A technical workforce for regional industrial development? Origin and dispersion of graduates from the technical secondary schools in Malmö and Borås 1855–1930

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Article History
Received 23 August 2020
Accepted 8 March 2021

Keywords
Technical education; regionalism; industrialisation; economic development; migration

JEL Codes
n33; n93

1. Introduction

Human capital has been assessed as of minor importance for the Industrial Revolution. Goldin and Katz (2009, pp. 93–94; 123–125) divide the last two hundred years of industrial development into three phases, but the relative demand of skilled labour increased only in the transition to the third phase, when process industries and serial production emerged alongside with the introduction of electricity, separate power sources, intensified machine-use, and transport systems in the factories. Most studies supporting the conclusion about human capital’s insignificance are based on measures of the average worker’s skills and literacy. This picture is one-sided. Mokyr (2005, p. 1115) states ‘Clearly human capital as a concept is indispensable, but we need to be far more specific as to what kind of human capital was produced, for and by whom, what was the source of the demand for it, and how it was distributed over the population’. Mokyr and Voth (2009, p. 35) state that the Industrial Revolution was carried ‘by the ingenuity and technical skills of a minority’. Some recent studies have distinguished between basic human capital, such as literacy, and human capital beyond
the basics. They have reached the conclusion that so-called ‘upper-tail knowledge’ (de Pleijt, Nuvolari, & Weisdorf, 2020; Squicciarini & Voigtländer, 2015) or intermediate human capital (Diebolt, Le Chapelain, & Menard, 2021) played major roles at the onset of industrialisation.

Despite of being comparably literate as early as by 1800 (Nilsson & Pettersson, 1990, 1996, pp. 4–5; Sandberg, 1979, pp. 225–226) Sweden was a late industrialiser. However, the mid-nineteenth century international trend of technological optimism also reached Scandinavia. The construction of a railway net (Berger & Enflo, 2017) and the extension of technical education reflect this optimistic view (Lundh Nilsson & Grönberg, 2019, p. 251). Early technical education consisted of lower-level Sunday and evening schools, military academies, and the mining institutes in Falun and Filipstad, whereas the Technological Institute, whose name was changed to the Royal Institute of Technology in 1877, was the country’s leading technical educational institution. The Technological Institute developed gradually into an advanced school, even by international standards (Ahlström, 1993, p. 118). The school provided larger industries, often Stockholm-based, with an educated workforce, but many of the institute’s graduates also went into public administration. However, numerous, emerging, medium- and small-sized industries all around Sweden also needed a skilled workforce (Isacson & Magnusson, 1983, pp. 86–91; Torstendahl, 1975a, p. 41). Here, even persons in managerial and semi-managerial positions often lacked formal technical education (Lundh Nilsson, 2015). This lack of educated intermediate-level technicians, who could serve in regionally and locally based medium- and small-scale industries, sparked worries about Sweden’s future industrial competitiveness (Ahlström, 1993, pp. 118–119).

What was considered missing can be compared to what Diebolt et al. (2021) define as intermediate human capital: ‘general knowledge that goes beyond basic literacy and numeracy skills. Basic scientific and technical knowledge (linear drawing, geometry and mechanics, chemistry and physics, mathematics, marine and hydrography)’.

The technical Sunday and evening schools were regarded as insufficient as their teaching was on a low level and dominated by general subjects (Nilsson, 2008, pp. 85–86). The worries echoed in the 1851 statement, whose main principles were voted through in the Parliament, by the Technological Institute’s principal, Lars Johan Wallmark (1810–1855) who had made study visits to a large number of technical schools in the German states, England, France, Belgium, and Austria among other countries. Wallmark was, like many others at this time, worried that Sweden would fall behind in the competition with other industrialised countries. His study visits had convinced him that Sweden should try to emulate the impressive German system with three levels of technical education (Wallmark, 1851, pp. 5–16).

Despite the shortcomings, the Sunday and evening schools would constitute the lower level in the new system of technical education that Wallmark sketched, whereas the Technological Institute would constitute the higher level. Inspired, foremost, by the German Gewerbeschulen, Wallmark suggested the establishment of intermediate-level technical secondary schools (tekniska elementarskolor). The aims of the technical secondary schools also paralleled the purpose of some nineteenth-century French schools: to foster the acquisition of basic technical skills and scientific knowledge (Diebolt et al., 2021), even if the practical sides of engineering were at the fore in the Swedish schools. Wallmark’s idea was to begin the extension of intermediate-level technical education by establishing schools in Malmö and Stockholm, followed by schools around the country (Wallmark, 1851). The capital city soon fell away because of limited interest from the local authorities. The four-estate parliament agreed on launching this new, and internationally unusually systematised, technical education (Torstendahl, 1975b, p. 26, 171, 181, 184). After at times heated discussions about the locations of the schools, technical secondary schools were established between 1853 and 1857 in four southern and central cities: Malmö, Borås, Örebro, and Norrköping. Local stakeholders argued for ‘their’ cities and they usually had representatives in the parliament. Cities, where industry and trade played prominent roles, were thus favoured whereas academic cities were less successful (Lundh Nilsson & Grönberg, 2019). The primary aim was to provide Sweden with an educated workforce for the country to be industrially competitive, and the Members of Parliament viewed schools in industrial cities as more useful to reach this aim.
There are several examples of how governments and authorities in different countries aimed at creating local and regional industrial and economic growth by the establishment of intermediate and higher-level education: in the nineteenth (Lundh Nilsson & Grönberg, 2019; Semrad, 2015) and early twentieth century (Brandt & Nordal, 2010, pp. 89–95), but not least during the Post-War Era (Musial, 2013; Neave, 2011, pp. 52–54; Sörlin, 2006; Välimaa, 2004, pp. 37–39, 43; Westlund, 2004). Fox and Guagnini (1993, p. 7) underline that almost every country had regional patterns in technical education before World War II but compared to Sweden, these patterns were more evident in countries with substantial tensions between administrative centres and emerging districts of economic activity. In these countries, regional education initiatives usually owed little to governmental support but much more to industrial pressure groups, local councils, and teachers. Sweden’s above-mentioned systematisation had a unifying character, and the establishment of a technical secondary school needed support in the parliament. However, Wallmark and the advocates of technical secondary schools aimed first and foremost to supply locally- and regionally-based industries and crafts with an educated workforce to benefit the industrialisation process (Wallmark, 1851). In this article, therefore, we especially explore the extent to which the technical secondary schools functioned as regional technical education nodes. We do so by studying the geographical recruitment patterns of students and the dispersion of students upon graduation—geographically and to different industrial branches. We ask the following questions.

- To what extent did the schools attract students from different parts of the region that the schools were intended to serve as well as from the rest of Sweden?
- To what extent did the graduates remain in the school region, two, five, and 10 years after graduation?
- Which industrial branches took advantage of the knowledge that graduates brought with them, and to what extent did the graduates serve in new and developing branches?
- To what extent did the graduates start businesses?

Another of Wallmark’s ideas was that the technical secondary schools should prepare students for higher technical studies at the Technological Institute to solve the problem with poorly prepared students—a prerequisite for being able to raise the level of higher education as well. Graduating from a technical secondary school before entering the Technological Institute was therefore encouraged, although never a requirement. We, therefore, ask the following question.

- Did the technical secondary schools serve as a stepping stone to further technical studies, and to what extent did the students continue at the Technological Institute/the Royal Institute of Technology in Stockholm?

Our focus is on the schools in Malmö and Borås from their establishment around 1855 until the educational reforms around 1920.

1.1. The study programmes

From the beginning, the duration of the education was three years, except in Örebro, where it was two years until 1861 (Gallander, 1925, pp. 34–35). To be admitted, the applicant should have reached the age of 14. Entry requirements, consisting of basic knowledge of mathematics, Swedish and German grammar, religion, geography, and history could be met by presentation of grades from an educational institution or a private teacher (SOU, 1876:7, p. 12). During the first two decades, education was characterised by a relatively large proportion of lesson hours in general subjects such as history, geography, and languages. Due to differences in the regional industry, there were small variations between the schools, but education generally aimed at broad knowledge. A reform at the end of the 1870s (proposed in 1874) meant that the proportion of natural sciences and
technical subjects increased markedly (See Table 1), at the same time as a division into three tracks – a mechanical, a chemical, and a building track was introduced to meet an increased need for specialisation. The economic upswing during the late 1860s and early 1870s led to an increased interest in technical education and the committee who proposed the 1874 reform discussed an expansion of the number of schools, but no decision was taken. At the same time as the reform was implemented, interest in technical education drastically fell due to the strong economic downturn, and the number of students in Malmö fell continuously from 102 in 1877 to 51 in 1885. At the turn of the century, the number of students was back to about 100 and some years late reached its maximum of 123, thus reflecting a new optimistic view of the demand for technicians (Montéen, 1928).

Industrial development manifested in new innovations like the use of electricity and the internal combustion machine led to the need for further specialisation and reorganisation. A new Committee presented their proposals in 1912. The education of technicians with practical knowledge should be taken care of by specialised two-year technical schools (fackskolor), not only specialising in the three above mentioned tracks but also in electronics, road and canal building, timbering, textile industry, and paper and pulp industry. A revised proposal was approved by the parliament in 1918, implying the end of the technical secondary schools as a school form (Montéen, 1928, pp. 23–25).

1.2. Database

The technical associations in Malmö and Borås issued commemorative books: the former in 1928 (Montéen, 1928), and the latter in 1912 (Köhler, 1912). These books constitute a more comprehensive source material, compared to the sources from Örebro (Forsberg & Adlers, 1925) and Norrköping (Eurenius, 1912; Isoz, 1921). The high-quality Malmö book contains biographies of a majority of the students who graduated from the 1850s until 1920. The biographies in the commemorative books are usually less complete for the earliest graduates, but they still provide valuable information. Furthermore, biographies on graduates living abroad are usually sparser: a problem occurring for many editors of technical biographies (Grönberg, 2003, pp. 35–37; Indebetou & Hylander, 1937, vol. 1, p. V). This is also true for the book from Borås, which generally is not of the same high quality. First, it covers only the period up to 1912. Second, it is incomplete when it comes to earlier students. Borås’s technical association has, however, published biographies of some graduates online, on the website of the Federation of Swedish Genealogical Societies (www.rotter.se/faktabanken/portrattfynd). Compared to the commemorative book, the online data adds a few new graduates from the years 1859–1879 and completes the information with notes concerning careers after 1912. The commemorative books issued by the Swedish Technical Association (Indebetou & Hylander, 1937) and the Chalmers Institute of Technology (Bodman, 1929) constitute another example of complementary sources. They have some shortcomings but are generally of high quality (Carlsson, 1991, p. 182; Grönberg, 2003, p. 36). These biographies contain useful information on graduates, who continued their studies on a higher level, or had gained

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Table 1. Malmö technical secondary school – share of subject fields

|               | 1857 | 1870 | 1874 proposal | 1906 |
|---------------|------|------|---------------|------|
| Natural science and technical subjects | 65   | 72   | 91            | 86   |
| General subjects | 35   | 28   | 9             | 14   |

Sources: Malmö City Archives, Sweden: Tekniska elementarskolan i Malmö, volume F2B:1, Arbetsordningar, lektionstabeller, 1854–1883. SOU, 1876, p. 7, p 24; SOU 1918:10, p. 10, pp. 356–357.

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1This commemorative book includes graduates alive in 1924 and who sent biographical notes to the editors. About 50 per cent of the graduates are missing.

2These registers give snapshots of the graduates’ workplaces in 1912 and 1921 respectively. It is demanding to track the graduates’ careers before, between, and after these years.
membership in the Swedish Technical Association since they—scientifically, artistically, or practically—had worked successfully for the good of Swedish industry, architecture, or structural engineering (Westrin, 1918, p. 1070). Far from every graduate thus qualified for inclusion.

Yearly lists containing information about the graduate’s position and workplace (Teknologernas förening i Borås, 1874, 1885–1900, 1903–1904, 1913–1930, 1950) constitute a useful complementary source for the Borås study. As for the above-mentioned commemorative books, there are reasons to evaluate the information in these lists carefully. It was expected that the graduates would send information to the Borås technical association once they changed position and workplace, but if they did not, the editors most likely copied previous year’s information. Therefore, we face the risk of underestimating both geographical and occupational mobility.

The same risk is present in the use of other complementary sources, for example, parish records and censuses. These sources, available online through the National Archives’ website (https://sok.riksarkivet.se/), Stockholm City Archives (sok.stadsarkivet.stockholm.se/Rotemannen2012/Search.aspx), and other genealogical platforms (www.ancestry.com; www.myheritage.se) are useful to track graduates, both in Sweden and abroad. However, parish records and censuses usually give only residence and occupation. The Swedish parish records, for example, may state ‘engineer’, although the graduate may hold a position as head engineer and even manager, chemist, or entrepreneur. Furthermore, especially in the very beginning of their careers, many graduates were temporarily employed in the near and far, but often remained registered in their parental home or study location. Therefore, the risk of underestimating mobility, geographically and occupationally, has to be considered.

All in all, our database covers 1498 graduates. Graduates had their family background in all classes. Sampling indicates that about one third had their family backgrounds in farming and that the differences between the two schools were small. Our database covers around 80 per cent of the graduates until 1920 from both schools. The schools registered students who graduated in numerical order. We base this calculation on the number of the last 1920-graduate from each school. A rough estimation is that graduates from the two schools represent about 15 per cent of technicians with at least three years of technical education from Sweden 1850–1920 (Grönberg, 2019, p. 76). Since there also were technicians with foreign education only in the country, these graduates’ share of the total number of technicians working in Sweden must be somewhat lower. These samples ensure an unusually high degree of representativeness when it comes to studying the graduates’ geographical origin and occupational/social as well as geographical mobility.

1.3. Delimitations

The reality that met the recently graduated engineers of the 1860s and 1870s was probably quite different from that of the late nineteenth and early twentieth century. During the intervening decades, Sweden not only underwent rapid industrialisation, but society and people’s living conditions changed to a similar degree. Schön (2000, p. 24) characterises the year 1890 as a watershed between a period of early industrialisation within the agricultural society and the breakthrough of the modern industrialised society. The period after 1890 was thus characterised by the use of applied science, research, engineering knowledge, and rational planning in production as well as many new products and production processes. (Schön, 2000, p. 209). Although the material allows for detailed statistical calculations over time, we have chosen to reflect the development over time by studying two periods—the period before 1890 and the period 1891–1920.

When Malmö’s technical secondary school was established in 1853, it was clear that the purpose mainly was to serve the southernmost province, Scania. The industrial development of this part, Sweden’s most populous, and not least in the city of Malmö, called for well-educated middle-level technicians. Besides, a technical school in Malmö was considered a necessity as the south-Swedish youth had to bridge long distances to get to Stockholm or Gothenburg. Some members
of parliament also feared that potential students from Scania would choose nearby Copenhagen instead (Lundh Nilsson & Grönberg, 2019, p. 265).

In this article, we regard Malmö as the school city, Scania as the school province, and Blekinge, southwest Småland (the southern parts of Kronoberg County), and southern Halland as nearby areas, meaning that they were closer to Malmö than to any other technical secondary school.

Borås is situated in the province of Västergötland and became the closest technical secondary school for most youngsters from that province. We will regard Borås as the school city, and Västergötland as the school province, although the northeast corner is closer to both Örebro and Norrköping. The following provinces (or parts of them) constitute the nearby areas: Dalsland, except the northeast corner, the parts of Småland constituting Jönköping County and northern Kronoberg County, Halland from Halmstad and northwards, and Bohuslän. The reason for these divisions is mainly practical and analytical. The map in Appendix 1 shows the regions of the two schools.

The establishment of a technical secondary school in Borås was motivated by the city’s status as a centre for the textile industry (Lundh Nilsson & Grönberg, 2019, pp. 270–272). Some members of parliament argued against an establishment in Borås owing to the nearness to Gothenburg, where Chalmers was located. Chalmers was an industrial school founded in 1829 but viewed as a future technical secondary school in the 1850s. However, another argument was that Chalmers’s profile did not meet the demands of the textile industry. Chalmers also developed a higher-level technical education at an early stage, be it still secondary to the Technological Institute (Björck, 2004). As the levels came to diverge, Borås became the closest intermediate technical school also for areas that were closer to Chalmers: Gothenburg city in itself, northern Halland, and Bohuslän.

The two schools’ cities, provinces, and nearby areas together form the school regions. We will use these divisions both for the study of origin and dispersion of the graduates.

2. Geographical origin and dispersion

2.1. Geographical origin

In this section, we investigate whether the schools met the expectation of attracting young technologically interested boys and men, not only from the city where the schools were established but from a larger area. The government approved Malmö’s 1850 application for a subvention to start a preparatory school for higher technical studies, but demanded that the school made room for at least 25 per cent students from outside the city (Lundh Nilsson & Grönberg, 2019, pp. 263–264). They certainly thought of other locations in southernmost Sweden in the first place, but there were no legal obstacles for more long-distance applicants. The entrance requirements of the technical secondary schools were detailed, but they never mentioned anything about geographical origin (SOU, 1876:7, p. 12).

It probably took some years before the existence of the schools became known outside, in this case, Malmö’s and Borås’s vicinities, and probably the development of communications over time also played an important role for the decision to study in another place of residence. We, therefore, intend to investigate the following two questions:

1) To what extent did the schools attract students from different parts of the region that the schools were intended to serve?
2) Did the distribution of the students’ geographical origin change over time?

We need to underline a few circumstances here. First, while most graduates certainly resided in their birthplaces when they applied for the schools, this did not apply to all of them. Some graduates had moved to the school regions from other parts of Sweden and a few from abroad. A random sampling (every fifth graduate) indicates that roughly one-third of Malmö graduates born outside Malmö’s school region applied from domiciles within the school region. The corresponding share
for Borås was about one-fifth. Most foreign-born graduates had at least one Swedish parent, whereby a significant majority of them sent their applications from domiciles in Sweden. Eight of 16 foreign-born Borås graduates applied from the school region, whereas the number for Malmö was eight of ten. The school region shares would thus have been larger if we had taken our point of departure from domiciles rather than birthplaces. Second, the discussions about the closest school are based on as-the-crow-flies distances. Especially in areas halfway between the schools, communications might have been faster to the school somewhat further away.

Table 2 shows the distribution of birthplaces for graduates from the two schools up to 1890 and 1891–1920. The pattern is rather clear: the students in Borås travelled longer to get to the school. Over time, the share originating from the school city and the province was significantly higher in Malmö, which is explained partly by the fact that Malmö was a considerably larger city. Malmö had about 13,000 inhabitants in 1850, and about 88,000 inhabitants in 1910. Corresponding numbers for Borås were 2,700 inhabitants in 1850 and about 21,000 inhabitants in 1910 (http://ortshistoria.se/befolkning/1850, http://ortshistoria.se/befolkning/1910).

The school in Malmö also attracted noteworthy higher shares from its province, compared to the counterpart in Borås. At a first glimpse, these differences are surprising as Västergötland’s population was slightly larger. In 1855, Västergötland had about 470,000 inhabitants (Statistiska Centralbyrån, 1859), whereas the number was 655,000 in 1910 (Statistiska Centralbyrån, 1912). Scania had roughly had 465,000 inhabitants in 1855 and around 630,000 inhabitants in 1910 (www.regionfakta.com/skane-lan/befolkning-och-hushall/befolkning/befolkningsutveckling-1805-2010/).

Distance and possibilities to study at other nearby technical schools constitute plausible explanations of the pattern. Västergötland’s area is about one and a half times larger than Scania’s. The province’s northeast corner was approximately 150 kilometres from Borås and had Örebro as its closest technical secondary school. The school in Norrköping was also closer, at least as-the-crow-flies. Furthermore, the city of Gothenburg is also a part of the province. Chalmers probably diverted some potential students away from Borås. The school in Gothenburg hosted a higher-level education with higher entrance qualifications than the technical secondary schools and a lower-level education with lower entrance qualifications. (SOU, 1876:7, p. 178). There were probably some students on the higher-level who would have studied in Borås if this education had not existed. Scania’s youth had fewer technical education alternatives within reasonable distances unless we include Copenhagen. The most distant parts of Scania are situated around 100 kilometres away from Malmö, but it was still the closest technical secondary school. Malmö also had several industrial towns in its vicinity, such as Landskrona, Helsingborg, and Trelleborg.

Borås’s nearby areas were, however, larger and more populous than Malmö’s counterparts. In 1880, Malmö’s nearby areas had about 300,000 inhabitants, whereas the number of inhabitants in Borås’s counterpart was over 500,000 (Statistiska Centralbyrån, 1882). Borås’s nearby areas included industrial cities like Halmstad, in the province of Halland, and Jönköping, in the province...
of Småland about 70 kilometres east of Borås. The latter city was discussed as a new location for a technical secondary school. An 1874 governmental inquiry on Swedish technical education described the city as a centre of considerable industrial activity (SOU, 1876:7, p. 66). The plans never materialised, partly because of the nearness to Borås.

The share born in the rest of Sweden was about three times as high in Borås as in Malmö, reflecting that Borås was closer for most of Sweden’s population. A relatively large number of graduates were, for example, born in the western central province of Värmland. Nevertheless, almost 75 per cent of the Borås graduates from 1859 to 1920 were born in the school region. The corresponding share in Malmö was 90 per cent. Thus, the schools recruited huge majorities from their school regions, but this trend was more marked in Malmö.

Table 2 also shows, however, that longer-distance students seem to have become increasingly more common over time. The share of Malmö graduates born in the nearby areas was higher after 1890, and more graduates born in the rest of Sweden also left the school from the 1890s to 1920. In Borås, there was a constantly higher share of graduates born in other parts of the country from the 1890s. One plausible explanation may be the prominent position of the textile industry in the Borås area, which was emphasised in the early discussions about the localisation of the technical secondary schools. It is also likely that more developed communications, such as railways, facilitated the possibilities to study further away from home over time, be it in Borås or Malmö.

All in all, the two technical secondary schools educated mostly students originating from their school regions. However, whereas roughly half of the Borås students came from the school city and the school province, the Malmö shares for these two categories were significantly higher. The Malmö school, therefore, seems to have functioned more in accordance with its original purpose to serve as a technical education alternative for the region’s youth.

2.2. Geographical dispersion

Even if at least around 70 per cent of the students at the two technical secondary schools originated from the school regions, this alone does not necessarily imply that the schools functioned as support for regional economic and industrial development. To fulfil this purpose, the graduates also needed to do at least part of their careers in these regions. We intend to investigate the following questions:

1) To what extent did the graduates work in the school city, school province, school region, rest of Sweden, and abroad two, five, and 10 years after graduation?

2) How did the graduates’ geographical employment patterns change over time?

As mentioned, compared to Borås, Malmö was a significantly more populous city and, unlike Borås, also a provincial capital. Malmö was Sweden’s fifth-most populous city in 1850 but passed Karlskrona and Norrköping in the 1850s and 1860s. Scania also possessed other industrial cities within its borders, in addition to a developing sugar industry in the countryside. Borås, on the other hand, was not a county seat but possessed more populous and industrialised nearby areas with cities such as Jönköping and Halmstad.

These patterns are reflected in the geographical dispersion of the graduates, two, five, and 10 years upon leaving school. Figure 1 shows that the Malmö graduates stayed in the school region to a larger extent than the Borås graduates. Around 65 per cent of the Malmö graduates worked in the school region two years upon graduation. The corresponding share for Borås was somewhat below 50 per cent. Nearly half of the Malmö graduates were in the school region after 10 years, compared to about 35 per cent of the Borås graduates. These results also correspond well with an investigation of the geographical dispersion of technicians in 1908.

About two-thirds of the Malmö graduates, and somewhat more than every second Borås graduate, worked in the school region. Graduates from both Malmö and Borås worked in their respective
school region more frequently than their colleagues from Örebro and Norrköping (SOU 1918:10, p. 10, p. 519).

Borås was a more industrialised city in relation to its population, but Malmö showed a 259 per cent growth of factories between 1850 and 1910. In Borås, the corresponding growth was 167 per cent (Sveriges Kommerskollegium, 1850, 1912). As Malmö’s population was between four and five times larger during the entire period, it is clear that the city offered a significantly larger labour market than Borås. Malmö’s size also implied a larger city engineering office, providing employment opportunities at municipal gas, water and electricity works, tramways, and the like.

In Wallmark’s statement and the parliamentary debates prior to the establishment, the participants underlined that the Malmö school’s primary aim was to serve southernmost Sweden (Lundh Nilsson & Grönberg, p. 263–266). Scania underwent a quick industrialisation between 1870 and 1910; the number of factories sevenfold. However, the nearby area consisting of Blekinge, southwest Småland, and southernmost Halland was less industrialised and received relatively few graduates. The number of factories were fewer and, as opposed to in Scania, a significant majority of them were located in the countryside (Sveriges Kommerskollegium, 1874, 1912).

As for Borås, it was the opposite: nearby areas outside Västergötland with Borås as the closest technical secondary school received many graduates. Halmstad belonged to Sweden’s most growing cities 1850–1900, even if industrial employment was somewhat below the national average. Jönköping was heavily industrialised and one of the country’s fastest growing cities in the 1860s and 1870s (ortshistoria.se). Furthermore, Figure 1 also reflects Borås’s more northern location. Higher shares of the Borås graduates were employed in the parts of Sweden that were closer to other technical secondary schools. Appendix 2 shows, for example, that between 11 and 14 per cent of the Borås graduates were employed in the city of Stockholm and Stockholm County over time, whereas the corresponding Malmö share lay between seven and eight per cent. Borås graduates had higher

Figure 1. Geographical distribution of graduates from the technical secondary schools in Malmö and Borås, 1855 (1859)–1920: two, five, and 10 years after graduation. Sources: See Table 2.

### Figure 1

- **School-city**
- **School-province**
- **Nearby areas**
- **Rest of Sweden**
- **Abroad/Unknown**

3A calculation for the technical secondary school in Härnösand also shows that about two-thirds of the graduates were employed in the school region. However, this calculation is only based on 19 cases, since the first graduates left the school in Härnösand in 1904.
shares in every county in central (Svealand) and northern (Norrland) Sweden. Appendix 2 also shows that Västmanland County became a, relatively speaking, important destination for graduates from both schools; the reason was the location of the main plants of ASEA, Sweden’s leading electro-technical company, in the county capital of Västerås. All around the country, there was a multitude of employment opportunities in, for example, railway building, surveying, and municipal engineering. Such opportunities spurred migration, both over shorter and longer distances.

The employment pattern for graduates from both schools also reflects the birthplace pattern: many graduates went back to their origin upon graduation, but we must remember that many, especially early in their careers, remained registered in their parental homes or the city of study, while they could have worked elsewhere. Finally, the differences as regards foreign employment were smaller than the differences within Sweden. Malmö’s location on the southern tip of Sweden was possibly somewhat more facilitating for studies or employment abroad, even if few went to Denmark. This is a bit surprising considering the labour market in Copenhagen, just across the strait, described by Hyldtoft (1984, p. 418) as a capital whose industrial domination over the rest of the country hardly had any counterpart in Europe. Germany’s industrial development and labour market, however, attracted the Malmö graduates to a higher degree than Denmark. The Borås region’s focus on the textile industry, a business wherein Britain remained strong, may, on the other hand, explain that the United Kingdom was a more frequent destination among Borås graduates than among Malmö graduates. This was also true for North America, partly because of Borås’s location in a district with, relatively speaking, strong transatlantic migration (Carlsson, 1976). Compared to the German-speaking countries, the United States was more of a dual destination. On the one hand, many technicians arranged what Kristensen (2004) calls placements abroad, that is, they took employment for a limited period with the purpose of learning and acquiring experiences, for example, in America. On the other hand, some technicians were certainly migrants following in the footsteps of millions of Europeans settling in North America.

The shares working in areas further away from the schools increased with increasing duration from graduation: from two to five to 10 years for the rest of Sweden and from two to five years for those going abroad. Employment in northern Sweden (Norrland) accounted for one per cent of the Malmö and about two and a half per cent of the Borås graduates after two years. Corresponding shares after 10 years were three and a half and six per cent. Employment around Stockholm, however, did not increase as much as one could have expected, considering that prestigious public positions in the State Railways and the like, requiring accumulated experience, often were located to the capital. All these geographical differences between the schools persisted over time.

2.3. Changes in geographical dispersion over time

Table 3 shows geographical patterns over time. The unknown cases—most likely graduates who had emigrated without leaving any traces behind—are, as we can see, very few and do not have any impact on the results. We can safely conclude that it was more common to stay in the school region among the Malmö graduates during the two schools’ entire period of existence. The difference between the schools was smaller among the pre-1890s graduates. The school region’s importance for employment decreased over time as the career proceeded, but also after 1890. Nevertheless, more than half of the Malmö graduates worked in the school region more or less all the time; the only exception being the later (1891–1920) graduates 10 years upon leaving school. If we compare the graduates from 1855–1890 with the ones from 1891–1920, Malmö’s school region increased in importance for early employment but became less important for the more experienced technicians. The Borås graduates differed as more than half of them were employed outside the school region all the time. The differences between the two periods resemble, however, the Malmö pattern: the increasing importance of the school region for the freshmen and decreasing

4Gävleborg, Västernorrland, Jämtland, Västerbotten and Norrbotten counties.
for the more experienced. Generally, a conclusion is that technicians educated in Borås worked further away from the school. This is also reflected in significantly higher shares in the nearby areas in other provinces that still belonged to the school region. Major industrial cities such as Halmstad and Jönköping were located nearer Borås than any other city hosting a technical secondary school, but still in neighbouring provinces. Whereas Scania, as mentioned above, hosted several major industrial cities such as Helsingborg, Landskrona, and Trelleborg, Malmö’s nearby areas in Blekinge, southwest Småland, and southernmost Halland had few and rather small industrial settings. The navy shipyard in Karlskrona and the cellulose factory in Delary are two exceptions from the rule.

It was somewhat more common for Malmö graduates to work in their province and significantly more common to be employed in their school city. Compared to Borås, Malmö’s higher degree of industrialisation, size, and significant population growth implied that the city could maintain a larger and growing labour market over time. This observation is valid, regardless of the point in the career or period. As opposed to the province level, however, it became somewhat more common to work in the school cities among the post-1890 graduates, a difference compared to the provinces and the school regions at large. The increase was especially significant among the freshmen from Borås, reflecting a growth of population and industry. The number of factories fourfold from 1870 to 1910 (Sveriges Kommerskollegium, 1874, 1912). From the 1870s through the 1890s, the city showed a significant net inflow of people (ortshistoria.se).

Many graduates moved however out of the school regions: to other parts of Sweden and abroad. Geographical mobility was an important part of a technician’s identity on to the twentieth century (Cardozo de Matos & Diogo, 2007; Gouzévitch, 2011; Grönberg, 2019). Stang (1989, p. 25) argues that engineers are ‘a geographically eminently mobile social category’. Stang and other scholars base their statements on studies of international mobility, but the mobile mobility characterising technicians certainly removed obstacles also for domestic mobility. Employment in the rest of Sweden generally increased for the graduates of the two schools, both with career years and from the earlier period to the later. The late nineteenth century was a time when Swedes generally started to migrate more and over longer distances as industrialisation caused new employment opportunities in urban

| Region                  | Years upon graduation | 1855–1890 | 1891–1920 | 1859–1890 | 1891–1920 |
|-------------------------|-----------------------|-----------|-----------|-----------|-----------|
| SCHOOL CITY             | 2 years               | 32.2      | 35.9      | 11.6      | 16.2      |
|                         | 5 years               | 27.2      | 28.1      | 8.5       | 9.7       |
|                         | 10 years              | 24.0      | 25.6      | 8.0       | 8.5       |
| SCHOOL PROVINCE         | 2 years               | 27.2      | 26.6      | 25.5      | 20.5      |
|                         | 5 years               | 27.2      | 20.2      | 22.9      | 16.6      |
|                         | 10 years              | 26.0      | 18.5      | 21.8      | 15.0      |
| NEARBY AREAS            | 2 years               | 2.7       | 4.6       | 10.9      | 12.8      |
|                         | 5 years               | 3.4       | 3.5       | 12.6      | 8.0       |
|                         | 10 years              | 3.4       | 2.4       | 10.7      | 8.7       |
| SCHOOL REGION           | 2 years               | 62.1      | 67.0      | 48.0      | 49.5      |
|                         | 5 years               | 57.7      | 51.7      | 44.0      | 34.3      |
|                         | 10 years              | 53.4      | 46.4      | 40.5      | 32.2      |
| REST OF SWEDEN          | 2 years               | 18.6      | 19.9      | 39.8      | 37.2      |
|                         | 5 years               | 19.5      | 26.7      | 35.5      | 43.2      |
|                         | 10 years              | 22.3      | 34.7      | 34.3      | 50.3      |
| ABROAD                  | 2 years               | 18.9      | 12.9      | 12.2      | 13.3      |
|                         | 5 years               | 22.1      | 21.5      | 19.5      | 22.5      |
|                         | 10 years              | 23.6      | 18.8      | 23.5      | 17.2      |
| UNKNOWN                 | 2 years               | 0.3       | 0.2       | 0.0       | 0.0       |
|                         | 5 years               | 0.7       | 0.0       | 1.0       | 0.0       |
|                         | 10 years              | 0.7       | 0.0       | 1.7       | 0.3       |

Sources: See Table 2.
and rural industrial areas. For more recent time periods, several studies conclude that there is a causality between higher education and the readiness for within-country migration. One reason is that highly educated usually have specialised jobs, and thereby the need to look for employment within a larger geographical area. Unskilled jobs requiring none or little education are usually available on the domicile (Borsch-Supan, 1987; Haapanen & Böckerman, 2017; Machin, Salvenes, & Pelkonen, 2012; Malamud & Wozniak, 2012; McHenry, 2013; Weiss, 2015). There are reasons to believe that this also was the case in the nineteenth and early twentieth centuries. The mobility of graduates from the technical secondary schools in Malmö and Borås increased after 1890. The parts of Sweden that were closer to other technical secondary schools attracted more graduates from both schools later on as communications developed. Migration to areas closer to other technical secondary schools is, however, significantly stronger for graduates from the more northern located school in Borås after two, five, and 10 years during both periods. After 1890, more than every second Borås graduate worked in the rest of the country 10 years upon graduation.

Employment abroad shows a somewhat ambiguous pattern. Improved communications most likely contributed to more opportunities to seek employment abroad over time. This is nevertheless not reflected in Table 2, where we can observe decreased foreign employment in the period 1891–1920, except for the Borås graduates two and five years upon graduation. One might have expected that the international turmoil of the 1910s influenced the results. Interestingly enough, the above-mentioned decrease began already among the 1890s graduates, except for the early-career graduates (two years upon graduation) in general, and the Malmö alumni in particular. The decrease in foreign employment intensified among the graduates of the 1910s, but technicians observed 10 years upon graduation constituted an exception. These technicians are all observed during the so-called roaring twenties and, consequently, after World War I.

One of the main conclusions from this study is that graduates from the technical secondary school in Borås to a larger extent were employed outside of its school region, as the investigation from 1908 also shows. Among the graduates leaving the Borås school in the 1890s and onwards, only around every third remained in the school region five and 10 years upon graduation. The shares were higher in Malmö’s school region, but also below 50 per cent 10 years upon graduation from the 1890s onwards. In practice, the schools educated to a large extent for other parts of Sweden and foreign countries. This is not necessarily problematic. Decision-makers and school boards hardly imagined a situation where all graduates remained in the school regions. One of the aims of the technical secondary schools, at least in the earliest stages of their existence, was to prepare students for higher technical studies. This implied that they had to move, primarily to Stockholm or perhaps abroad. It must have been in the balance that these alumni of the technical secondary schools might not return to the school regions afterwards. Furthermore, there was, of course, also an exchange of graduates between different school regions: some graduates moved away to other parts of the country, while other graduates arrived from more distant places.

As we have seen, there were more or less persistent differences between the schools as to where students came from and where they went after graduation. In the next section, we will look at the dispersion of graduates on the branch-level.

3. Dispersion of graduates on branch-level

As mentioned, one problem that was identified with the technical education in mid-nineteenth century Sweden was that the Technological Institute primarily educated for larger industries and public administration, whereas the lack of educated technicians in medium-sized and smaller regionally-based industries and crafts was identified as a major obstacle for the desired industrial and economic development. This section focuses on the industries in which the students were active two, five, and 10 years after graduation, regardless of when, during the period 1855–1920, they completed their studies. The development over time will be discussed in a separate section. Before proceeding, we need to underline that entrepreneurs and students are discussed separately and that
graduates with an unknown employer are not included in Table 4. We can note that the latter implies a falling off of between four and 11 per cent for Malmö, and between 11 and 19 per cent for Borås.

Table 4 clearly shows that a majority of the graduates from both schools went to industry and craft. Industry and craft’s share of the Swedish workforce grew continuously between 1850 and 1920, which is reflected in the fact that higher shares of graduates worked in this main group after 1890. Industry and craft employed about one-fourth of the total male workforce in 1900 (Statistiska centralbyrån, 1914, p. 13–15) and about one-third in 1920 (Statistiska centralbyrån 1929, p. 28–31). These shares are significantly lower than for the Malmö and Borås graduates, which comes as no surprise since the graduates primarily were educated to serve in these branches.

The industry and craft pattern was also evident in the investigation of the diffusion of technicians in 1908, where three-fourths of all technicians in Sweden as well as from all the technical secondary schools worked in these branches. Malmö and Borås showed somewhat lower shares (SOU 1918:10, p. 10, p. 491), partly because central and northern Sweden hosted the major mining and forestry districts, meaning that a majority of the other schools focused more on the education of technicians for these branches. There were, for example, two schools devoted only to mining. Nevertheless, the pattern for Malmö and Borås was evident already among those who graduated during the early industrialisation, but the pattern intensified during the industrial breakthrough after 1890. The schools, thereby, fulfilled one of their major aims. The most common local employer for the Malmö graduates was the mechanical workshop, Kockums, which over time developed into one of Sweden’s leading shipyards. Interestingly enough, Kockums was a more frequent employer for the earlier graduates. Another major local employer was Skånska Cementgjuteriet (The Scanian Cement Casting Ltd.), especially after 1890.

Malmö graduates also had employment opportunities at mechanical workshops, foundries, and shipyards in nearby places in Scania such as Arlöv, Hässleholm, Helsingborg, Landskrona, Limhamn, Lund, Svedala, and Trelleborg. Gothenburg’s major mechanical workshops and shipyards —Eriksberg, Götaverken, and Lindholmen— attracted some Borås graduates, but the single most frequent employer in Västergötland was Nyqvist & Holm in Trollhättan, one of Sweden’s largest mechanical workshops. Employment in industry and craft was somewhat more common among the Borås graduates. A similar pattern can be observed for the most important sub-branch in this group: mechanical workshops, machine shops, motor factories, and the like. We have also created a second sub-branch under this group: electrical industry, which grew in importance in the light of the second industrial revolution in the late nineteenth century. It was slightly more common to go to the electrical industry among the Malmö graduates. This pattern was also reflected among those who went to electrical power stations in the main infrastructural group.

The differences between the two schools were clearer in some smaller sub-branches. Spinning and weaving factories, important in the southern parts of Västergötland, were, of course, more important employers for the Borås graduates. This was also evident in 1908 when nine per cent of the Borås graduates worked in these branches compared to only one percent of their colleagues from Malmö. The average for the technical secondary schools was seven per cent (SOU 1918:10, p. 10, p. 491), partly due to Norrköping’s status as the other textile industry centre in Sweden. These factories were located in the city of Borås, where the Viskaberg weaving-mill was the most frequented, but also in nearby places such as Fritsla, Kinna, and Mölnlycke. The same was valid for timber and pulp and paper industries around Lake Vänern and in Småland, areas that were within or nearer to Borås’s school region. Paper-mills in Vargön and Mölndal in the school province as well as in Jönköping and Munkedal in the nearby areas employed graduates. More graduates from Borås also went to the central and northern parts of Sweden, where these industries were even stronger. The Malmö graduates went significantly more often to food processing and the

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5Graduates of the Royal Institute of Technology, Chalmers, five technical secondary schools, two mining schools, one lower-level mechanical school, one lower-level constructional school, and foreign technical institutes.
Table 4. Distribution on branch level of graduates from the technical secondary schools in Malmö and Borås, 1855 (1859)–1920. Students and graduates with an unknown position are not included.

| School Period | 1855–1890 | 1891–1920 | TOTAL | 1859–1890 | 1891–1920 | TOTAL |
|---------------|-----------|-----------|-------|-----------|-----------|-------|
| **Infrastructure** |           |           |       |           |           |       |
|                | 16.3      | 21.8      | 24.7  | 17.7      | 19.3      | 25.2  |
| Rail- and tramways, civil engr. | 8.9       | 13.8      | 13.6  | 7.6       | 7.9       | 8.5   |
| Surveying     | 1.6       | 2.2       | 3.7   | 0.0       | 0.2       | 1.1   |
| Teaching and education | 1.1       | 0.4       | 1.6   | 0.4       | 1.2       | 2.7   |
| **Electrical power stations** | 0.0       | 0.0       | 0.0   | 3.5       | 3.0       | 4.2   |
| Gas and water purification | 0.5       | 0.4       | 1.2   | 0.4       | 1.6       | 2.2   |
| Other infrastructural work | 4.2       | 4.9       | 4.5   | 5.8       | 5.4       | 6.5   |
| **Industry and craft** | 62.1      | 53.3      | 50.2  | 69.1      | 66.7      | 60.3  |
| Food and stimulant | 5.3       | 6.7       | 6.6   | 5.0       | 4.9       | 4.2   |
| Spinning and weaving | 0.5       | 1.3       | 0.4   | 0.6       | 0.2       | 0.4   |
| Timber and sawmill | 2.1       | 2.2       | 3.3   | 1.1       | 1.9       | 2.7   |
| Pulp and paper | 0.0       | 0.0       | 0.4   | 0.4       | 0.5       | 0.4   |
| Stone, clay, coal, and peat | 3.2       | 2.7       | 2.5   | 9.1       | 8.6       | 8.3   |
| Chemical       | 0.0       | 1.3       | 1.2   | 2.4       | 1.6       | 2.2   |
| Metal          | 6.3       | 8.0       | 11.1  | 7.3       | 7.5       | 8.7   |
| Mechanical**   | 41.1      | 27.6      | 20.6  | 25.7      | 23.1      | 19.4  |
| **Electrical** | 1.1       | 1.3       | 2.1   | 11.9      | 14.0      | 10.0  |
| Other industries and crafts | 2.6       | 2.2       | 2.1   | 5.6       | 4.4       | 3.8   |
| Architecture/Construction | 8.4       | 8.0       | 6.6   | 7.8       | 7.2       | 6.7   |
| Other branches** | 13.2      | 16.9      | 18.5  | 5.4       | 6.8       | 7.8   |
| TOTAL***       | 100       | 100       | 100   | 100       | 100       | 100   |
| Unknown position**** | 6.3       | 10.4      | 12.5  | 3.4       | 6.7       | 9.3   |
| Students****   | 30.6      | 13.8      | 5.1   | 8.7       | 8.1       | 1.8   |
| **TOTAL2**     | 100       | 100       | 100   | 100       | 100       | 100   |

The division of branches is based on: Sveriges Kommerskollegium (1912). Kommerskollegi underdåniga berättelse för år 1910. Bidrag till Sveriges officiella statistik. D, Fabriker och manufakturer. Stockholm, p. XXX-XXXVI. *exclusive of the electrical industry, **including agriculture, trade, banking, offices, other technical, non-technical employment as well as named employers in unknown branches, ***calculated on the number of graduates whose employer is known, ****percentage of all graduates.

Sources: see Table 2.
nutrient industry; one explanation connects to Scania’s numerous sugar refineries. Stonemasonry and clay was another industry attracting more Malmö graduates.

Over time, infrastructure was the second branch for the two schools’ graduates. Table 4 shows an increasing trend with experience and that it was more attractive among the Malmö graduates. The largest sub-branch was railways, tramways, and civil engineering, also showing an increasing trend accounting, with a minor exception, for between six and 14 per cent of the employment over time. Employment at electrical power stations as well as gas and water purification works was also more common among the Malmö graduates, partly because they had more employment opportunities in their considerably larger school city. Other infrastructural works, including harbours and canals, post, customs, telephone and telegraph services, and inspection were also more attractive employers among Malmö graduates. The only sub-branch to which the Borås graduates were more inclined to go was surveying.

The other branches in Table 4 offer no major surprises. They are generally counted on small numbers. Architecture and construction as well as ‘other technical employment’ diminished to some extent with a continuous career, whereas agriculture, employment in trade, banking, and other offices, and other non-technical employment increased.

### 3.1. Dispersion on the branch-level over time

Several patterns can be derived from Table 4. Borås graduates went, for example, significantly more often to infrastructure and considerably less frequently to architecture and construction before 1890. The Malmö patterns in these two branches oscillated. However, the already observed pattern that Malmö graduates more often were employed in infrastructure persisted over time. This was also reflected in sub-branches such as railways; tramways; civil engineering; post; telecommunications; customs; and electricity, gas, and water purification works. Malmö simply offered, as mentioned, more possibilities within the infrastructural field compared to Borås’s counterpart: More than every second Malmö graduate employed in infrastructure worked in the school city, compared to every sixth Borås graduate. Employment in other branches decreased for the alumni of the two schools. Most constant and significant is the development of industry and craft over time. This branch increased from the earlier to the later graduates by around 20 per cent at every point of observation. This reflects the industrialisation process. Employment in spinning and weaving was all through the period more significant for the Borås graduates, whereas it was the opposite for the food and stimulant industry as well as for stonemasonry and clay. This reflects regional industrial differences between Scania and the region around Borås.

Interesting sub-branch patterns within industry and craft and infrastructure are highlighted in bold italics in Table 4. Among those who graduated before 1890, very few were employed in the electrical industry and at electrical power stations. After 1890, however, there was a significant increase, be it with some divergences between the two schools, reflecting the breakthrough of electricity in the light of the second industrial revolution. The country’s leading electrical manufacturer, Västerås-based ASEA, was the main employer of graduates in this field, but they also worked at smaller competitors such as Luth & Rosén and Förenade Elektriska, with headquarters in Stockholm and Ludvika, respectively. Electrical employment thus often implied migration outside the school regions.

If we look at the declared aim to provide local and regional industries and crafts with an educated workforce, it is rather clear that the Malmö school functioned more in line with these ideas. Seventy per cent of the Malmö graduates working in industry and craft served in the school region two years upon leaving school; the corresponding share for the Borås graduates was 45 per cent.

### 3.2. Starting one’s own business

Some graduates also started their own business or, alternatively, took over a family business or the like. Figure 2 shows that the shares increased the more time had passed since graduation, that it was
more common before than after 1890, and that Borås graduates started businesses more frequently than Malmö graduates in the earlier period, whereas it was the other way around in the latter. At most, around eight to nine per cent of the graduates owned their own business, but we need to consider that there could have been several self-employed among the graduates whose positions are unknown.

Entrepreneurial enterprise often took place in the school city, especially among the Malmö graduates. More than every second Malmö graduate starting his own business did so in the city of Malmö. The city of Borås, too, hosted significantly higher shares of self-employed Borås graduates than Borås graduates at large. The provinces show more ambiguous percentages, but the school city pattern echoed for Borås graduates being self-employed in Västergötland after 1890. There were lower shares of self-employed graduates than of graduates at large in the nearby areas, the rest of Sweden, and abroad.

As for the dispersion to branches, the self-employed differed significantly from the graduates at large. Starting a business in industry and craft was less common than being employed in these branches. There were only single self-employed in food processing, spinning and weaving, timber and sawmilling, stone cutting, the chemical industry, and the electrical industry, whereas at least half of the self-employed in industry and craft owned mechanical workshops and the like, more common among the graduates from Malmö up to 1890, and the opposite thereafter. One example is Carl J. F. Ljunggren (1858–1927), who graduated in Malmö in 1875 and continued his studies at the Swiss Polytechnic in Zurich. Upon his return to Sweden, he took over his father’s business in Kristianstad, and he also founded an industrial museum in the north Scania city (Meijer & Westrin, 1912, p. 881). Whereas there were no self-employed in infrastructure, architecture and construction represented between 30 and 40 per cent of the self-employed Malmö graduates after 1890. This pattern was different among the graduates from Borås. What is labelled as ‘other branches’ was also more of a self-employed pattern: working in trade was generally uncommon among the graduates at large, but represented between one fourth and 60 per cent of the self-employment for the graduates who left school before the 1890s. Trade showed lower self-employment shares among the later graduates, but higher than among everyone who left the schools 1891–1920.
4. Continuing to further studies

As mentioned in the introduction, the Technological Institute’s principal, Wallmark, also drew attention to the problem of the often low level of knowledge among the institute’s novice students. Initially, therefore, the technical secondary schools—the school in Norrköping was an exception—also aimed at preparing students for further studies at the Technological Institute (SOU, 1876, p. 8, p. 63–64). However, the 1874 Committee, whose members had been appointed to investigate and propose changes regarding the lower technical education, including the technical secondary schools, came to the conclusion that the aim of the technical secondary schools should be to prepare for practical work in the industry. Although the Technical Institute’s teaching would be based on science and theory, the teaching at the technical secondary schools would be focused mainly on the practical. As a result, the committee stated that preparing for higher studies should be the responsibility of the secondary grammar school and not the technical secondary schools (SOU, 1876, p. 7, p. 30–32). The Technological Institute was, however, not the only possible educational institution for further studies in Sweden, and some young men also chose to study abroad. In this section, we investigate the extent to which graduates from the technical secondary schools continued to studies at the Technological Institute (from 1877, the Royal Institute of Technology) and the impact of the reform in the late 1870s on this pattern. We also investigate the willingness to continue to different kinds of further studies in Sweden and abroad during the whole period.

Several graduates continued to study after they had left the technical secondary schools in Malmö and Borås. Figure 3 shows that these studies not only took place at technical universities but also at agricultural schools and in surveying. The category ‘Other studies’ includes different kinds of specialised technical schools below the level of technical university, general grammar schools and universities, military schools, and art schools. Practice and study visits during international and domestic study trips also belong to this category. All in all, roughly every sixth graduate from both schools studied two years upon leaving the technical secondary school, but Figure 3 shows that it was much more common before the 1890s. During that period, the Malmö alumni studied somewhat more frequently than their colleagues from Borås two years upon graduation. As for five and 10 years, the pattern was the opposite. Hardly surprising, the student-group diminished significantly with increasing time upon graduation. Ten years upon leaving a technical secondary school, a graduate was often fully trained, even if a few still were study travelling, and

![Figure 3](image-url)
surveyor students constituted a minor exception. Their education was usually longer than for most professions. Some of the alumni from the two schools had graduated as surveyors, but upon graduation followed a rather long period when they served as surveyor trainees (lantmäteri-auskultanter) which meant that the candidates assisted the district surveyors but were not yet allowed to practise the profession independently (Rosén & Westrin, 1885, p. 708).

Figure 4 also shows two striking patterns: It was significantly more common for the Borås graduates to study surveying up to 1890, but the differences between the two schools had disappeared during the latter period. It was, on the other hand, more common among their colleagues from Malmö to continue to higher technical studies. Malmö was closer to Germany’s Technische Hochschulen. However, although Malmö lay further away than Borås from the higher-level domestic technical institutes, it was also more common for Malmö graduates to continue to higher technical studies in Sweden. Continuing to agricultural schools was also more common among the graduates from Malmö. One of Sweden’s major agricultural schools, Alnarp, was located less than 10 kilometres from Malmö city centre. Accordingly, many graduates interested in agriculture went there.

4.1. Technical university studies

As for technical university studies, we observe differences from the earlier period to the later. The earlier graduates usually studied at the domestic higher technical institutes: 22 of the 31 graduates studying two years upon leaving the school in Malmö studied at the Technological Institute/Royal Institute of Technology, whereas another two studied at Chalmers. Students abroad were dispersed to Denmark’s Polytechnic Institute in Copenhagen, the German Technische Hochschulen in Berlin-Charlottenburg, and Hannover and the Swiss Polytechnic in Zurich. The pattern after five years was similar: Four out of seven studied at the Stockholm based institute and the remaining three in Charlottenburg and at the mining school in Leoben, Austria.

The new directives, implying that the technical secondary schools would only prepare for practical work, did not unequivocally lead to lower shares of graduates continuing to higher technical

Figure 4. Distribution across different types of studies among graduates from the technical secondary schools in Malmö and Borås, 1855 (1859)–1890, and 1891–1920, who studied two, five, and 10 years upon leaving the schools. *other schools, practice, and study trips. Sources: See Table 2.
studies in general, but foreign schools overtook the Royal Institute of Technology as the most frequented higher technical institutes, especially for the Malmö graduates. Seventeen of 28 Malmö graduates 1891–1920 conducting technical university studies after two years did so in Germany, whereas the remaining 11 stayed in Sweden. König (1993) argues that Germany’s success in technical education mainly was due to a manifold of specialisations. Whereas the Royal Institute of Technology limited the places in their programmes (Berner, 2000, p. 77), there were several study options in a nearby country which Swedish engineers regarded as a primary model for technical education and development (Nilson, 2006; Runeby, 1997). The Royal Institute of Technology was still the single most frequented institute; only one Malmö graduate enrolled at Chalmers. Most Malmö graduates studying at Technische Hochschulen were in Darmstadt and Charlottenburg, but a few also went to Dresden and Hannover. The five-year pattern was essentially the same, partly because most students had not yet graduated, whereas only a total of six graduates, from both schools, studied at technical universities after 10 years: Four of them were enrolled at the Royal Institute of Technology, including the two from Borås, and one each at Chalmers and in Dresden.

In total, fewer graduates from Borås than from Malmö continued to technical studies, but the two-year pattern resembled Malmö’s; most went to Stockholm. However, the Finnish-born 1877 graduate Waldemar Aspelin (1854–1923) continued his studies at the Finnish Polytechnic Institute and became a well-known architect in Hamina and Helsinki, designing several of the Finnish capital’s commercial and residential buildings (Ashby, 2007, p. 137–139). One interesting observation is the minor importance of Chalmers. Only two Borås graduates enrolled at the technical institute in neighbouring Gothenburg: Both of them studied naval architecture five years after they had left the school in Borås. The earlier mentioned differences between the two schools might be reflected in these statistics; Chalmers was from early on viewed as a technical institute with little importance to the textile industry, dominating around Borås. Another difference between the Borås and the Malmö graduates was that an overwhelming majority of the former studied at the Royal Institute of Technology also after 1890.

To sum up, the Borås alumni gravitated towards Stockholm for higher technical studies, all from the 1850s to the early 1920s. From the beginning, the Malmö graduates also had this orientation. However, if the schools had a responsibility to prepare for the Royal Institute of Technology, they were not very successful. In the earlier period, seven per cent studied there two years after they had left the school in Malmö, but the share decreased in the later period and of course also with increasing time upon graduation. Over time, Malmö’s technical secondary school became more of a springboard to German Technische Hochschulen than to higher technical studies in Sweden. Finnish, Norwegian, and numerous technical schools around the world functioned in similar ways, but students from at least Finland and Norway had to go abroad to obtain the highest level of technical education before around 1910 (Andersen, 1987; Grönberg, 2019, p. 130–140; Myllyntaus, 2003; Nerheim et al., 1999, pp. 119–122; Pedersen, 2012). As this was not the case in Sweden, geographical location combined with a multitude of options presumably mattered.

### 4.2. Surveying, agricultural, and other studies

Many graduates continued to study to become surveyors. As a consequence of the ongoing agricultural land reforms and infrastructural investments like railway building, the demand for persons with the competence to measure and chart land grew. Studying surveying was significantly more common among Borås graduates before 1890, after which, the differences between the two schools levelled out. Surveying studies almost exclusively took place in Sweden. Only one graduate studied the subject abroad. Malmö’s vicinities offered good possibilities to study surveying. Before 1890, 16 Malmö graduates studied surveying after two years, and most of them pursued their studies in Scania. These patterns were similar among the graduates studying surveying after five years and also in the later period. However, Malmö graduates who still studied surveying after 10 years had generally left the school province. The Borås alumni, on the other hand, generally conducted surveying
studies outside the school region regardless of whether they were two, five, or 10 years ahead in their careers, and regardless of whether they had left school up to 1890, or thereafter. Many conducted their studies in northern Sweden (Norrland), often to take over a position as assistant and later chief land surveyor.

In contrast to the study of surveying, agricultural studies were more common among the Malmö alumni: There were no agricultural students among the Borås graduates from 1891 and onwards. Agricultural studies were often conducted through apprenticeships on farms and estates: The few agricultural students from Borås went to farmhouses in Västergötland, Halland, Småland, Scania, and single graduates to the Almarp agricultural school by Malmö. This school, of course, was frequented more by the Malmö alumni and contributed to the above-mentioned patterns. However, countryside farms and estates in Scania also received graduates from Malmö’s technical secondary school as apprentices.

Typical of other studies was that they often took place abroad. Except for the Borås alumni from the earlier period, at least half of the graduates conducting this kind of study did so abroad. The most frequented country was, also in this context, Germany. Graduates went there to study, for example, chemistry, and brewing. Nevertheless, the United Kingdom and the United States were almost equally important: the latter to some extent because permanent emigrants educated themselves in different branches after they had settled. Taking into consideration that there are many undefined studies, we can note that some graduates deepened their studies in mechanical and electrical engineering, for example at the vocational schools of the large American electro-technical companies Westinghouse and Allis-Chalmers. France was another relatively common destination. A few graduates studied arts in Paris. Denmark was more important for the Malmö alumni in this group, compared to the technical university studies, but the crossings of the narrow strait to Copenhagen were still not as frequent as one could have assumed. Lower-level technical schools and the Danish Academy of Arts are Copenhagen-based institutes hosting graduates from Malmö.

Especially before 1890, some graduates also continued at the Royal Swedish Academy of Fine Arts, probably to become architects. Domestic migration for other studies was often destined for Stockholm, and apart from the above-mentioned arts academy, graduates also went to the military academies at Karlberg and Marieberg. Others went into university studies in places such as Uppsala, Lund, and abroad, and some studied at general grammar schools. We can note one pattern typical of the Borås alumni: studies connected to the textile industry, in the city itself, but also in, for example, Germany. A few Borås graduates also went into pharmacy and other medical studies, whereas no one from the Malmö alumni studied in these fields. The opposite was true for navigation. Some graduates from Malmö continued their studies at the city’s navigation school, whereas none from Borås studied this field.

To sum up, fewer graduates continued to study during the period 1891–1920. The abandonment in the late 1870s of the aim to prepare for higher technical studies constitutes one part of the explanation. Another reason was the increasing importance of human capital and skill after the Swedish industrial breakthrough after 1890 (Schön, 2000). Technical secondary school skills were entirely sufficient to enter the labour market as a foreman, a supervisor, or a middle manager. Therefore, the incitements for further studies hypothetically decreased. A well-paid job attracted more.

5. Concluding discussion

Goldin and Katz (2009) conclusion that the industrialisation meant a deskilling process has been widely acknowledged but has also in recent years been challenged by other researchers, for example, Mokyr and Voth (2009), Squicciarini and Voigtländer (2015), de Pleijt et al. (2020), and Diebolt et al. (2021), who all point to the importance of distinguishing between general knowledge among the majority and special knowledge of a minority. In line with these recent findings, this article aims at shedding light upon Swedish aspirations to accelerate industrialisation through the establishment of intermediate-level technical education.
When the Swedish Parliament discussed the locations of technical secondary schools in the 1850s, the focus lay on the schools’ possibilities to provide youth from different parts of Sweden with intermediate-level technical education nearby. Implicitly, upon graduation, the graduates were supposed to work in the regions that the schools served. In this article, we have discussed how the technical secondary schools in Malmö and Borås lived up to these aims during their entire period of existence from the 1850s to the 1920s.

The students’ birthplaces clearly show that the two schools at least lived up to the aim to provide local and regional youth with intermediate technical education. Although the share of students arriving from other parts of Sweden increased over time, the share of students born in the school’s regions never fell short of 80 per cent in Malmö and 60 per cent in Borås, the latter reflecting the fact that Borås was closer to home for most of Sweden’s population.

The conclusion that the schools fulfilled the aim to educate for local and regional industry and craft is less clear when we look at the geographical mobility patterns upon graduation. Half of the Malmö graduates had their careers outside the school region 10 years upon leaving school. The Borås share was even higher; two-thirds had left after 10 years, and a little more than every second Borås graduate had left the school region already two years upon graduation. These differences persisted over time, but it became more common to seek living outside the school regions from the 1880s and onwards. Some went abroad, Malmö graduates often to relatively speaking nearby Germany, whereas the textile industry link and more transatlantic connections in general probably explain Britain’s and the United States’ popularity among the Borås graduates. The differences between the schools were, however, rather small when it came to emigration; about every sixth–seventh graduate was abroad after two years, and every fifth after five and 10 years, respectively.

Regardless of school region, the brain-drain was not necessarily problematic because it is more relevant to speak of a ‘brain-exchange’. Graduates from technical schools in other parts of Sweden came to the Malmö and Borås school regions. There were for example 353 technicians working in Malmöhus County in 1908, of whom 237 were educated elsewhere than in Malmö. In Älvsborg, Borås’s County, there were 184 technicians of whom 141 had not graduated in Borås (SOU, 1918:10, p. 10, p. 519). Migration out of the school regions among Malmö and Borås graduates as well as in-migration of technicians educated elsewhere are both in line with the mobile mentality and the readiness for within-country migration among the highly educated. Nevertheless, the study clearly shows that the Malmö school region provided better conditions to keep technicians in the vicinity over time. This was probably because Malmö was larger and a growing city with a more diversified labour market. The Malmö graduates had more opportunities for a career within new sub-branches such as gas and water purification works and, later on, electrical power stations. On the other hand, a clear majority of the graduates from both schools worked in industry and craft already during the early industrialisation and to an even higher degree after the industrial breakthrough after 1890. The schools thereby fulfilled one of their major aims, to provide industries and crafts with a technically educated workforce. It is reasonable to include the graduates in the technically able and inventive minority that Mokyr (2005) and Mokyr and Voth (2009) describe as carriers of the Industrial Revolution. The technical secondary schools, however, were not mediators of ‘upper-tail knowledge’ (de Pleijt et al., 2020; Squicciarini & Voigtländer, 2015) in the sense that they educated eminent scientists. Still, in terms of the general state of knowledge, the education was relatively advanced. Not least, the schools adjusted their education as the industrialisation, and technical development progressed. Official reports from the 1870s and the early twentieth-century emphasised the importance of the technical secondary school training for positions as foremen, works managers, and supervisors. This emphasis leads us to conclude that it is relevant to use Diebolt et al.’s (2021) intermediate human capital to describe the technical secondary schools’ education, but it is not self-evident that this education was sufficient enough to exploit Sweden’s full industrial potential. Ahlström (1992, p. 7) judges that the numbers of engineers in Sweden in the latter part of the nineteenth century ‘succeeded fairly well in satisfying industry’s
demand for qualified engineers and technicians’. In the earliest years after 1900, however, critical voices centred on the education for middle-range positions and the low number of graduates from the technical secondary schools: the proportion of engineers in the industry was much lower than in the admired Germany (Ahlström, 1992, pp. 7–10). A governmental inquiry concluded that the Swedish below-university level technical education had not kept the same pace of development as the industry from the 1870s. Many early twentieth-century industries employed technicians from foreign technical schools in managerial positions. A majority was almost certainly Swedish-born graduates returning from technical education abroad. This pattern was especially relevant at the sugar and malt drink factories, in the electro-technical industry, and at dye-works (SOU, 1918:10, p. 10, p. 30–32).

The schools were located in regions with different traditions and prerequisites for industrialisation. Malmö was not only larger and faster-growing than Borås, but it was also the centre of Sweden’s most fertile province characterised by food production. Sugar factories were common in the Scania countryside, and the food and stimulant industry was important for the Malmö graduates. Borås, on the other hand, was the centre of a region with a long tradition of textile production as well as located close to emerging pulp and paper industries around Lake Vänern and in Småland. Consequently, these industries absorbed more graduates from Borås than from Malmö. Borås graduates were more inclined to employment in industry and craft, and some local and regional industries utilised graduates from the city’s technical secondary school. There are, nevertheless, reasons to ascribe greater importance to the Malmö school for local and regional industries and crafts. Significantly more often, Borås graduates had industrial employment in the rest of Sweden, that is, in areas that were closer to other technical secondary schools.

The introduction of electricity to factories as well as lighting in the streets meant a significant increase in job opportunities over time. Västerås-based ASEA was the leading company, but they also had domestic competitors with headquarters in Stockholm and Ludvika. Perhaps more than any other field, electricity symbolises Sweden’s shift from emerging industrialisation within the framework of the agricultural society to a large-scale industrial breakthrough leading up to the twentieth century’s modern industrial welfare society. A small, but important, observation in this context is the fact that almost none of the graduates from two of the country’s four technical secondary schools worked in the electrical field before 1890. In the decades from 1890 up to the 1920s, the corresponding share roughly lay between 12 and 17 per cent. Other emerging branches, such as chemical and pulp and paper industries, showed similar patterns, although not as marked.

It is more or less self-evident that entrepreneurship was viewed as a positive potential spin-off of the technical secondary schools. About one Borås graduate in eleven had his own business 10 years upon leaving the school up to 1890. This was a higher share, compared both to Malmö graduates and the later period. We can note domination of industrial entrepreneurship and that it often took place in the school cities and provinces. This is possibly a positive local and regional spin-off of the technical secondary schools, even if it is difficult to ascertain the short-term and long-term economic effects.

Sweden’s educated intermediate-level technicians met a different reality after around 1890. Large-scale industrialisation seemingly diminished the need for further studies; graduates could, to a larger extent, get employment immediately upon graduation. Before 1890, between one-fourth and one-third of the graduates were studying at other institutions or practising two years upon graduation. The schools, however, were hardly successful in preparing for the Royal Technical Institute. Few studied there, and Malmö graduates went instead increasingly to Germany. During the later period, fewer than 10 per cent continued studying. The industrialisation process does not, however, give the full picture. The abandonment in the mid-1870s of the technical secondary schools’ responsibility to prepare for higher technical studies also contributed.
Acknowledgement

During the work for this article, we have been fortunate to be able to discuss aspects with many fellow economic historians and historians. We would especially like to acknowledge Anders Nilsson and Pål Thonstad Sandvik as well as the journal’s anonymous reviewers.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This work was supported by Vetenskapsrådet: [Grant Number 2014-01993].

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Appendixes

Appendix 1

Sweden—school regions of the technical secondary schools in Malmö (blue) and Borås (green). The circles show the school cities, the darker coloured the school provinces and the lighter coloured the nearby areas.
## Appendix 2

Distribution of graduates on county and country level.

| County/Country                  | Malmö           |       | Borås           |       |
|---------------------------------|-----------------|-------|-----------------|-------|
|                                 | 2 yrs           | 5 yrs | 10 yrs          | 2 yrs | 5 yrs | 10 yrs |
| Sweden                          | 84.6            | 77.9  | 79.1            | 87.2  | 77.3  | 79.2   |
| Southern (Götaland)             | 72.3            | 62.4  | 60.1            | 56.9  | 45.1  | 45.3   |
| Östergötland                    | 1.0             | 0.7   | 0.9             | 1.8   | 1.5   | 2.0    |
| Jönköping                       | 0.6             | 1.1   | 1.2             | 5.1   | 5.1   | 4.3    |
| Kronoberg                       | 1.5             | 1.8   | 1.6             | 0.4   | 0.3   | 0.3    |
| Kalmar                          | 0.8             | 1.0   | 1.2             | 2.1   | 1.2   | 1.2    |
| Gotland                         | 0.1             | 0.1   | 0.4             | 0.0   | 0.0   | 0.2    |
| Blekinge                        | 3.0             | 2.4   | 1.9             | 0.7   | 0.8   | 1.1    |
| Kristianstad                    | 4.1             | 4.8   | 5.5             | 0.6   | 0.6   | 0.5    |
| Malmöhus                        | 57.2            | 45.8  | 40.9            | 2.5   | 2.4   | 3.5    |
| Halland                         | 0.6             | 1.2   | 0.9             | 2.8   | 2.6   | 3.1    |
| Gothenburg and Bohuslän         | 2.2             | 1.9   | 3.5             | 8.2   | 7.1   | 8.0    |
| Älvsborg                        | 0.5             | 0.7   | 1.2             | 26.3  | 18.8  | 16.9   |
| Skaraborg                       | 0.7             | 0.9   | 0.9             | 6.4   | 4.7   | 4.2    |
| Central (Svealand)              | 10.8            | 13.0  | 14.8            | 27.4  | 28.9  | 28.3   |
| Stockholm City and County       | 6.9             | 7.6   | 8.2             | 10.9  | 14.0  | 12.5   |
| Uppsala                         | 0.2             | 0.2   | 0.2             | 1.2   | 1.1   | 1.8    |
| Södermanland                    | 0.1             | 0.5   | 0.9             | 0.3   | 0.9   | 1.7    |
| Värmland                        | 0.2             | 0.5   | 1.0             | 7.2   | 5.9   | 6.4    |
| Örebro                          | 0.4             | 1.3   | 1.0             | 1.9   | 1.2   | 1.5    |
| Västmanland                     | 2.5             | 2.2   | 2.0             | 3.1   | 3.5   | 2.3    |
| Dalarna                         | 0.5             | 0.7   | 1.5             | 2.8   | 2.3   | 2.1    |
| Northern (Norrland)             | 12.2            | 2.4   | 3.9             | 2.6   | 4.7   | 5.9    |
| Gävleborg                       | 0.6             | 1.2   | 1.9             | 0.6   | 2.4   | 2.1    |
| Västernorrland                  | 0.2             | 0.6   | 1.1             | 1.2   | 0.6   | 1.1    |
| Jämtland                        | 0.2             | 0.2   | 0.5             | 0.3   | 0.9   | 1.4    |
| Västerbotten                    | 0.1             | 0.0   | 0.2             | 0.3   | 0.3   | 0.5    |
| Norrbotten                      | 0.1             | 0.4   | 0.1             | 0.1   | 0.5   | 0.8    |
| unknown in ‘Norrland’           | 0.0             | 0.0   | 0.1             | 0.1   | 0.0   | 0.0    |
| Abroad                          | 15.2            | 21.7  | 20.7            | 12.8  | 21.2  | 20.0   |
| Denmark                         | 1.4             | 0.7   | 0.5             | 0.0   | 0.0   | 0.2    |
| Finland                         | 0.0             | 0.1   | 0.6             | 0.3   | 0.5   | 0.8    |
| Norway                          | 0.1             | 0.4   | 0.5             | 0.3   | 0.5   | 0.8    |
| German-speaking Europe          | 8.1             | 10.1  | 6.5             | 3.4   | 3.6   | 2.0    |
| Russia                          | 0.2             | 0.5   | 0.9             | 1.3   | 1.8   | 1.5    |
| United Kingdom                  | 0.4             | 0.9   | 0.9             | 0.7   | 2.4   | 1.5    |
| Other European countries        | 0.2             | 0.9   | 0.9             | 0.0   | 0.2   | 0.2    |
| United States and Canada        | 3.4             | 6.8   | 8.1             | 6.7   | 12.0  | 12.7   |
| Other overseas countries        | 0.4             | 1.0   | 1.5             | 0.0   | 0.3   | 0.5    |
| Undefined abroad                | 1.0             | 0.2   | 0.4             | 0.0   | 0.0   | 0.0    |
| **Unknown**                     | 0.2             | 0.4   | 0.2             | 0.0   | 0.5   | 0.8    |
| **TOTAL**                       | 100.0           | 100.0 | 100.0           | 100.0 | 100.0 | 100.0  |

Sources: see Table 1.