117	0.254	0.104	0.267
Sd outcome	0.032	0.093	0.029	0.098
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	0.003	0.003	0.001	0.005
	(0.003)	(0.007)	(0.003)	(0.008)
Travel time * 2007 and after	0.005	0.019*	0.003	0.020**
	(0.004)	(0.010)	(0.004)	(0.010)
Mean outcome	0.117	0.254	0.104	0.267
Sd outcome	0.032	0.093	0.029	0.098
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. The denominator is fixed in 1997 and specific to the study field. 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 B6: Native enrolment in non-affected fields at UAS (robustness checks)

	Outcome: share of enrolled native first-year students			
	Baseline	+ Education supply	+ Labor demand	No weights
	(1)	(2)	(3)	(4)
30min * 2002-2006	0.003	0.002	0.002	0.002
	(0.003)	(0.003)	(0.003)	(0.003)
30min * 2007 and after	0.013***	0.013***	0.012***	0.010***
	(0.004)	(0.004)	(0.004)	(0.004)
UAS within 20km		0.001		
		(0.003)		
Number of fields within 20km		0.003***		
		(0.001)		
Bartik control			0.047	
			(0.035)	
Mean outcome	0.077	0.077	0.077	0.071
Sd outcome	0.040	0.040	0.040	0.041
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 in birth cohort in non-affected fields. The denominator is fixed in 1997 and 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 5, 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. Standard errors in parentheses are clustered at the commuting zone level. * p<0.1; ** p<0.05; *** p<0.01. Source: SHIS-studex.

Table B7: 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. The denominator is fixed in 1996 and specific to the 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 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 B8: Individual characteristics of first-year native students

	Outcome: mean of individual level characteristics			
	Urban origin	German speaking origin	Age	Female
	(1)	(2)	(3)	(4)
30min * 2002-2006	0.005	-0.001	0.017	-0.003
	(0.005)	(0.001)	(0.057)	(0.009)
30min * 2007 and after	0.003	-0.000	0.066	-0.015
	(0.006)	(0.000)	(0.068)	(0.011)
Mean outcome	0.607	0.729	21.133	0.490
Sd outcome	0.293	0.440	0.572	0.074
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 mean value of different characteristic among first-year student. 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 a specific education category in 1997. Standard errors in parentheses are clustered at the commuting zone level. * p<0.1; ** p<0.05; *** p<0.01. Sources: SHIS-studex, FSO.

Table B9: Graduation rates of first-year native students by institutional type

	Outcome: graduation rate			
	All	University	University of Applied Sciences	University of Teacher Education
	(1)	(2)	(3)	(4)
30min * 2002-2006	0.004	0.002	0.008	-0.105**
	(0.005)	(0.009)	(0.010)	(0.052)
30min * 2007 and after	0.003	0.001	0.006	-0.094
	(0.005)	(0.008)	(0.009)	(0.059)
Mean outcome	0.693	0.633	0.676	0.687
Sd outcome	0.305	0.289	0.295	0.353
Commuting zones	106	106	106	106
within 30 min	35	35	35	35
N	2226	2226	2224	1749

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 that graduated within 1997–2017 relative to the number enrolled. 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.

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), at a University of Applied Sciences (UAS) or a University of Teacher Education (UTE). Our dataset starts in 1990 for UNI, 1997 for UAS and 2001 for UTE. Information on received degrees are available for UNI since 1990, for UAS since 2000 and for UTE since 2003. The data on enrolment 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.[15] Furthermore, we take first time enrolments 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 in order to have a sample of individuals who have not left the educational system for a longer period. 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/UTE 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

[15] 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.

ISCED 2-digit fields, we do not observe students pursuing a degree 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 is typically, but not exclusively, offered by Universities of Teacher Education. Since teacher education at any institution is directed towards the same occupation, we subsume all students enrolled in this study field under UTE. This re-allocation affects study fields at the University of Bern as well as schools from the UAS in Zurich (Zürcher Fachhochschule) and Northwestern Switzerland (Fachhochschule Nordwestschweiz).

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. The response rate is 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 enrolment. 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 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 reported in October. 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.

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.