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Teacher demand, teacher education, and teacher shortages. A new data set 1861-2024 for Norway

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Abstract

This paper documents the construction of a historical data set for Norwegian compulsory education covering more than 160 years from 1861 to 2024. The data include the number of students and teachers, teacher shortages measured by the share of teachers without the formal qualifications determined by law, and the number of admitted students and graduates from teacher education institutions. In addition to the national time series, we also present panel data at the county level at a five-year frequency covering the period 1870-1935. The construction of the data series is based on a historical description of the development of the compulsory education system, including school finance and teacher wage-setting institutions, in addition to the system for teacher education. The School Act of 1860 required that teachers should have formal teacher education or similar qualifications in order to be appointed to permanent teaching positions. Variants of this rule have been a legal constraint since 1860. The data constructed in this paper provides the basis for more detailed empirical analyses of the relationship between teacher shortages, fluctuations in teacher demand, and teacher supply as determined by the number of graduates from teacher education institutions.

1. Introduction

Empirical evidence confirms that teachers are the most important school-based factor for student learning (Koedel et al., 2015, Falch and Strøm, 2020, OECD, 2021). Consequently, policymakers all over the world invest considerably in enhancing the skills of the teaching workforce and several academic studies try to identify determinants of teacher qualifications and teacher shortages. Studies of teacher shortages include Goldhaber et al. (2020, 2021) and Clotfelter et al. (2023) for the US, Sims (2020) for the UK, Andersson and Waldenström (2007) and Andersson et al. (2011) for Sweden, and Bonesrønning et al. (2005) and Falch et al. (2009) for Norway.

Measures of teacher qualifications are context dependent. In most countries, entering a teaching position requires some form of certification. In some countries, like the US, the specific requirements in terms of completed programs vary by state. Other countries, like the Nordic countries, have national requirements.[1] The present paper constructs a consistent time series of teacher shortages in Norwegian public compulsory education from the school year 1861-62 to the school year 2023-2024. We use the share of teaching positions filled with persons without the required formal qualifications as our definition of shortages. The formal requirements were at first defined in the School Act of 1860, and the wording is basically unchanged in the revisions of the law thereafter. In addition to the construction of data on teacher shortages, this paper also provides data on the number of students and teachers in compulsory education and the number of admitted students and graduates from teacher education programs. The construction of the different data series are based on a historical description of the development of the compulsory education system, including school finance and teacher wage-setting institutions, in addition to the system for teacher education.

Researchers in education history have recently provided some descriptive and qualitative evidence on teachers' sources of income, their socioeconomic characteristics and teaching practices based on detailed micro-level information from different regions and historical time periods. Marklund (2021, 2023) and Westberg (2015, 2022) provide evidence on income sources and socioeconomic characteristics of Swedish teachers for the last part of the 19th century and the first part of 20th century, during periods with large expansions in compulsory schooling. Evertsson (2022) examines the impact of school inspections initiated by the central government on teachers' professional development and teaching practices in Sweden. Moore (2019) describes the role of government inspections on the development of the teaching profession in Austria during the expansion and secularization of the education system in the second half of the 19th century. These historical studies provide important insights into the

[1] A literature discusses the development of informal teacher qualifications. Studies of long-run patterns find falling trends in the academic ability of teachers over time in many countries, see Corcoran et al. (2004), Corcoran (2007), and Bacolod (2007) for US evidence, Leigh and Ryan (2008) for Australia, and Fredriksson and Öckert (2007) and Alatalo et al. (2021) for Sweden. Some US studies find that measured academic ability increases teacher contribution to student learning, see Clotfelter et al. (2006) and Goldhaber (2007). Recent cross-country evidence by Hanushek et al. (2019) points in the same direction, while Grönqvist and Vlachos (2016) report similar findings using Swedish data.

living conditions and institutional constraints facing the teachers and the teaching profession during periods with large institutional and political changes.

The construction of macro-level data series on teachers for a long time period in the present paper represents an extension of the current historical literature in two ways. First, the use of macro data combined with an extensive historical description of institutions enables us to consider in a direct way the relationship between teacher labor market characteristics and institutional development in terms of the wage-setting system, the school financing system, and the teacher education system. Second, the data series on key teacher labor market variables provide an important historical context for the current policy debate on teacher shortages and teacher education that takes place in many countries around the world.

Obtaining the formally required teacher qualifications takes time and is mainly determined by the capacity of the institutions providing teacher education and prospective students' motivation and interest in such studies. Thus, there is an important distinction between short-term and long-term mechanisms. The supply of qualified teachers in the short term is determined by a combination of the previous amount of teacher education graduates and the share of those graduates offering themselves for work as teachers. In the longer term, the capacity of teacher education programs and the propensity for young people to enter these programs are essential determinants of teacher supply. In other words, teacher shortages fluctuate both because qualification requires an educational investment and because formally qualified teachers make decisions on whether to work as teachers or not.

The introduction of formal requirements in 1860 in Norway implied that a large share of the persons in teaching positions was defined as unqualified. However, the rapid expansion of teacher education programs led to a sharp decline in teacher shortages, and after 2-3 decades teacher shortages were approximately equal to the long-term "normal" level. However, shortages varied substantially over time. Teacher shortages increased during the world wars. However, while teacher shortages declined rapidly after WW1, it continued to increase after WW2. During the recessions in the 1920s and 1930s, the excess supply of teachers led the government to reduce the number of students enrolled in teacher education programs dramatically. As a response to the baby boom after WW2 and school reforms, teacher education expanded massively. In recent decades, teacher shortages have fluctuated around the typical historical level.

The construction of time series for the number of students, teachers, teacher shortages and teacher education for compulsory education in Norway from the school year 1861-62 and to the present is based on a variety of historical sources. Although The School Act of 1860, which for the first time defined required teacher qualifications for rural schools, introduced a requirement for school districts to report on key school statistics to the government, the construction of complete time series for this long period faces a number of challenges. Some key information is available only each fifth year during the period from the school year 1875-76 to 1935-36, and little information is available for the period around WW2 and around 1960. Up to 1960, there were different legislations for urban and rural areas, and an increasing share

of the students lived in the cities. In the paper, we document the different methods used to deal with incomplete information and other practical challenges in order to obtain complete yearly data series.

The rest of the paper is organized as follows. Section 2 presents the conceptual framework for teacher shortages based on teacher demand and supply. Section 3 describes the historical context, and presents an overview of the key institutional changes most relevant for understanding the development of compulsory schooling and the teacher labor market in Norway. Sections 4 and 5 represent the main part of the paper and include detailed information of the construction of the different macro data series for the whole period 1861 to 2024. Section 6 includes a description of key compulsory school variables at the county level for the period 1870 to 1935, while Section 7 concludes. Appendix A presents overview of data sources and data adjustments. Actual numbers are presented in Appendix B and Appendix C.

2. A conceptual framework for teacher shortages

Shortages of qualified teachers reflects that the demand for teachers exceeds the supply of teachers. In other words, it is not possible to recruit qualified teachers for all vacant teaching positions. This section presents a conceptual framework similar to Bonesrønning et al. (2005), Ladd (2007), and Burgess et al. (2022).

Figure 2.1 illustrates the teacher labor market in the short term at the national level. The number of qualified teachers is given by previous teacher education graduates, denoted Q^{max}. The supply of qualified teachers is posititively related to the wage W because teachers have alternative job options. Teacher demand is the sum of the demands in the individual school districts and is downward sloping. Teacher wages are the major cost components for schools, and school district revenues are limited. Thus, higher wages reduce the demand for teachers.

At the wage level W^e, the market is in equilibrium in the sense that demand equals supply. There is neither excess demand nor excess supply. At the prevailing wage $\overline{W}$, the demand for qualified teachers is given by Q^D, while the supply is only Q^S. It is excess demand given by $Q^D - Q^S$.

An important question is how schools handle the situation of excess teacher demand. Given that students have the right to schooling, education must take place even though it is not possible to recruit a sufficient number of formally qualified teachers. Worldwide, it seems to be a common practice that teacher recruitment takes place in two steps. Firstly, the wage and the number of teacher positions are determined. Secondly, teachers are hired. In the second step, the best-qualified teachers are employed, and they might miss the formal qualifications.

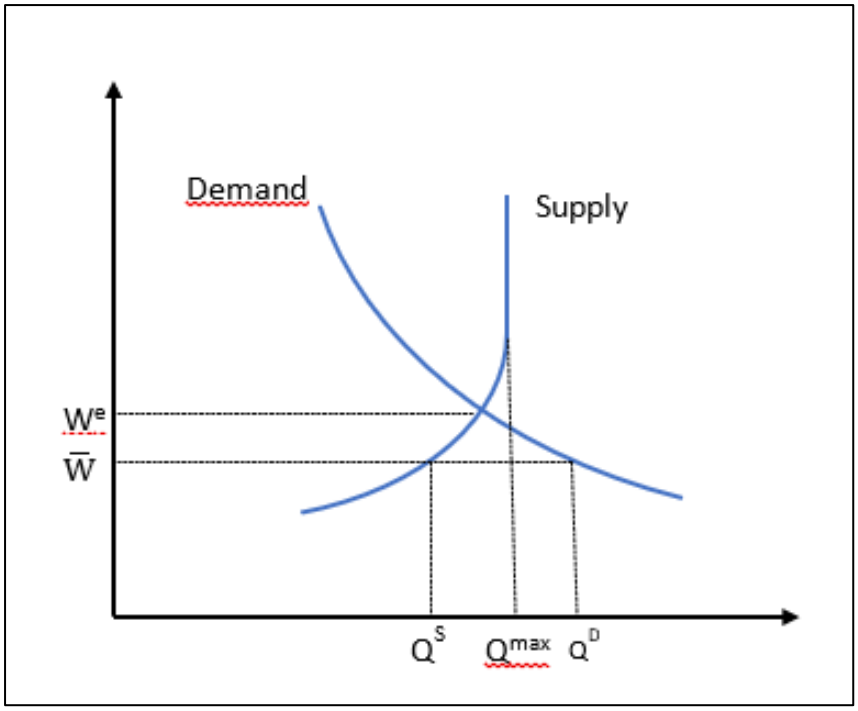

Figure 2.1. The teacher labor market and teacher shortages

Consequently, we define teacher shortages as the ratio of unqualified teachers to the total number of persons in teaching positions. Referring to Figure 1, that is $\left(Q^D - Q^S\right)/Q^D$. To measure the rate of teacher shortages at the national level, it is sufficient to measure Q^D and Q^S.

Since the 1860 Norwegian School Act, the school legislation has included a rule that schools can hire unqualified teachers in vacant teacher positions only if it is not possible to recruit a sufficient number of qualified teachers. Thus, in our data, Q^D is simply observed as the number of teachers. The main challenge of establishing a consistent time series for teacher shortages is the measurement of either the number of qualified teachers Q^S or the number of unqualified teachers $Q^D - Q^S$.

A change in teacher shortages must be caused by changes in demand, supply, or the prevailing wage. An important question is why the teacher wage does not adjust to the equilibrium level in the case of teacher shortages. Relevant mechanisms are rigid wage determination at the national level due to collective bargaining, long-term wage contracts, or other legal constraints on teacher wage flexibility.

In the case of national wage rigidities, regional imbalances may occur and cause shortages and surpluses to coexist in different regions. Figure 2.2 describes a stylized situation with two regions, a national teacher wage level $\bar{W}$ equal across regions, equal teacher demand in both regions, but lower teacher supply in region 2 than in region 1 due to some regional characteristics. The result is a teacher surplus in region 1, and consequently no teacher shortages there. Teacher shortages are only prevalent in region 2. However, since measures of

national teacher shortages count teacher man-years, the national teacher shortage is given by $\left(Q_2^D - Q_2^S\right)/\left(Q_1^D + Q_2^D\right)$. Even though teacher shortage is not prevalent in most regions, there will be some aggregate teacher shortages as long as teacher supply is low in some regions.

If the prevailing wage increases, there are three different mechanisms on teacher shortages in a regional setting. First, teacher supply will increase by movement upwards the supply curve. More teachers want a teacher position since teaching becomes more attractive compared to alternative occupations. Second, teacher demand will decline as employment moves upwards along the demand curve. Fewer teachers will be employed. Finally, since there are fewer teaching positions in region 1 some will be interested in teaching positions elsewhere. The supply of teachers increases in region 2, further reducing national teacher shortages.

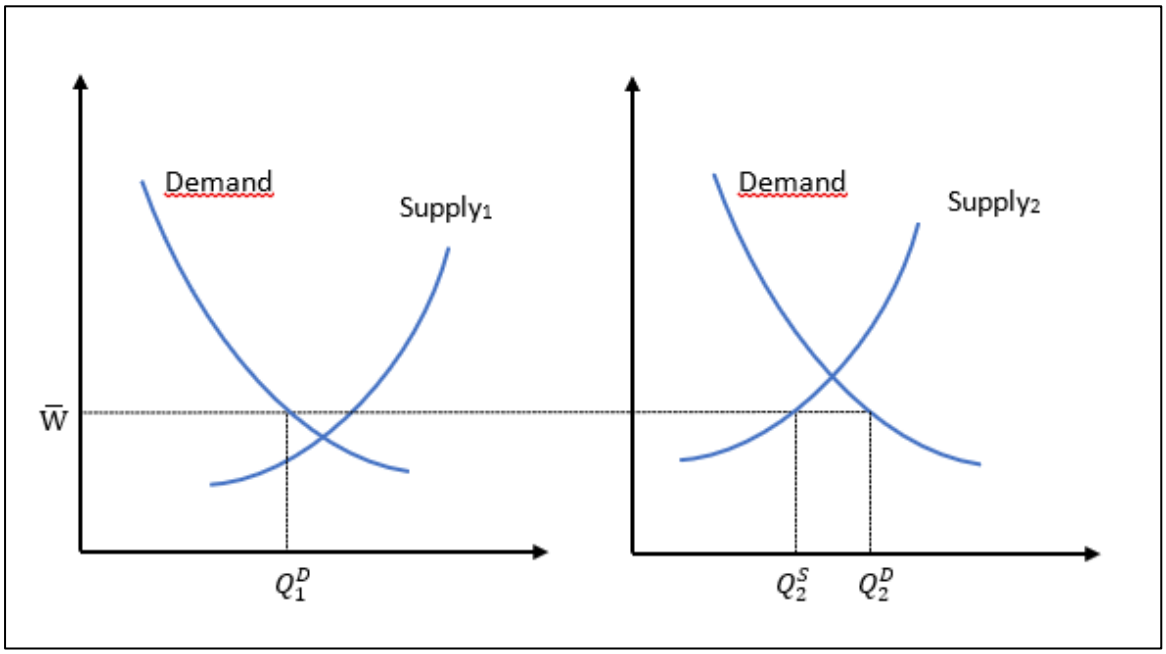

Figure 2.2. Regional imbalances and teacher shortages

3. Historical background and institutional setting

This section provides a description of the historical and institutional context for the construction of data series for the number of students, teachers, teacher shortages and teacher education in compulsory school.[2] After being a part of Denmark for four centuries, The Kiel peace treatment of January 1814 after the end of the Napoleonic Wars, implied that Norway should be transferred from Denmark to Sweden. In the transfer process from Denmark to

[2] The presentation in this section builds on the historical descriptions of compulsory schooling written in the Norwegian language. Key references are Dokka (1988), Hagemann (1992), Grankvist (2000), and Telhaug and Mediås (2003). In addition, the section draws heavily on the detailed review of the historical development in legislation concerning teacher appointments in Jakhelln (1995). Institutional descriptions in English include Falch and Rattsø (1999), Kvam (2014), Kvam (2018) and Skinningsrud and Skjelmo (2016), and the brief overview in a Nordic context in Imsen and Volckmar (2014).

Sweden, Norway established a separate Norwegian Constitution (*Grunnloven*) including an independently elected parliament (*Stortinget*). During the period in union with Sweden, 1814-1905, The Norwegian parliament was given substantial and increasing influence on the legislation and public policies in several areas, including economic issues, education, and infrastructure.

3.1. School system and legislation

Table 3.1 presents a brief description of the historical development of the legislation of the school system from the late 18th century up to the present. The first public school system started while Norway was still a part of Denmark. In 1739, King Christian VI issued the Ordinance for the rural school of Norway (*Skoleforordningen*) as part of the state-controlled pietism in Denmark-Norway. The 1739 School Act required public schooling for at least 3 months a year for all children between 7 and 10-12 years old. Combined with the Lutheran Church Confirmation established in 1736, it is fair to say that formalized religious education was introduced in rural areas in Norway.[3] The ambition was to teach the children some very basic skills in reading, writing, and arithmetic, in addition to knowledge of Christianity. However, there was substantial local resistance against the establishment of formal schooling because permanent schools and teacher salaries had to be financed by local taxes. As a compromise, in order to reduce the local financial burden, most of the education in rural areas took place in ambulatory schools (*omgangsskoler*) with teachers moving across certain farmhouses to teach the children. This illustrates the decentralized nature of compulsory schooling where funding and school organization were determined at the local level while the role of the central government was limited to providing a general legal framework. This is quite similar to the situation in Sweden in the 19th century as described in Westberg (2022).

The 1827 School Act passed by the Norwegian Parliament (*Stortinget*) partly represented a continuation of the older legislation, see Skinningsrud and Skjelmo (2016). §15 stated that compulsory schooling started when children were 7 years old (or 8 if the circumstances did not allow schooling from age 7) and lasted until confirmation.[4] §14 stated that the curriculum should consist of reading, writing, and basic arithmetic in addition to biblical history, reading the Bible, and singing Christian psalms. The church continued to be an important participant in primary education. Teaching in permanent schools was partly a responsibility of the parish sexton (*klokker*), while additional teachers and teachers in ambulatory schools had to be

[3] Section 1 in the 1739 School Act reads: «Ville Vi allernaadigst, at alle Klokkere i Vor Rige Norge skal efterdags, i Stæden for den i Lovens 2 Bogs I5 Cap. 2 Art. foreskrevne ugentlige Underretning i Børne-Lærdommen, være pligtige, efter Bispens Anordning og Præstens Anviisning, under deres Embedes Fortabelse, Sommer og Vinter at holde ordentlig Dansk Skole, og at underviise Ungdommen flittig i deres Christendom, Læsen, Skriven og Reignen, og ellers i alle Maader at forholde sig efter den Instruction, som Skoleholderne i Almindelighed Allernaadigst bliver foreskreven»

[4] §15 in the 1827 School Act reads: «Skolepligtige ere Børn fra det fyldte 7de, eller, hvor Omstændighederne lægge Hindringer i Veien for at Børnene i denne Alder søge Skolen, fra det fyldte 8de Aar, indtil de confirmeres, naar Sognepræsten finner det fornødent, at de søge Skolen saa længe. Skoleholdere, saavel i de faste Skoler, som i Omgangsskolerne, skulle holde en ordentlig af Sognepræsten auctoriseret Protocol over alle skolepligtige Børn, og deri anmærke Enhvers Alder, Fremgang og Forhold, samt de Forsømmelser og Uordener, der maatte finne Sted.»

approved by the parish minister (*sogneprest*), the dean (*prost*), and ultimately by the bishop (*biskop*). The clergy also had the overall responsibility for supervision of the education system.

Table 3.1. School legislation 1739-2024

Year	Name	School districts	Compulsory age
1739	Skoleforordningen	Rural areas	7-12/confirmation
1827	Lov angaaende almueskolevæsenet på landet	Rural areas	7/8-12/confirmation
1848	Lov om Almueskolevæsenet i Kiøbstæderne	Cities	7-confirmation
1860	Lov om Almueskolevæsenet paa Landet	Rural areas	8/7-confirmation
1889	Lov om folkeskolen i kjøpstæderne/ Lov om folkeskolen på landet	Two separate acts for rural areas and cities	7-14
1936	Lov om folkeskolen i kjøpstædene/ Lov om folkeskulen på landet	Two separate acts for rural areas and cities	7-14
1959	Folkeskoleloven	Common act for all school districts	7-14
1969	Grunnskoleloven	Common act for all school districts	7-16
1998	Opplæringslova	Includes the non-compulsory high school education	6-16
2024	Ny opplæringslov	Extends the rights to high school education	6-16

The 1848 School Act introduced formal legislation for public elementary education in urban areas (cities). Wealthy families in urban areas organized education privately, either by hiring private teachers or enrolling the children in private schools. Children from poor families on the other hand either had no education available or could possibly be enrolled in specific schools for the poor (*Fattigskoler*). Thus, the 1848 School Act introduced for the first time a national law regulating elementary education for all children in the cities. According to §13 in the 1848 School Act, children should enter school at age 7. In addition, the school act introduced formal qualification requirements for teachers in the cities. The teacher should have passed exams at a teacher college (*lærerseminar* or *lærerskole*) or similar exams that the bishop found satisfactory.

For rural areas, the School Act of 1860 introduced some main legislative changes. First, §63 of the law introduced qualification requirements for rural area teachers, similar to those in urban areas established already by the 1848 School Act. Details of the rural area requirements are described in §63 in the 1860 School Act.[5] The law also described how to deal with situations

[5] §63: «Som Lærere ved Kredsskolerne ansættes i Almindelighed kun de, som have bestaaet theoretisk og practisk Afgangsprøve ved et Seminarium eller en Lærerskole, eller som have underkastet sig en lignende Prøve, hvis Indhold og Form bestemmes af Kongen eller den, han dertil bemyndiger. Naar der til ledige Lærerposter ved Kredsskolerne ikke melde sig duelige og velskikkede Ansøgere, som have bestaaet nogen saadan Prøve, skal der

without formally qualified applicants for vacant teacher positions. In such cases, applicants with some specific education above compulsory education should be prioritized.[6]

Second, §3 in the law states that teaching should normally take place in permanent school buildings while teaching in ambulatory schools could be used only under specific circumstances.[7] Third, the 1860 Scool Act circumvented the school starting age in the earlier 1827 School Act. § 49 in the 1860 Act states that yearly schooling is mandatory from age 8, while the school authorities can enroll children from age 7 in special circumstances.[8] Schooling is mandatory up to confirmation, normally at age 14. In addition, §50 allowed parents to educate their children themselves, conditional on timely notification to the school authorities.[9]

The clergy continued to have some formal role in the organization of education as teachers continued to be formally approved and appointed by clergymen, but the responsibility of secular authorities represented by the local governments (*kommuner*) increased. The law also reflects the gradual secularization of education in the 19th century with increasing emphasize in the curriculum on subjects like history, literature, basic mathematics, and natural sciences at the expense of knowledge of Christianity and reading the Bible. Finally, the law required that the rural school authorities should report key statistics and a description of the situation in the schools to the Ministry of Education[10].

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ved Ansættelsen tages fortrinligt Hensyn til Saadanne, som have gjennemgaaet idetmindste den lavere Afdeling i en høiere Almueskole og et eetaarigt Øvelsescursus som Lærerlærling ved en Skole, hvis Lærer af Stiftsdirectionen er bemyndiget til at antage Lærerlærlinge til Veiledning.»

[6] §63 of the 1860 School Act reads: «Som Lærere ved Kredsskolerne ansættes i Almindelighed kun de, som have bestaaet theoretisk og practisk Afgangsprøve ved et Seminarium eller en Lærerskole, eller som have underkastet sig en lignende Prøve, hvis Indhold og Form bestemmes af Kongen eller den, han dertil bemyndiger. Naar der til ledige Lærerposter ved Kredsskolerne ikke melde sig duelige og velskikkede Ansøgere, som have bestaaet nogen saadan Prøve, skal der ved Ansættelsen tages fortrinligt Hensyn til Saadanne, som have gjennemgaaet idetmindste den lavere Afdeling i en høiere Almueskole og et eetaarigt Øvelsescursus som Lærerlærling ved en Skole, hvis Lærer af Stiftsdirectionen er bemyndiget til at antage Lærerlærlinge til Veiledning.»

[7] Part of §3 reads: «…..Hvor Kredsens Bosteder ligger mere adspredte, eller Stiftsdirectionen efter Forestilling fra Skolecommissionen finder, at andre Hensyn gjøre Skolehold i eget Locale utilraadeligt, kan Skolen holdes som Omgangsskole, dog at forsvarlig Locale dertil afgives…..»

[8] §49 reads: «Skolepligtige ere Børn fra det fyldte 8de Aar indtil de udskrives af Skolen. Skolepligten gjælder for hvert Aar kun i den ifølge § 6 fastsatte Skoletid. Udskrivning af Skolen foregaaer i Regelen ved Barnets Confirmation. Tidligere kan Udskrivning skee, naar Barnets Forsvar forlanger det, Barnet har fylt sit 13de Aar, og Skolecommissionen finder, at det har naaet den fornødne Kundskab og Udvikling. Udskrives et Barn af Skolen før Begyndelsen af dets Forberedelse til Confirmation, er dets Forsvar pligtig til at sørge for, at Barnet vedligeholder sin Christendomskundskab. Skeer ikke dette, kan Barnet paany af Præsten henvises til Skolen. Under særegne Omstændigheder kan Indskrænkning i det enkelte Barns Skolegang eller Fritagelse for at deeltage i et enkelt Underviisningsfag tilstaaes af Skolecommissionen og midlertidig af Sognepræsten. Ligesaa kan Skolecommissionen, naar den finder, at locale og andre Omstændigheder tillade det, fatte Beslutning om, at Børn, der have fyldt deres 7de Aar kunne tilstedes Adgang til Skolen.»

[9] §50 reads: «De Forældre eller Foresatte, der enten selv undervise eller ved Andre lade undervise de Børn, de have at opdrage, i de for Kredsskolerne bestemte Gjenstande, kunne, naar de itide anmelde det for Skolecommissionen, fritages for at sende dem i Almueskolen, men skulle dog lige med Andre deeltage i de Udgifter og Byrder, som det almindelige Skolevæsen kræver. Hvis Skolecommissionen finder, at noget Barn forsømmes, skal den henvise det til den almindelige Skole.»

[10] §82 reads: «Skolecommissionerne og de specielle Bestyrelser for de høiere Almueskoler skulle aarlig indsende Beretninger om Skolevæsenets Tilstand, affattede efter anordnrde Schemata, til Stiftsdirectionen, som derefter selv til vedkommende overordnede Myndighed aarlig indgiver Beretning om Almueskolevæsenets Tilstand i det hele Stift».

A revision of the school act in 1869 allowed for the employment of female teachers in rural areas. At the time, females had been teaching in cities for decades and accounted for almost 50% of the teachers.

The development towards a more secular school continued with the 1889 School Act, in separate laws for rural and urban areas. This 1889 School Act established the concept of public primary schools (*Folkeskole*) for all children between 7 and 14 years old. In addition, the minimum length of the school year expanded. Thus, it is reasonable to conclude that by the 1889 reform, fully implemented by the school year 1892-93, Norway had established public primary education for all between 7 and 14 years old.

The compulsory school system consisted of different tracks similar to that in Sweden, see Fischer et al. (2020). After finishing the first four grades in *Folkeskole*, children could switch to an academic track called *Middelskole* (lower secondary school) lasting for up to six years[11]. After six years in lower secondary, they could enter upper secondary schools (*Gymnas*), which was a requirement for university enrolment. The tracking system was largely abolished in 1920 when the national parliament introduced the requirement of a comprehensive primary education (*enhetsskole)* as a condition for receiving financial support from the state.

The next main change took place with the 1936 School Act, which continued to have different laws for rural and urban areas. However, this law made public compulsory education in rural areas more similar to urban areas both in terms of instruction time (minimum number of school days increased in rural areas) and class size (maximum class size reduced to 30 pupils in rural areas, similar to the cities).

After WW2, the 1959 School Act represented a further movement towards a common system for primary education in rural and urban areas with a common legislation for all schools in the country. The 1959 law also prepared the way for a comprehensive school system for pupils aged 7-16, which was gradually introduced by the local governments. The intention in the 1959 legislation was to combine a comprehensive school system with internal tracking (*kursplan*) in the last years of comprehensive schools. This internal tracking implied that after ending grade 7 at age 14, the children could choose between two years in an academic track (*Kursplan 3*) or two years in a less academic track (*Kursplan 1* or *Kursplan 2*). Completion of the academic track (*Kursplan* 3) was a requirement for enrollment into upper secondary schools (*Gymnas*) and subsequently into higher education.

The comprehensive school system for ages 7-16 was formally enacted in the 1969 School Act. The extension had been gradually introduced in the local governments from 1959 on and the process was complete by 1974. The law abolished internal tracking, which implies a comprehensive compulsory education with an equal curriculum for all students.

[11] This was changed to the first five years in *folkeskole* from 1896, and the length of the *middelskole was* reduced from 6 to 5 year from the same year, see Hagemann (1992, p. 175).

The most recent major change took place with the 1998 School Act, which formalized the extension of the length of compulsory schooling by one year from ages 7-16 to 6-16, implemented from the school year 1997-98. This school law was an extension compared to the previous laws by including upper secondary education, i.e., the non-compulsory grades 11-13. A new School Act will be implemented in 2024, which expands the rights in the non-compulsory upper secondary education.

An important, but difficult question is to identify determinants of institutional shifts in school system and school legislation. A common argument is that compulsory schooling is a way to enhance nation-building and to instill certain civic values in the population. Bandiera et al (2017) provide evidence in support of this hypothesis exploiting variation in school legislation in the US states from 1850 to 1914. Another hypothesis inspired by the political economy literature is that education reforms and legislation changes is determined by the political strength and composition of the government and the parliament.Falch and Rattsø (1999) investigate determinants of the Norwegian school reforms in the period 1880-1990, including, in addition to the new legislations in Table 3.1, some extensions of the school year. They find that the probability of reform is positively related both to the share of socialists in the national parliament and whether the government has a majority in the parliament or not, and it is negatively related to the duration of the government in power.

3.2. Teacher education

Qualification to the teaching profession requires an investment in the form of teacher education. Shortages of formally qualified teachers as a concept is closely linked to the inherent educational investment.

Table 3.2 provides a brief description of the historical development of teacher education in Norway. Teacher education programs in different regions of the country were introduced during the 19th century, see Dahl (1959). From the beginning of the 19th century, alternative routes to obtain the required teacher skills existed. According to §8 in the School Act of 1827 for rural areas (later replaced by the 1860 School Act) the central government became responsible for the establishment, localization, content, and financing of teacher education colleges.[12] §9 in the law states that teacher education programs at existing institutions were eligible to receive government grants to finance their activity.[13] §63 in the 1860 School Act stated that one could obtain a teacher position either by having completed education (passing exams) at a teacher college (*lærerseminar* or *lærerskole*) or by taking similar exams with a

[12] §8 in the 1827 School Act reads: «Efterhaanden, som Oplysningsvæsenets Understøttelsesfonds Indtægter tillade det, skal der i Stiftstæderne, eller paa andre passende Steder, oprettes Læreanstalter, hvor der gives dem, der attraae at ansættes til Kirkesangere ved Hovedkirker, og til Lærere ved faste Skoler, en til deres bestemmelse passende Dannelse. Disse Læreanstalters Antal, Indretning og Varighed, Stederne hvor de skulle oprettes, Underviisnings-Gjenstanderne ved samme, og Valget av Præster og andre Lærere, som derved ansættes, samt disses Løn, bestemmes av Regjeringen, efterat den har indhentet Stiftdirectionens Betænkning».

[13]The last part of §9 in the 1827 School Act reads: «Læreanstalter, der allerede ere opprettede, skulle ligeledes, forsaavidt de findes hensigtsmæssige, have Adgang til de fornødne Bidrag af Oplysningsvæsenets Understøttelsesfond»

content and curriculum approved by the Ministry. This allowed privately organized institutions to contribute to the education of teachers, see Tveiten (1994).

The first state-financed teacher college providing a teacher education program of two years was established in 1826 (*Trondenes seminar*, later moved to Tromsø). By 1875 there were six main regional institutions. The main programs of the time were two-year studies. Some private institutions with similar structures and curricula were established in the 1890s. The government institutions provided programs free of charge, while students at private institutions had to pay tuition fees. The number of applications typically exceeded admissions, i.e., the supply of study places determined the actual number of graduates. The government decided on the number of new students at each institution.

In addition, several private institutions provided shorter teacher education programs. By 1875, there were 8 such institutions. Further, a program for female teachers for the first four grades in school existed. All these programs were gradually closed down during the first two decades of the 20th century.

Table 3.2. Teacher education for compulsory education, 1800-2024

Period	Institutions	Minimum qualifications	Length of the education
-1920	*Lavere lærerprøver* and similar	Primary education	Typically 1 year
1826- 1901	*Lærerseminarer*	Primary education	2 years
1902-1929	*Lærerskoler*	Primary education	3 years
1930-1975	*(Statens) Lærerskoler*	Compulsory education	4 years
1936-1945	*Lærerskoler*	High school	2 years
1946-1959	*Statens lærerskoler*	High school	2 years, but a third year as a regular teacher in some colleges
1960-1975	*Lærerskoler*	High school	Both 2- and 3-year programs
1976-1991	*Lærerskoler*	High school	3 years
1992-2016	Regional University Colleges	High school	4 years bachelor
2017-	Universities and University Colleges	High school	5 years master

Teacher education expanded to a three-year program in 1902 and to a four-year program in 1930. Few formal requirements existed for admission to teacher education programs except for completed compulsory education and passing an entrance exam. In practice, competition for study places implied that most of the admitted students had some additional education, see also the overview of teacher education in Møglestue (1977, p. 14-15).

In 1936-37, a new two-year teacher education program based on a diploma from high school (*Gymnas*) was introduced. At the time, there existed 7 state and 3 private teacher colleges. By 1947, all teacher education was provided by public institutions. In the period from 1945 to about 1959, some of the teacher education institutions included a practice year between the first and the second year as an ad hoc solution to deal with the major shortages of qualified

teachers in schools in the first part of the post-WW2 period. In effect, the students used three years to finish their teacher education in these cases.

After WW2, the capacity of teacher education for compulsory schools expanded substantially. Eight new teacher colleges were established in the period 1953-1973, including colleges in the larger cities Bergen, Trondheim, and Stavanger.[14] During the 1970s, both the two-year and four-year programs were removed and replaced by a three-year program based on the diploma from high school. The study expanded to four years in 1992 and to five years in 2017. The teacher colleges typically merged into more general regional colleges in the 1990s.

Teacher education to non-compulsory education, i.e., upper secondary schools (*gymnas* or *videregående skole*), has traditionally been the responsibility of the universities. Students with disciplinary education at universities could add on pedagogical courses in order to be qualified for teaching in upper secondary schools. By the expansion of compulsory education from 7 to 9 years in the 1960s, university-educated teachers became formally qualified to teach the three last years in compulsory education, i.e., in lower secondary education. By the reduced starting age from 7 to 6 years of age in 1997, pre-school teachers with some additional courses became formally qualified to teach the first four years of primary education.

Since the requirement of teacher education was introduced in the School Acts of 1848 and 1860, the specification of the requirements was quite similar up to the act of 1998. The rule is basically that formal qualifications are required for employment as a teacher. In practice, this implies completion of a teacher education program provided by public or private institutions regulated and financed by the state. The School Act of 1998, introduced some flexibility, and the specifications were delegated to specific regulations.[15] These regulations states that teachers should have teacher education or corresponding competence.[16]

3.3. School financing

The financing system of public primary education also underwent considerable changes during the long period covered in this paper. [17] Initially, all funds were raised at the local government level, with one specific fund for school expenditures (*skolekasse*), another fund for poverty relief expenditures (*fattigkasse*), etc. These funds were administered by separate boards (*skolekommisjon* and *fattigkommisjon*) and financed by separate taxes with property as the tax base. The School Acts of 1860 and 1889 implied that the local governments (*Kommune*) received central government grants administered by the county (*Amt*), with the intention to initiate the building of permanent schools and to finance parts of teacher salary.

[14] In addition, the relatively small private teacher college in Oslo was taken over by the state in 1947 and expanded.
[15] The School Act of 1998 describe the requirements as "relevant professional and pedagogical competence (§ 10-1) and "the Ministry gives more detailed requirements [.] for different grades and different types of schools" (§ 10-2, authors translation).
[16] The regulation (*Forskrift til opplæringslova, present version dated 23.06.2006*) is very detailed after the general remark of «pedagogical background in line with the requirement in framework plan of the teacher educations [,], or corresponding pedagogical competence" (§ 14-1, authors translation).
[17] The historical description of the financing system is partly based on Falch and Rattsø (1997) and Falch et al. (2022).

The Tax Act of 1882 instructed the local governments to have an overall budget and one single account system covering all activities. The act made local income taxation compulsory and introduced property tax rate caps. According to Borge (2010), the income tax was the most important local tax in 1900 (about 60% of tax revenues), while central government grants amounted to about 10% of total local government revenues. The tax rate varied substantially across the local governments. The local fiscal autonomy regime came under pressure because of increased income tax rate variation and debt crises during the recession after WW1. Redistribution concerns raised the demand for national redistributive schemes. After the introduction of some ad hoc schemes during the 1920s, a new national revenue-sharing regime was initiated by the establishment of the tax equalization fund (*Skattefordelingsfondet)* in 1936.

With the expansion of welfare services provided by local governments after WW2, the process towards revenue equalization and reduced local taxation autonomy continued. According to Borge (2010), by 1980 the central government grants amounted to approximately 40% of local government revenue. After 1970, income tax rates have not varied across governments since all use the maximum allowed rate, while there is some limited discretion left for property taxation. Falch and Tovmo (2003) show that while the correlation between local per capita income and local government spending was strongly positive in 1934-1935, it gradually decreased and became negative from the 1970s.

The present equalization system, initiated with a major grant reform in 1986, consists of a single block grant scheme, where the block grant is determined mainly by demographic variables (e.g., population and population age shares) and differences in the income tax base. However, the local governments have considerable discretion in allocating the total revenues across different expenditure items, where compulsory education and health care are the largest services.

3.4. Teacher wage setting

In the first part of the 19th century, teacher wages were determined by the local authorities. Later on, minimum wages for teachers in rural and urban areas were introduced. According to §27 in the 1860 School Act, the determination of minimum wages per week of schooling was delegated to the county authorities.[18] In addition to monetary salaries, §24 required each local government to provide in-kind benefits in terms of family housing and a small amount of farmland to at least one teacher.[19] This is quite similar to the system in 19th century Sweden as described in Westberg (2019).

[18] §27 in the 1860 School Act reads: «For ethvert Amt fastsætter vedkommende Amtsformandskab Lavmaal af Løn for de ved den lavere Almueskole fast ansatte Lærere. Stiftsdirectionen har i den Anledning i betimelig Tid at indhente Skolecommissionernes Forslag, som den med vedkommende Provststers Erklæring og sin egen Betænkning oversender Amtsformandskabet. Reguleringen vedtages enten for det hele Amt undereet eller for mindre Dele af samme; den skeer saaledes, at der fastsættes et Beløb for hver Skoleuge».

[19] The first part of §24 in the 1860 School Law reads: «I enhver Skolecommune skal der, med eller uden Bidrag af Amtsskolekassen, idetmindste til een af Lærerne anskaffedes Familiebolig med hosliggende Jordvei af saadan størrelse, at derpaa mindst to Kjør kunne fødes og en Have andlægges».

The 1889 School Act introduced minimum national teacher wages, and the amounts were explicitly specified in the law.[20] By itself, this naturally introduced some wage rigidity because a change in the minimum wage required a change of the law.

In 1892, a national teacher organization was established (*Norsk Lærerforening*), but the union did not have formal collective bargaining rights before WW2. Despite the absence of formal collective wage bargaining agreements, the teacher union was considered an important organization as illustrated by the fact that the increase in minimum teacher wages in 1910 and 1920 was partly a result of pressure from the national teacher union, see Hagemann (1992) and Falch (2001).

After WW2, the localized nature of the teacher wage setting completely changed. The first national collectively bargained wage contract between the national teacher union and the government was established in 1948. The result was a completely centralized teacher wage setting, see Hagemann (1992, ch. 12) and Seip (2020). Between 1948 and 2004, the employer side in the wage negotiations was represented by the central government, although the local governments were responsible for the administration and financing of primary schools. The centralization implied that teachers should be paid according to a national pay schedule (*Statens lønnsregulativ*) and in-kind benefits were removed. Salaries were completely determined by individual seniority and formal education with no possibility for the local authorities to deviate from the national schedules.

Since the variation in wages across local governments was substantial in the old system, the centralization generated some dissatisfaction among teachers in areas with relatively high pay levels. An illustration of this dissatisfaction is the strike among teachers in the city of Oslo in 1954, where the schools were closed for approximately one month, see Hagemann (1992, p. 282-288) and Storaas (2011, p. 166). Later, some separate wage increases were introduced in particular areas in the northern part of the country with large teacher shortages, see Falch (2010). Since 2004, the employer side of the centralized wage bargain has been represented by the organization of local governments (KS). The new agreement allowed for some local flexibility in the wage, but the centralized feature of teacher wage setting has continued.

4. Teacher demand, teacher education, and teacher shortages in historical periods

This section constructs comparable time series of teacher demand, teacher education, and teacher shortages in public compulsory schools for three different historical periods. Appendix A provides an overview of data sources and data adjustments. Data definitions and data availability vary across the periods, although the teacher qualification requirements are basically unchanged as discussed in Section 3. Data on school spending for a somewhat shorter period is developed in Falch and Rattsø (1996, 1997) and is not considered in the present paper.

[20] The first part of §20 in the 1889 Scool Act for rural areas reads: "For hvert Amt fastsætter Amtsformandskabet Lavmaal av Løn for de i fullstændige Lærerposter ansatte Lærere. Lavmaalet fastsættes særskilt for Lærerposter i Folkeskolens anden Avdeling og særskilt for poster i Smaaskolen, for de første ikke under Kr. 12,00 og for de siste ikke under Kr. 8,00».

4.1. The pre-WW2 period: 1860-1936

The Ministry of Church and Education issued the first school statistics publication for the school year 1861-62 and continued with the same format in yearly issues up to 1951-52. At the start of this period, the publications only included schools in rural areas. Information for teacher education was included gradually from the late 1860s, and schools in the cities were included from the mid-1870s.It is some revisions in variables published, and each fifth year of the publication includes more detailed information. Up to 1924, the school authorities reported on the situation at the end of the calendar year and thereafter at the end of the school year.

The cities were included in the statistics in the school years 1867-68 and 1870-71, and yearly from 1875-76. Urbanization was low in the 19th century and most of the population lived in rural areas, mainly based on farming and fishing. Figure 4.1 presents the rural share of students and teachers. More than 85% of the students were in rural schools up to 1877-78 and below 75% in 1910. Thereafter the development reversed. The relative population of the rural areas increased during the economic crises between the world wars. The development reflects both the degree of urbanization and the share of children attending public schools.[21] The share of teachers follows a similar pattern as the share of students, but reflects shorter school years in rural areas than in cities, and thus a higher student-teacher ratio. From about 1915, increased state grants improved the situation in the rural areas.

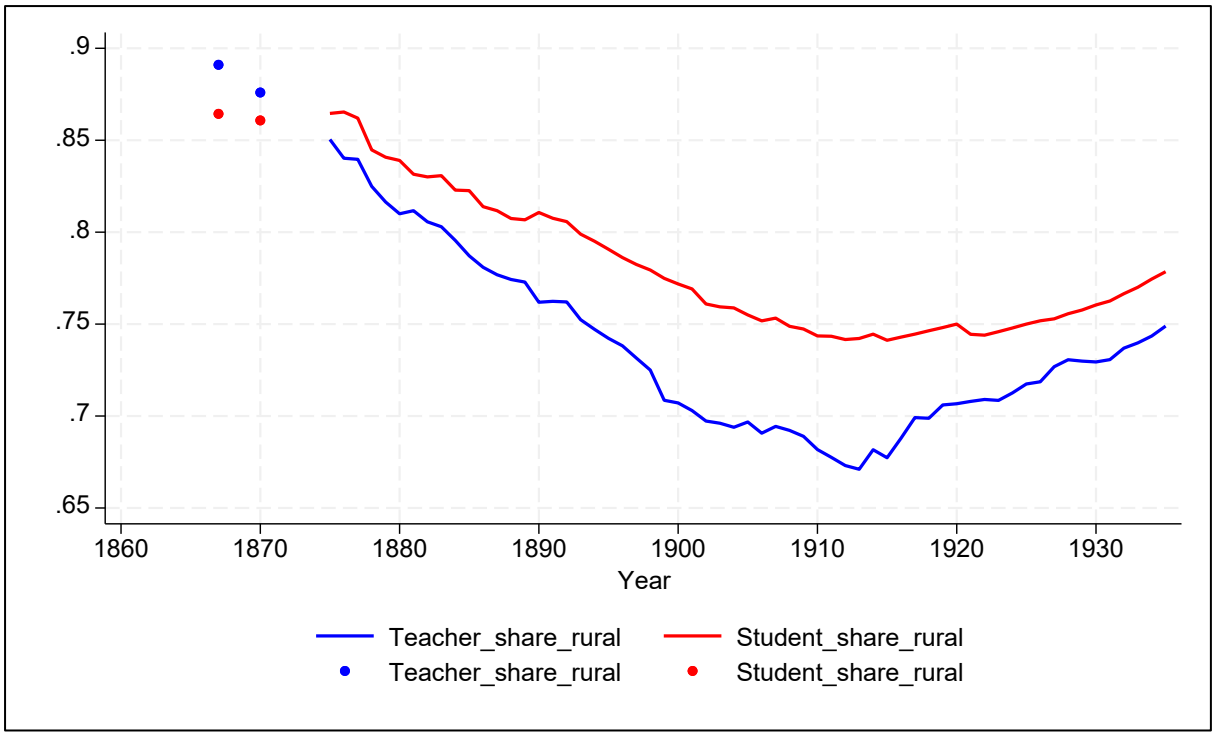

Figure 4.1. The share of students and teachers in rural areas

[21] In 1867-68, the share of eligible children attending public schools was 74.0% and 95.8% in cities and rural areas, respectively. The shares increased to 83.1% and 95.0% in 1905-06, and to 98.0% and 99.1% in 1935-36, respectively.

4.1.1. Teacher education

Information on the number of students in teacher education is available for the first time in 1866-67, information on the number of graduates is available from 1871-72, and information on admission is available from 1875-76. We use the information on the number of students to predict the number of graduates prior to 1871-72. The short teacher education program (see Table 3.2) admitted more students than the main teacher education program in the 1870s, thereafter gradually declining in importance to less than 10% of total admissions from about 1905.

Figure 4.2 presents the number of admissions and graduates up to the school year 1935-36. There is some uncertainty in the admission data prior to 1910 due to limited information on the short teacher education programs. The data on the number of graduates are complete, but predicted based on the number of students up to 1870-71. Surprisingly, the number of graduates exceeds admissions in the period after the expansion to a three-year program in the early 1900s. According to Møglestue (1977), students with high school education (*Gymnas*) could in the period 1902-1930 enroll in teacher education directly in the third grade or take the final examination as an independent candidate. This system explains why the number of graduates exceeds admissions.

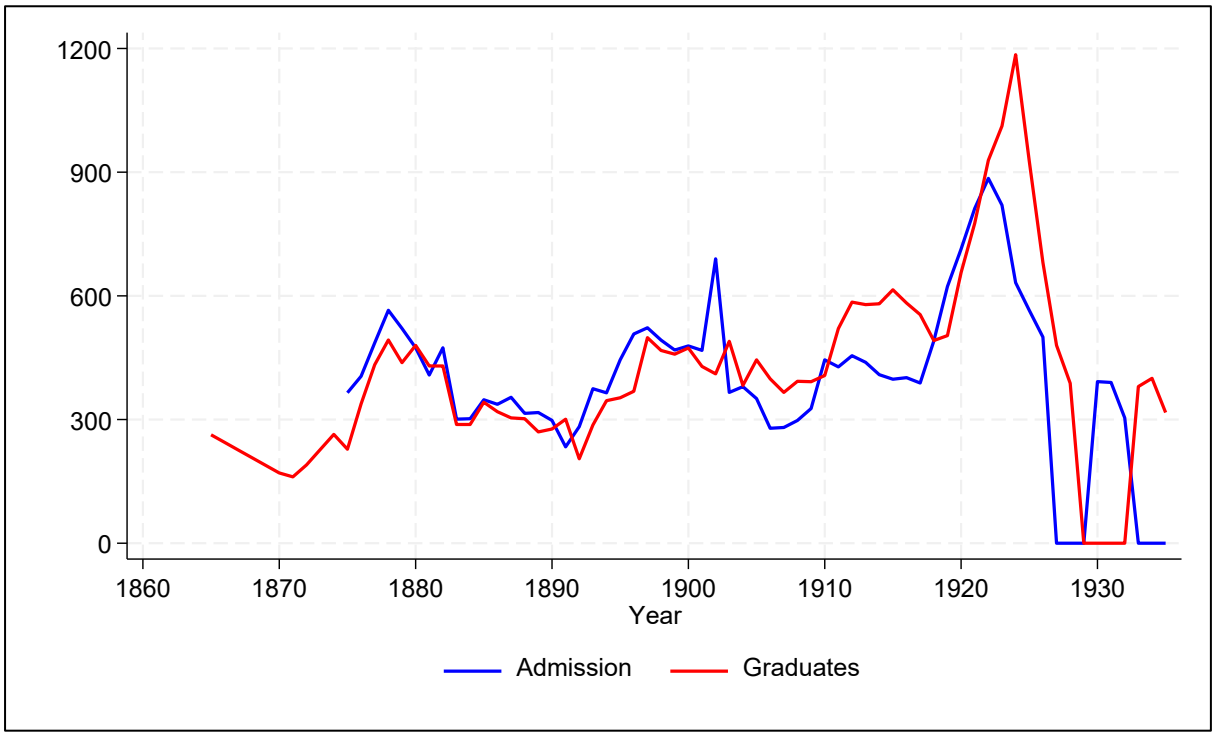

Figure 4.2. The number of admissions and graduates in teacher education

To avoid a year without graduates related to the increased length of teacher education in 1902, two cohorts were admitted. The extension to a four-year-long education in 1930 happened in a period without any admissions. There is a striking spike in the number of admission and graduates in the early 1920s. However, shortly afterwards the number of admissions in teacher

education programs dropped to zero for three years in a row. These rapid shifts seem to be responses to fluctuations in teacher shortages.

4.1.2. Teacher shortages

The qualifications of the teachers in rural areas were a major concern when the education system expanded and included more non-religious subjects. The new school act of 1860 required some specific teacher education. Information on accomplished teacher education should therefore be reported by the rural school authorities yearly. When the situation improved by 1875, this information was reported only each fifth year.

Lack of qualified teachers was not regarded as a problem in the cities and was consequently not reported. Thus, this section only analyses formal teacher qualifications in rural areas.

The reported share of unqualified teachers in the official statistics is presented in Figure 4.3. There was a strong decline after the School Act of 1860. In 1861-62, 62% of the teachers did not have any teacher education, which dropped to 16% in 1875-76. It was below 5% in the period 1890-1915, increased sharply to 10% in 192,0, and was record-low at 0.8% in the school year 1935-36.

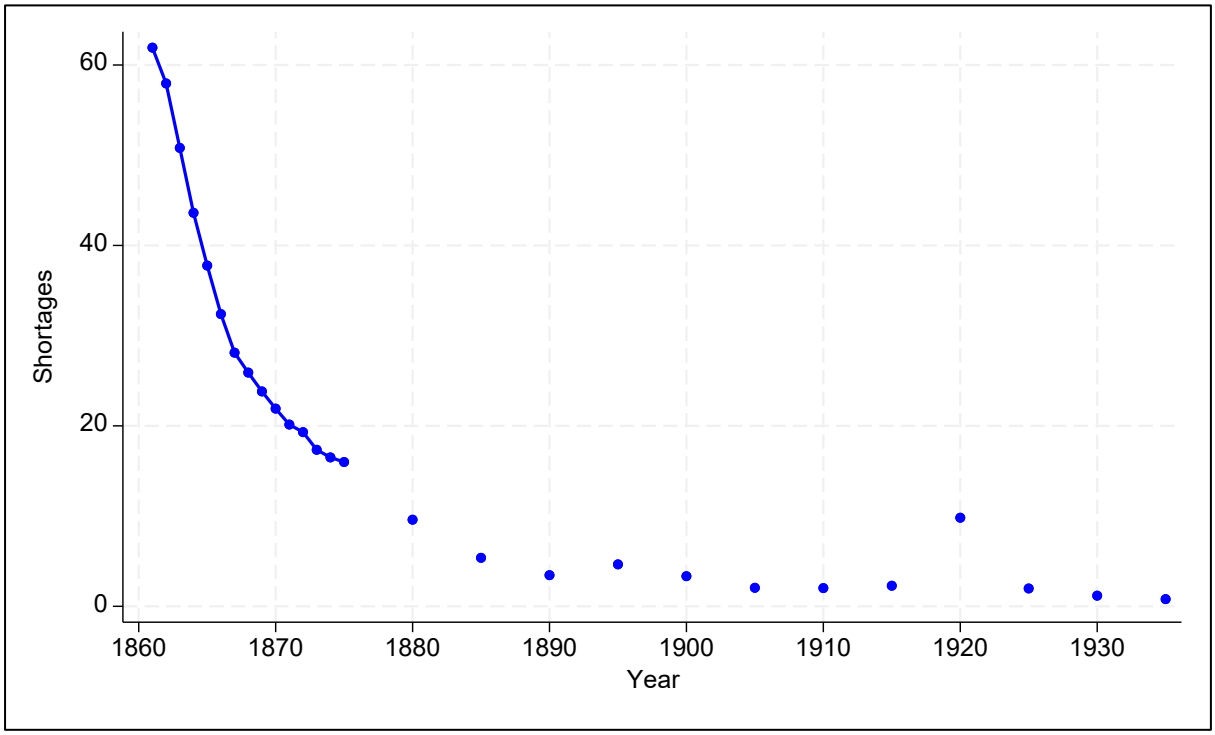

Figure 4.3. Registered teacher shortages in rural areas, percent

The development in Figure 4.3 is related to changes in teacher demand and supply. We exploit yearly information on demand and supply factors to predict teacher shortages in the years without registration based on an empirical model. Changes in supply are to a large extent determined by the number of teacher graduates and the number of teachers leaving teaching,

while new hires are by definition given by teacher turnover and the change in the total teacher demand. We estimate variants of the following regression model

$$(1) \qquad \Delta^5 Unq_t = \alpha_0 + \alpha_1 * Unq_{t-5} + \alpha_2 * \Delta^5 D_t + \alpha_3 * \sum_{t=-4}^{0} T_{t-1} + \alpha_4 * \sum_{t=-4}^{0} G_{t-1} + \varepsilon_t$$

The model exploits that data on unqualified teachers are available each fifth year, where Δ^5 denotes five-year difference. Unq_t is the number of unqualified teachers at time t, D is demand measured by teacher employment, T is turnover, G is the number of teacher graduates, and ε is the error term. For graduates and turnover, the model includes the sum over the past five years to take into account the structure of the data.[22]

Figure 4.4 presents the turnover rate used in the regression model (left panel), together with the reasons for leaving teaching positions (right panel). Turnover is relatively stable at 2-3%, but higher in the period 1918-28. Retirement is the most common reason for leaving teaching. The importance of retirement rises during the period, while deaths among teachers decrease. Marriage leads to attrition only for female teachers and the share of female teachers increased during the period. Marklund (2023) studies the relationship between teaching and family obligations in Sweden from 1860-1937, and find that family obligations did not affect male teacher working careers, while the practice to return to work when the children were older increased over time for female teachers.

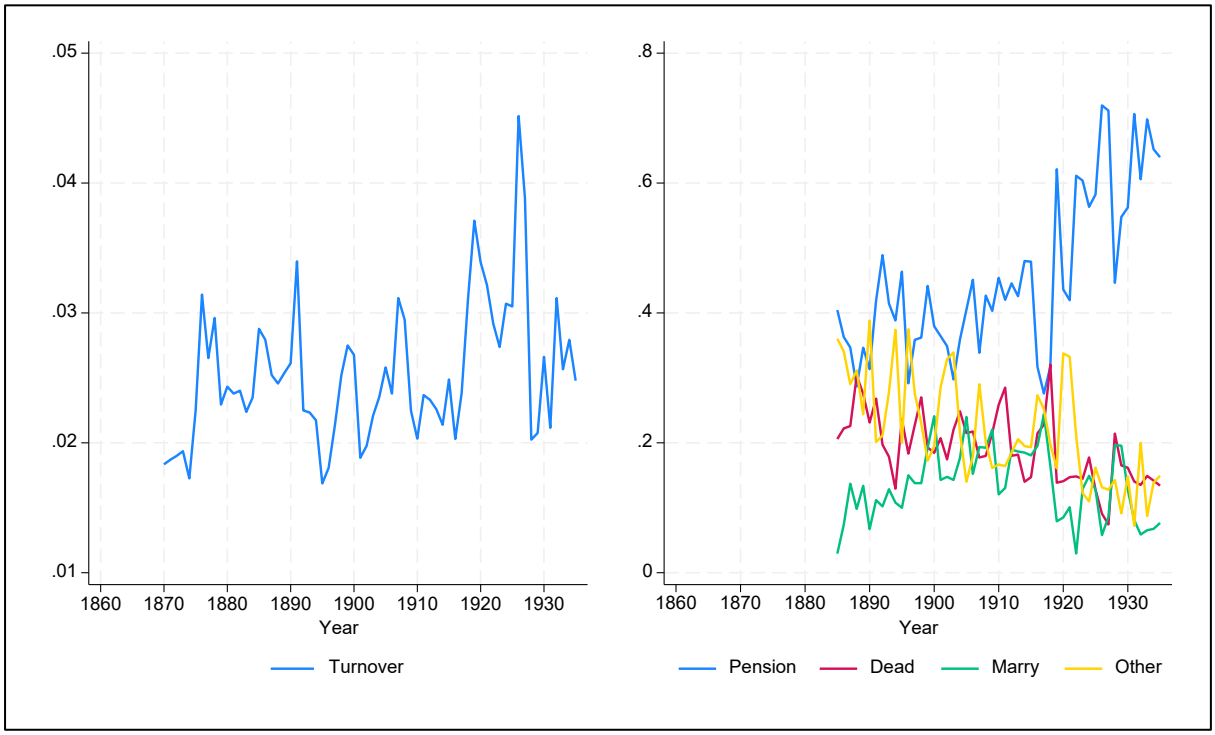

Figure 4.4. The turnover rate (left panel) and share of types of turnover (right panel)

[22] Graduates are employed in both cities and rural areas, and likewise teacher turnover is not available separately for urban and rural areas. In the regressions, we scale the variables by the share of teachers in rural areas.

We expect that increased teacher demand and increased turnover increase the number of unqualified teachers. Because both factors give the same quantitative effects on teacher recruitment, we expect the effects to be similar, i.e., $\alpha_2 = \alpha_3 > 0$. More teacher graduates increase the supply and are expected to decrease the use of unqualified teachers, i.e., $\alpha_4 < 0$. Because new graduates might choose other occupations than teaching, we expect the effect to be smaller than the effect of the demand factors, i.e., $|\alpha_4| < \alpha_2$. This difference is, however, expected to be small because teaching was an attractive profession at the time.

Figure 4.5 presents the development of the variables in the model. Teacher demand increased after the new school act of 1889 and the boom during WW1. The five-year sum of teacher turnover increased gradually, naturally following an increased number of teachers, and was high in the 1920s due to a high retirement rate. The five-year sum of graduates follows from Figure 4.2.

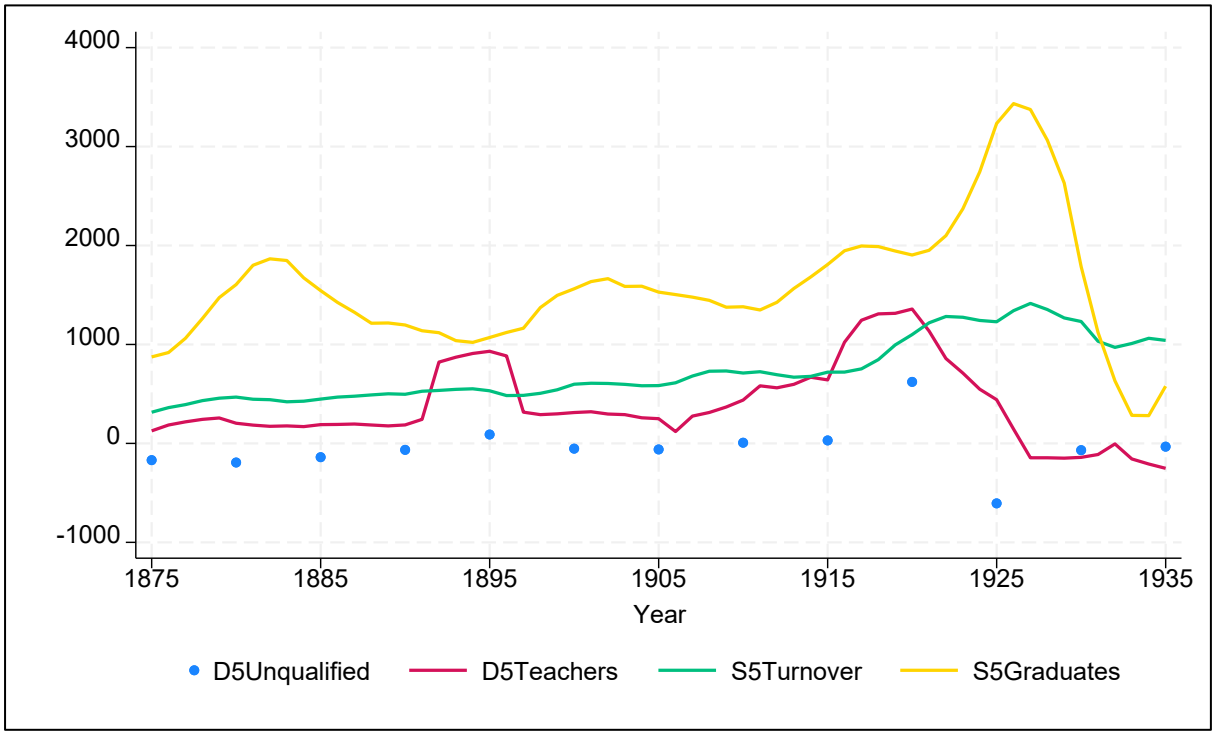

Figure 4.5. The five-year change in the number of unqualified teachers and the total number of teachers, and the five-year sum of teacher turnover and number of teacher graduates

The estimation results are presented in Table 4.1. The results must be interpreted with care because of the limited number of observations. The explanatory variables explain a large share of the variance in the dependent variable, and the signs of the estimated coefficients are as expected. Lagged teacher shortages are insignificant (model 1), and the effects of the demand factors are larger than the absolute value of the supply factor (model 2). We cannot reject at conventional significance levels that the effects of the demand factors are equal (model 3), and even though the effect of the supply factor is smaller in absolute value, we cannot reject that it is equal in absolute value to the demand factors (model 4). The parsimonious model (4) is a

statistically acceptable simplification of all the more flexible models in the table. The coefficient in model (4) implies that increasing the number of teachers by 100 increases the number of unqualified teachers by 39, all else equal. The effect is the same for 100 teachers leaving teaching and 100 fewer teacher graduates.

Table 4.1. Models for unqualified teachers. Dependent variable is $\Delta^5 Unq_t$

	(1)	(2)	(3)	(4)
Number of unqualified teachers, lagged five years $\left(Unq_{t-5}\right)$	-0.34 (0.23)	-	-	-
Five-year change in the number of teachers $\left(\Delta^5 D_t\right)$	0.43*** (0.11)	0.49*** (0.10)	-	-
Five-year sum of turnover $\left(\sum_{t=-4}^{0} T_{t-1}\right)$	0.22 (0.17)	0.35* (0.16)	-	-
$\left(\Delta^5 D_t + \sum_{t=-4}^{0} T_{t-1}\right)$	-	-	0.45*** (0.09)	-
Five-year sum of graduates $\left(\sum_{t=-4}^{0} G_{t-1}\right)$	-0.23** (0.10)	-0.33*** (0.08)	-0.35*** (0.08)	-
$\left(\Delta^5 D_t + \sum_{t=-4}^{0} T_{t-1} - \sum_{t=-4}^{0} G_{t-1}\right)$	-	-	-	0.38*** (0.07)
Observations	13	13	13	13
Adjusted R^2	0.73	0.70	0.71	0.69
Test of restrictions vs Model (1), p-value	-	0.17	0.27	0.26
Test of restrictions vs Model (2), p-value	-	-	0.43	0.36
Test of restrictions vs Model (3), p-value	-	-	-	0.22

Note. The time period is 1875-1935, with observations each fifth year. Standard errors in parentheses, and ***, **, and * indicates significance at 1%, 5%, and 10% level, respectively.

The predictions are very similar across the models. Figure 4.6 presents the predicted values from models (2) – (4) in Table 4.1 together with the dependent variable $\Delta^5 Unq_t$ (blue dots). It appears that the growth in the number of unqualified teachers was lower than predicted by the model in 1895 and 1935, but higher than predicted in 1920. The differences between the models are small, and because of the fact that the estimates are based on a small number of observations, we will in the following use the predictions from the parsimonious model (4).

4.1.3. Discussion

Following the decision in 1860 that all teachers should have teacher education, the teacher education system expanded and was able to basically eliminate teacher shortages during a period of 25 years.

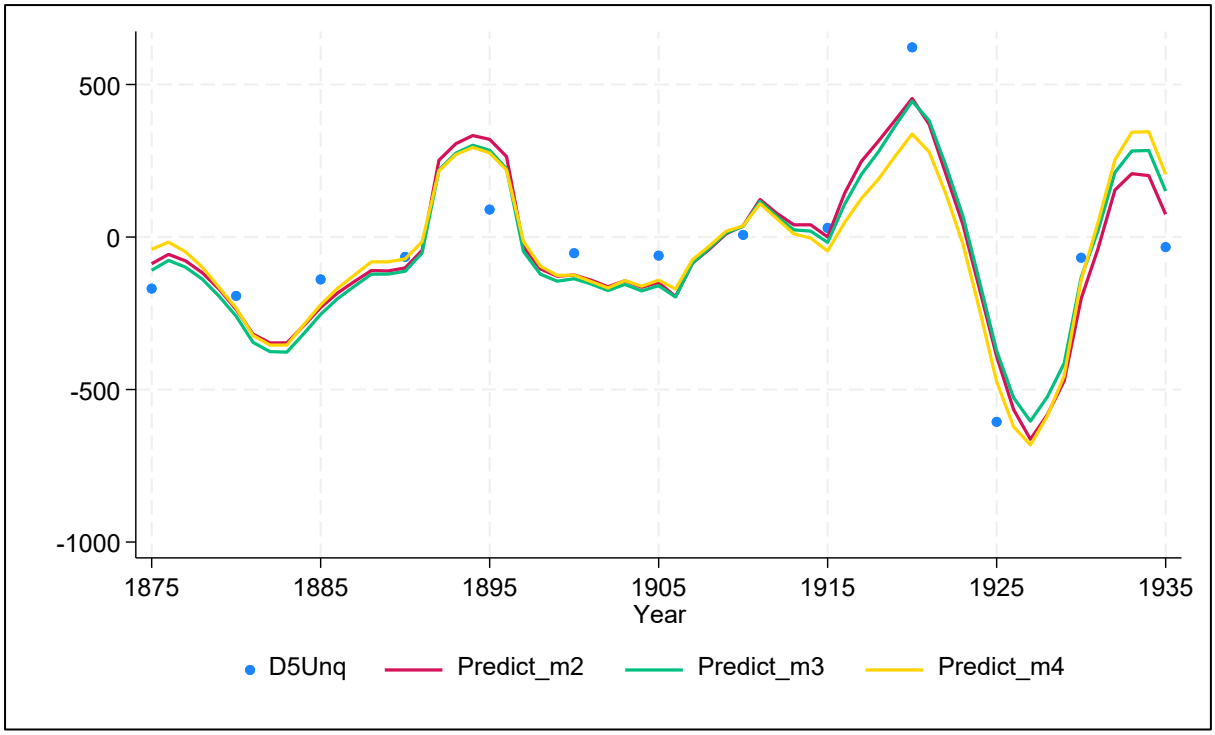

Figure 4.6. Predicted values from models (2) – (4) in Table 1, the dependent variable in dots

The period 1915-1935 involves large fluctuations. Between 1915 and 1920, teacher shortages increased sharply, which seems to be a result of both increases in teacher demand and high teacher turnover. These demand-side forces seem to have been matched by subsequent increased admissions into teacher education programs. The fact that completion of teacher education was normally expected to take three years implies a sluggish adjustment. There was a record-high number of graduates at the end of the school year 1924-1925. However, by 1925, teacher demand started to decline. Teacher shortages became record-low, and admission to teacher colleges completely stopped in the fall of 1927. During the following period of nine years, admission in teacher education programs was close to zero. Thus, at the end of the great depression, the Norwegian school system had a combination of surplus of qualified teachers and a very low capacity in teacher education institutions.

4.2. The post-WW2 period: 1951-2024

Ultimately, we are interested in the qualifications of the teachers facing the students. The implication is that we are interested in the extent of teaching by unqualified teachers. During the last 50 years, part-time teaching positions have been common and must thus be taken into account. In addition, an increasing part of teachers working time is used on administrative issues and other non-teaching activities in the schools.

The responsibility of collecting data moved in 1951 from The Ministry of Education to Statistics Norway. Initially, Statistics Norway followed the previous reporting format as the Ministry. In 1962, Statistics Norway changed the date of reporting from the end of the school year to the start of the school year. Simultaneously, they decided to not collect data for the

school year 1961-62. The format of the reporting varies during the period 1962 to 1997, see Appendix A for details.

The period is characterized by expansion of the education system. During a period of 25 years, from 1951-52 to 1975-76, the number of students increased by 72%, partly because of increased length of compulsory education and partly because of the baby boom after WW2. The number of full-time teachers increased by 141%, twice as much as the number of students. The school year increased and more resources were invested in schools. The growth continued after the mid-1970s, including the extension in 1997 from nine to ten years of compulsory schooling.

4.2.1. Teacher education

The extension of compulsory education from seven to nine years during the period 1959-1974 and to ten years in 1997 implied recruitment of new types of teachers in compulsory education. Graduates from disciplinary studies at universities with some specific pedagogical courses became qualified for teaching at the lower secondary level, in addition to graduates from the traditional teacher education programs. By the reform in 1997, pre-school teachers with some additional courses became qualified to teach the first four years of primary education. However, these new types of teachers have always been in a clear minority in compulsory education.[23]

This section only considers the main teacher education program, qualifying the students to teach at all grades in compulsory education. Notice, however, that the link between the main teacher education program and teacher shortages have become slightly weaker by the extension of compulsory education.

Teacher education expanded massively in the 1950s and 1960s. Unfortunately, information on the number of graduates does not seem available for the period 1957-58 to 1970-71. In addition, data on admission is not available for 1960-61 and 1961-62, and the admission data do not specify study program length in the period from 1957-58 to 1959-60. However, at the time most of the students were enrolled in the two-year program. We use interpolations the predict admission in the different teacher education programs during 1957-58 to 1961-62.[24]

The left panel of Figure 4.7 presents the actual number of graduates together with the number of graduates if every admitted student makes the final examination on the expected time. It is evident that dropout and delays were almost non-existent both prior to and after the period

[23] Information on the composition of teachers is available from 2015 (Source: Statistics Norway, Table 12071). In 2015, 64% of the qualified teacher man-years had the main teacher education program considered in this paper, 14% had teacher education that qualifies for lower and upper secondary education, 11% had teacher education for pre-schools, and 10% had some kind of unspecified pedagogical education. In 2022, the shares were 61%, 18%, 9% and 11%, respectively. Prior to the extension of compulsory education in 1997, a reasonable estimate is that 80-90% of the qualified teachers had the main teacher education.

[24] Total admission is linearly interpolated for the years with missing data (1960-61 and 1961-62). The admission share of the two-year teacher education program was 70.1% and 64.3% in the last two years prior to the break in the data (that is the school years 1955-56 and 1956-57, respectively), and 69.5% and 70.6% in the two first years after the break in the data (that is the school years 1962-63 and 1963-64, respectively). We assume an admission share of 70% in the years with missing data (1957-58 to 1961-62).

without information on graduates. Lagged admission, taking the length of the study program into account, seems to be a very good approximation of actual graduation. Thus, in the following, we use this variable as a proxy for graduation for the years with missing information on graduation.

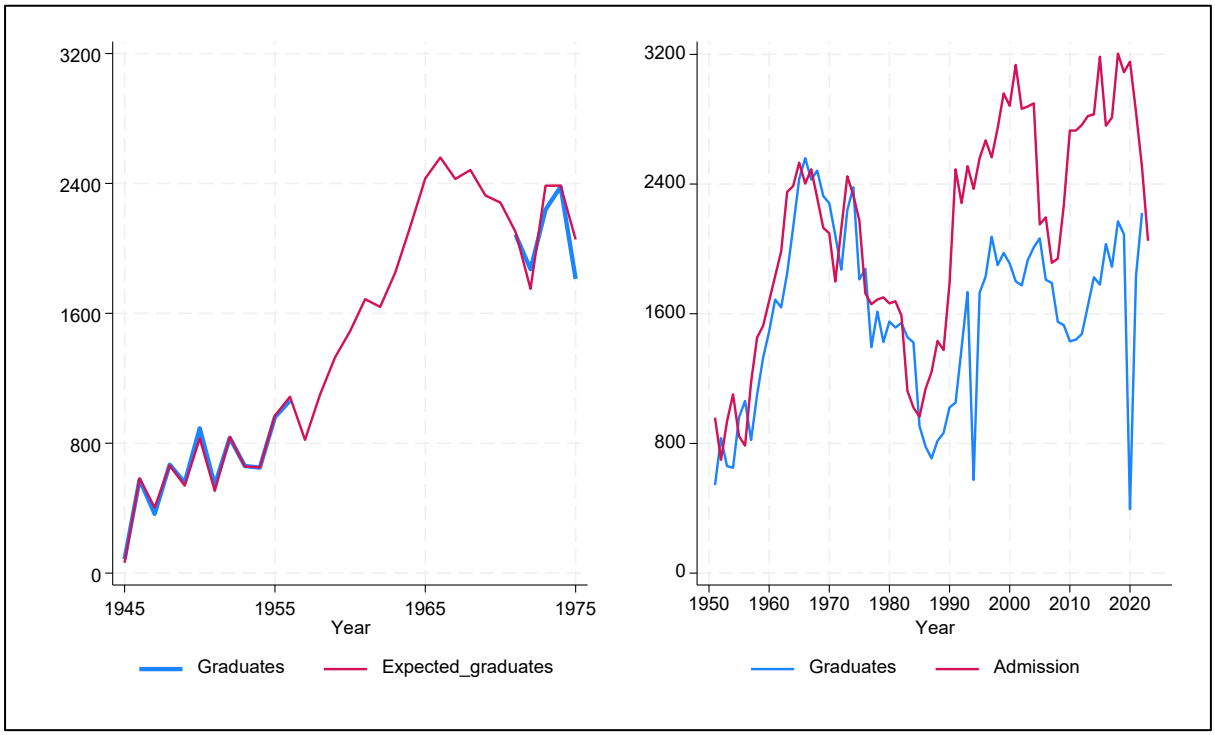

Figure 4.7. The number of graduates and the prediction based on lagged admission (left) and the number of admissions and graduates (right)

The right panel of Figure 4.7 presents the total admissions in the fall semester and the number of graduates in the spring semester.[25] The number of graduates increased from 543 at the end of the school year 1951-52 to an estimate of 2,560 in 1966-67, and declined gradually thereafter to 708 graduates in 1987-88.[26] Notice that the change from a system with two- and four-year teacher education programs to one three-year program based only on completed high school (*Gymnas*) was implemented gradually from about 1962 to about 1978. The extensions to a four-year program in 1992 and to a five-year program in 2017 explain the low number of graduates in 1994-95 and 2020-21.

Dropout from teacher education appears from the mid-1970s and increases to about 25-35% of the admitted students from the 1980s and onwards. The large fall in admission from 1983-84 coincides with reduced graduation three years later and a significant increase in the dropout

[25] Notice that from the mid-1990s, data specify whether the students graduate in the spring or the fall semester. Very few students graduate in the fall semester and they are therefore added to the number of graduates in the spring semester of the same calendar year because they mainly are delayed for some reason.
[26] The number of graduates are predicted to be highest for the school year 1966-67 with 2560 new teachers. Møglestue and Jeber (1976, p. 7) reports 2580 graduates this particular year. He does not, however, report any source of the number.

rate. Even though admission recovered in the 1990s and was record-high in the late 2010s, the number of graduates was below comparable numbers in the late 1960s due to dropout.

4.2.2. Teacher shortages

A new digital platform for reporting key statistics in compulsory education was implemented in the fall of 1992, in which the principals at the schools report on, inter alia, the number of teaching man-years and teacher qualifications.[27] In contrast to the previous system, the new system distinguishes between man-years for regular teaching and other tasks for teachers, including leadership tasks and follow-up of specific types of students. Teacher qualifications are only reported in relation to regular teaching. However, it seems like the data have some limitations in the first years, and for the school year 1994-95 data on teachers are missing. Prior to the mid-1990s we have to rely on information about the number of teachers in full-time positions and part-time positions.[28]

The first registration of unqualified teachers after WW2 is for the school year 1951-52. Figure 4.8 presents the available information on teacher shortages measured in percentages.

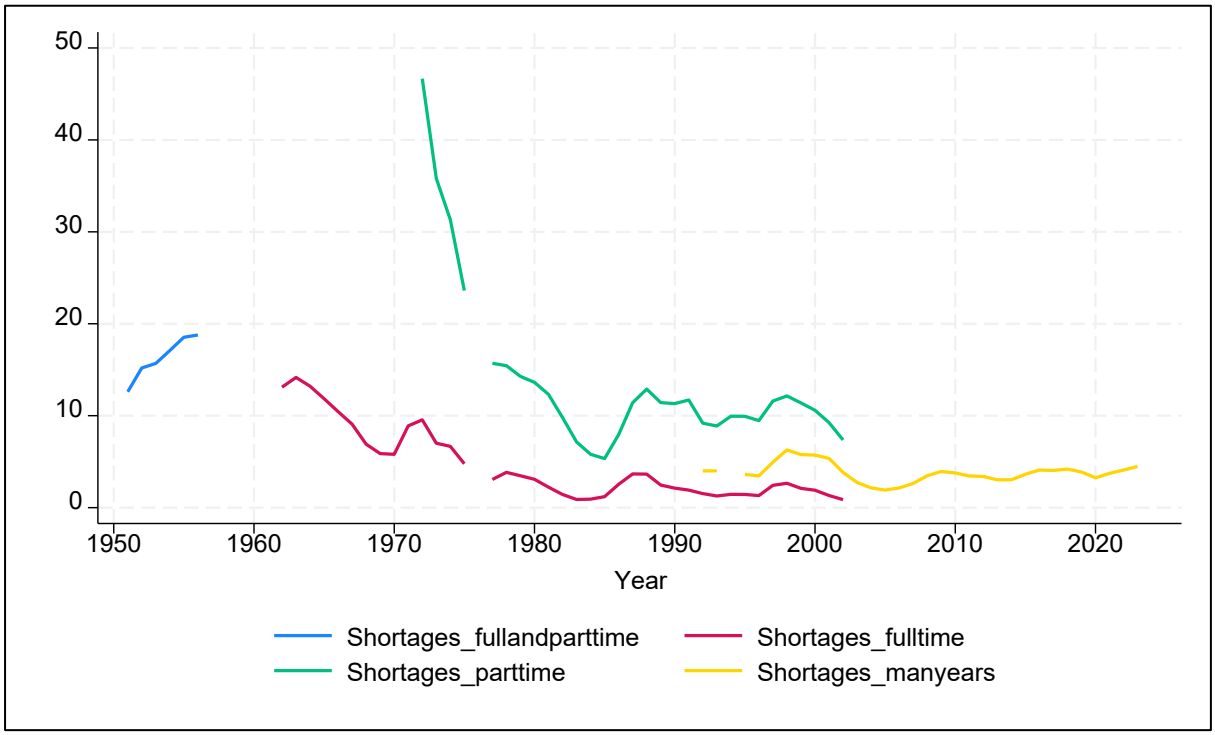

Figure 4.8. The available information on teacher shortages, percent

Figure 4.8 shows that teacher shortages were high in the 1950s and 1960s, and declined during the 1970s. In the period 1951-1957, the data is on the total number of unqualified teachers,

[27] In contrast to the previous system, the new system distinguishes between man-years for regular teaching and other tasks of teachers, including leadership tasks and follow-up of specific types of students. Teacher qualifications are only reported in relation to regular teaching.

[28] Up to the school year 1960-61, information was registered at the end of the school year. From 1962, registration changed to October. Because of the change, no information about the school year 1961-62 is collected by Statistics Norway. All data are linearly interpolated for this specific school year.

without distinguishing between teachers working full-time and part-time. In the period 1972-2002, separate information for full-time and part-time teachers is available. Figure 4.8 shows that the share of unqualified teachers is much larger for teachers in part-time positions than for teachers in full-time positions. Since the turn of the century, information on teaching man-years is available. No information on teacher qualifications is available around 1960.

In the 1970s, there was a massive increase in the number of part-time teachers. Figure 4.9 shows that less than 15% of the teachers had a part-time position prior to the mid-1970s. This is in line with the finding in Møglestue and Jeber (1976, Table 16) that 18% of the teachers graduating in 1965 reported part-time work in the fall of 1973. Thus, the data handling of part-time teachers prior to the 1970s will have a small effect on the estimated teacher shortages because they account for a small part of total teacher man-years. However, the transition during the 1970s might provide some challenges since the average working time for the two groups of teachers, full- and part-time teachers, is unknown. The growth in part-time positions seems to be related to the introduction of the right to claim a somewhat reduced position, which became popular among female teachers. Thus, it is reasonable that the average working time within the group of part-time teachers increased.[29]

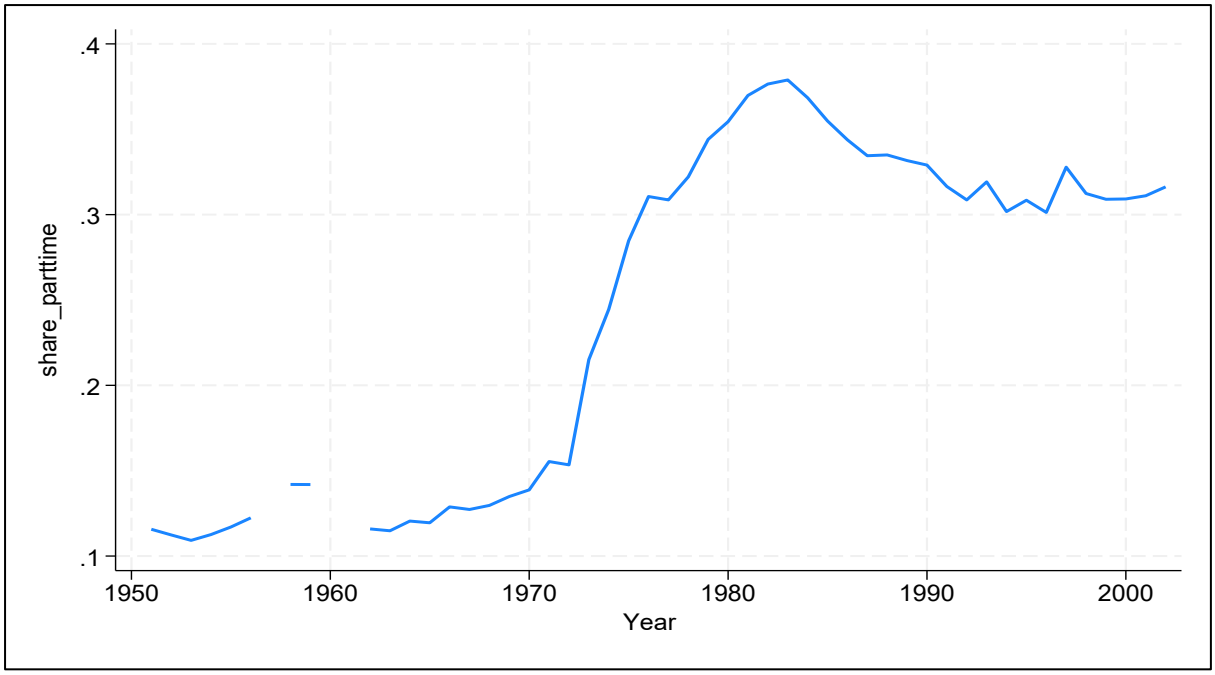

Figure 4.9. The share of part-time teachers

Lack of formal qualifications is much more common in part-time positions than in full-time positions. In the following, we follow the observation in the available data and assume that the share of unqualified teachers is five times larger in part-time positions than in full-time

[29] We assume that part-time teachers on average worked 1/3 of a full position up to 1972-73, 40% in 1973-74, and 50% of full position thereafter. Unfortunately, this assumption is based on very limited information.

positions during the period without separate information on unqualified teachers in part-time and full-time positions (up to 1971-72).[30]

Because information on unqualified teachers does not exist for the school years 1957-58 to 1961-62, we estimate models similar in spirit to equation (1) in order to predict the development for unqualified teachers in full-time positions. In contrast to the pre-WW2 period, the model covers both urban and rural areas with yearly data. We estimate variants of the following model, using data for different time periods.

$$(2) \qquad \Delta Unq_t = \alpha_0 + \alpha_1 * Unq_{t-1} + \alpha_2 * \Delta D_t + \alpha_3 D_{t-1} + \alpha_4 * \left(\tfrac{1}{3} \sum_{t=-2}^{0} G_{t-1} \right) + \varepsilon_t$$

Because data on teacher turnover does not exist, we use lagged teacher employment (D_{t-1}) as a proxy. The coefficient α_3 can be interpreted as the yearly turnover rate multiplied by the effect of turnover on shortages. We include the three-year average of teacher graduates in order to allow for some sluggishness in the transition from studies into teaching positions.

The results are presented in Table 4.2, where columns (2) – (5) estimate the model on different time periods. The estimated coefficients are qualitatively similar to the model for the pre-WW2 period (see Table 4.1). The effects of the change in employment are almost identical. With a turnover rate of 6%,[31] the estimated effect of lagged teacher employment in model (2) implies an effect of turnover on shortages of 0.7, about twice the effect in the pre-WW2 period. Accordingly, also the effect of the number of graduates is about twice the effect in the pre-WW2 period (-0.64 vs. -0.35).

Table 4.2. Models for unqualified full-time teachers. Dependent variable is ΔUnq_t

	(1)	(2)	(3)	(4)	(5)
Number of full-time unqualified teachers, lagged one year (Unq_{t-1})	-0.08	-	-	-	-
	(0.13)				
Change in the number of full-time teachers (ΔD_t)	0.39***	0.41***	0.35***	0.43***	0.42***
	(0.09)	(0.08)	(0.07)	(0.10)	(0.10)
The number of full-time teachers, lagged one year (D_{t-1})	0.037*	0.041**	0.020*	0.039*	0.050*
	(0.018)	(0.016)	(0.011)	(0.019)	(0.023)
Three-year average of the number of graduates $\left(\tfrac{1}{3} \sum_{t=-2}^{0} G_{t-1} \right)$	-0.56**	-0.64***	-0.43***	-0.81**	-0.71***
	(0.22)	(0.17)	(0.14)	(0.32)	(0.23)
Observations	20	20	25	15	17
Time period	1952-79	1952-79	1952-84	1963-79	1952-74
Adjusted R^2	0.55	0.56	0.50	0.53	0.49

Note. The estimation period is indicated, with missing data for 1957-58 to 1962-63 and 1976-77. Standard errors in parentheses, and ***, **, and * indicate significance at 1%, 5%, and 10% level, respectively.

[30] On average during the period with information on unqualified teachers separately for part-time and full-time teachers (1972-73 to 2002-03), the share of unqualified teachers is 5.49 times larger for part-time teachers than for full-time teachers. There is a weakly increasing trend in this share (coefficient of 0.065 per year, with a standard error of 0.027).

[31] Falch and Strøm (2005) report turnover rates of 5-7% in Norway in the 1990s.

The response to teacher mobility seems to have increased from the pre-WW2 period to the post WW2-period, although the results must be interpreted with care because of small sample sizes and potential misspecification of dynamics.

Figure 4.10 presents the predicted values for the models in Table 4.2 together with the actual change in the number of unqualified teachers. The predictions follow the actual development reasonably well. Naturally, the models using the shortest time period (models 4 and 5) have the weakest prediction at the endpoints of the sample. For the periods without information on teacher quality (1957-58 to 1961-62 and 1976-77), for which we will use the model predictions, the differences between the models, except model 4, are very small. In the following, we use the predictions from model 2.

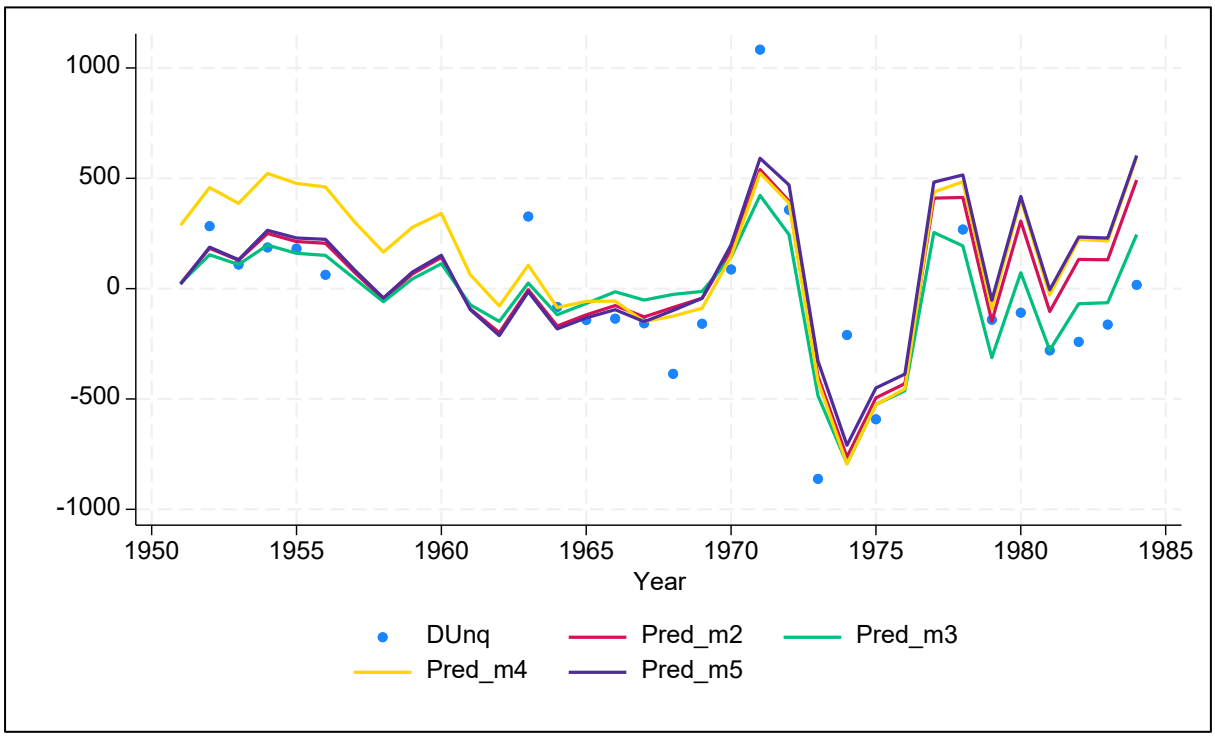

Figure 4.10. Predicted values from the models (2) – (5) in Table 2 together with the actual change in unqualified teachers in full-time positions in dots

4.2.3. Discussion

Teacher shortages in compulsory education at the end of WW2 was significantly higher teacher shortages than during the past 70 years. The following decades were characterized by a large growth in compulsory education. The 1950s had the baby boomers, in the 1960s compulsory education expanded from 7 to 9 years, in the 1970s the number of teachers continued to increase, and in 1997 compulsory education expanded to 10 years. Teacher education was lagging behind the development, contributing to continuous teacher shortages.

The number of graduates from teacher education almost quadrupled from the early 1950s to the mid-1960s. The highest number of graduates in our long time series is at the end of the

school year 1966-67. Thereafter there have been some major fluctuations in admission, and a dropout rate of 25-35% since the 1980s has contributed to a relatively moderate size of the number of graduates. One plausible hypothesis for the large fall in admission and graduation in the mid-1980s is that the teaching profession became less popular. In the last 40 years, in contrast to earlier periods, it has in general been challenging to fill all study places in several teacher education institutions, and the average academic qualifications of the students have declined.

4.3. The period around WW2: 1935-1952

During the nazi-German occupation of Norway, from the spring of 1940 to the spring of 1945, the collection of information from the school districts used the same sheets as the pre-war period and was published in the same format. However, the national reports from the Ministry of Education for the years 1943-1946, published after WW2, give the impression of challenges in receiving reliable information during the last years of WW2

For the northernmost county (Finnmark), information is not available for the school years 1942-43 to 1945-46. The challenge of estimating national statistics is most pronounced for the school year 1944-45 because of the Nazis' forced evacuation of Finnmark, including some additional school districts bordering Finnmark, prior to the liberation of the territory by the Soviet army in the fall of 1944. Some of the inhabitants are probably registered as students in other areas of the country for this particular school year. For national statistics, the challenge is limited because Finnmark only included about 2.5% of the teachers in the country. Based on county-level information, the national numbers of students and teachers presented below are estimated for the school years 1941-42 to 1946-47 to take account of the missing information for Finnmark.

The information included in this section covers both urban and rural areas, similar to the post-WW2 period.[32] Figure 4.11 presents the development in the number of students and the number of teachers in full-time positions. The number of students is compared with the relevant cohort sizes measured by births 7-13 years prior to the school year (left panel). The figure shows that the statistics on the number of students are reasonably accurate, which indicates that the same is the case for the number of teachers. The reduced difference between cohort size and the number of students in the late 1930s is due to less private schooling. There is no break in the time series related to the war. The rise in the number of teachers (right panel) in 1936-1938 is due to the longer school year in rural areas introduced by the School Act of 1936. Thereafter the number of teachers decline in accordance with the number of students. The number of teachers is at its lowest level in the school year 1945-46, i.e., the first school year after the end of WW2.

[32] Notice, however, that teacher shortages is mainly a challenge for rural areas. For the school year 1951-52, which is the first to provide information on teacher qualifications for the cities, the teacher shortage is about 6 times larger in the rural areas than in the cities. During the time period of this section, 1935-36 to 1951-52, the share of students in rural areas decreased from 77.5% to 74.0%.

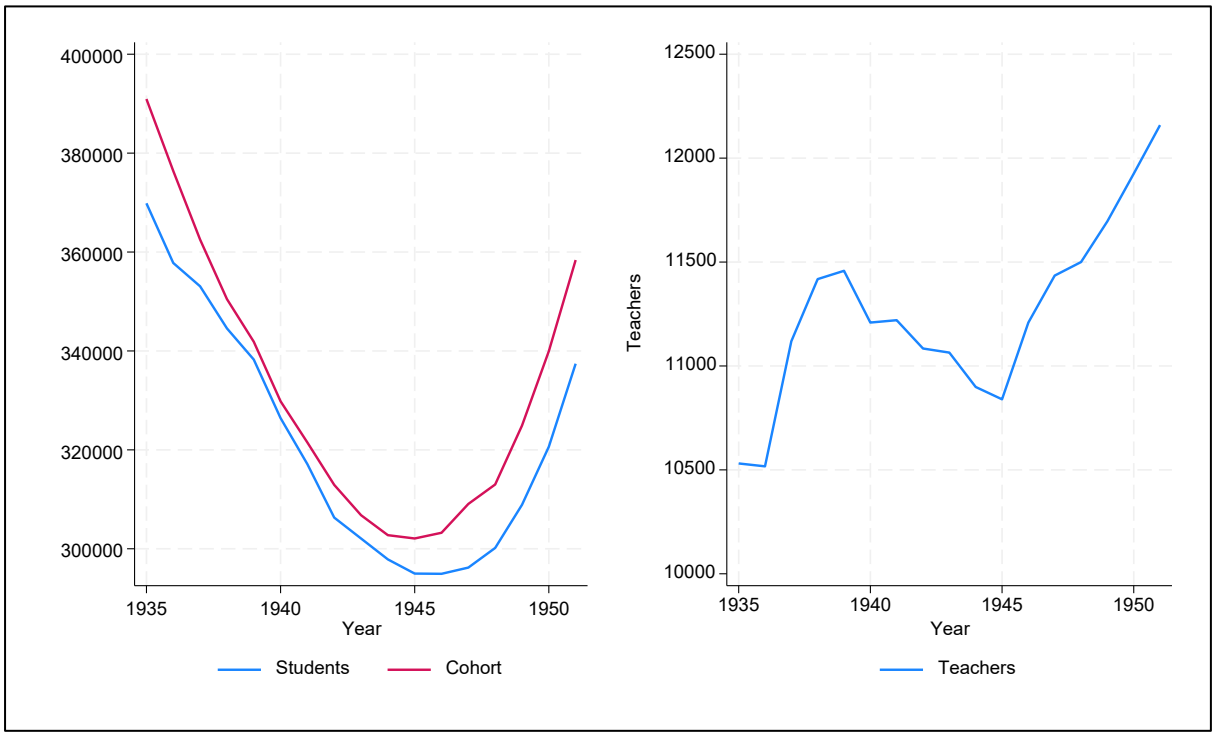

Figure 4.11. Cohort size and the number of students and teachers, 1935-36 to 1951-52

4.3.1. Teacher education

During WW2, higher education was disrupted. Close to zero students were enrolled in teacher education towards the end of the war. After WW2, most of the students were enrolled in the two-year program established in 1935.[33]

Figure 4.12 presents admission and graduates during the period. After low admission up to and during WW2, teacher education expanded afterward. The figure shows a staggered pattern after the war, where particularly the two-year program admitted more students each second year, perhaps as a response to a very high admissions in the fall of 1945. The number of graduates closely follows admissions, but with a lag because the education takes time. Since the two-year program dominated after 1945, the number of graduates closely follows the admission in the previous school year.

[33] The share of admission to the two-year program was on average 68.5% in the period 1945-46 to 1956-57, varying from 60% to 77%.

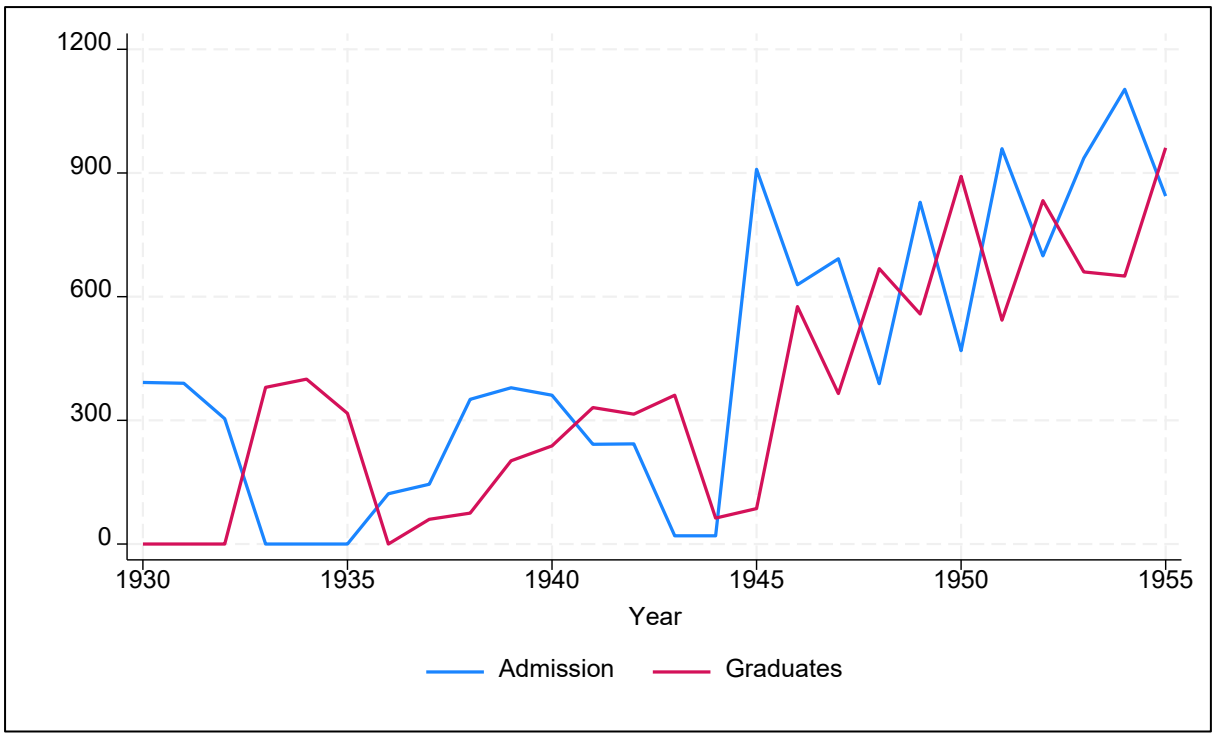

Figure 4.12. The number of admissions and graduates, 1930-31 to 1955-56

4.3.2. Teacher shortages

The school districts did not formally report on the number of unqualified teachers during the period. However, the local school authorities reported a severe lack of qualified teachers at the end of WW2. The description of the situation as summarized in the reports from the Ministry of Education, published in connection with the statistics for the school year 1947-1948, estimates a lack of about 1,800–2,000 teachers in the spring of 1945 and 1,200 teachers in the spring of 1948.[34] This is dramatically higher than in 1935-36, the last year with detailed reports from the school districts.

Figure 4.13 presents the actual number of unqualified full-time teachers together with the predictions based on the pre-WW2 and post-WW2 analyses.[35] The models have different predictions because the estimated coefficients of the underlying models differ. In general, none of the models perform well during the period. However, the post-WW2 model seems to predict reasonably after the school year 1947-48, while the pre-WW2 model seems to predict reasonably up to 1941-42.

[34] These numbers include both compulsory schools and continuing schools (*Framhaldsskolen*). However, only about 3% of the teachers were employed in the latter. In addition, the numbers include both full-time and part-time teachers. However, only 4-5% worked part-time during WW2, increasing to 10% in 1951-52. In the following, we assume that the number of unqualified teachers in full-time positions was 1800 and 1200 in 1944-1945 and 1947-48, respectively.

[35] Notice that the pre-WW2 model only includes teachers in rural areas. All variables are scaled accordingly. Thus, the actual number of unqualified teachers (the blue dots in the figure) is slightly lower in the left panel than in the right panel.

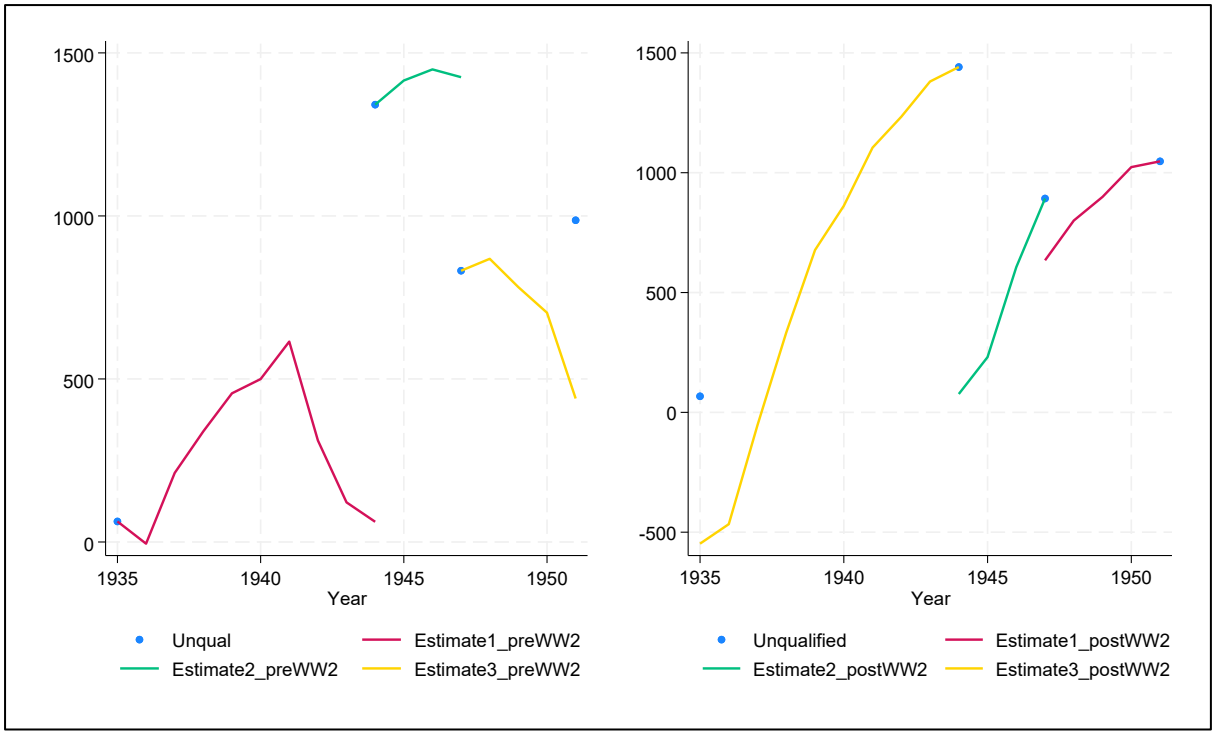

Figure 4.13. Predicted number of unqualified full-time teachers using the models for the pre-WW2 (left panel) and post-WW2 (right panel) periods, respectively

The number of unqualified teachers increases up to 1941 because of increased teacher demand and few teacher graduates. However, the pre-WW2 model is clearly not able to predict the large shortages in 1944-45. It must be the case that the amount of turnover is strongly underreported during the war since the other two variables in the prediction model seem to be correctly reported. The evidence clearly points to something specific happening toward the end of the war that our models are not able to capture.[36] None of the models are able to predict the fall in unqualified teachers from 1944-45 to 1947-48. One reasonable explanation is that some of the teachers leaving schools during the war returned afterward. It is a partial adjustment to the unexplained high teacher shortages in 1944-45.

The development in teacher shortages is more uncertain during the period around WW2 than in the other historical periods. In the following we will use the predictions from the pre-WW2 model for the periods 1936-37 to 1941-42 and the predictions from the post-WW2 model for the period 1948-49 to 1950-51. For the period 1942-43 to 1947-48, we use linear interpolation due to the absence of any other reasonable information.

4.3.3. Discussion

The turbulent times during WW2 and the following years make it challenging to make consistent time series. However, the numbers of students, teachers, admissions, and graduates seem accurately reported. The main challenge is to make estimates of teacher shortages.

[36] One potentially important incident is the so-called teacher strike in 1942. Since the large majority of the teachers in the country denied to teach the new nazi-curriculum, the nazis arrested teachers seemingly randomly in winter 1942 and sent them to prison camps. The teachers were reliefed in the fall 1942.

The School Act of 1936 expanded rural schooling and the demand for teachers. It seems that a consequence also was a slight increase in teacher shortages. However, teacher shortages were reported to be very high after WW2, and much higher than any model can predict. The main concern of the Ministry of Education was lack of teachers and school buildings. It seems reasonable that some teachers returned to the schools in the first few years after the war because the shortages decreased in the following years. However, the low capacity in teacher education prior to the war was exaggerated by the turbulences in higher education during WW2, which contributed to the increase in teacher shortages during the 1950s.

5. Teacher education and shortages in Norway during 163 years; 1861-2024

In this section, we connect the analyses for the three historical periods above to construct a coherent time series of teacher shortages, teacher education, and teacher demand for Norwegian public compulsory education.

5.1. Teacher man-years and the number of students

In most of the time period, the data is on the number of teachers in full- and part-time positions. Information on the number of teachers in part-time positions is available from 1938-39 in addition to three years in the period 1867 to 1875. While the share of part-time teachers was 4.0% in 1938-39 and 1939-40, it was 2.1%-2.3% in the observations from the 19th century. We assume in the following that the share of teachers with a part-time position was 4% in 1915-1938 and 2% prior to 1915.

From 1995-96, information in terms of teaching man-years is available. We spline the data series on teacher positins and teaching man-years by the school year 1997-98. There is nevertheless a break in the time series related to the extension of compulsory schooling to ten years this year. The number of man-years is considerably lower than the calculations based on positions. The difference is partly due to the fact that man-years are based on actual teaching, while the older data include all teachers at schools, including, e.g., principals and teachers in other leadership positions.[37] In addition, the older measure might be overestimated due to our assumption that teachers registered in full-time positions on average work 100%, while teachers registered in part-time positions on average work 50%. The definition of full-time has most likely been less than 100% position. However, the break in the data might be of limited importance for teacher shortages because we are mainly interested in shares based on the same data definition. However, it matters for other ratios based on different data sources, for example the graduation rate in teacher education presented below.

Figure 5.1 presents the logarithm of the two variables on teachers, together with the number of students. The variables are scaled to unity for the first year in the sample. The difference

[37] According to the new database on teacher and teaching man-years, about half of the difference is related to the change from measuring all teacher positions at school to measure only man-years in teaching.

between the two data series on teachers is about 20% at the time of the break in the data.[38] In the following, we spline the data at the reform year 1997-98. There is nevertheless a break in the time series related to the reform. This does not matter much for teacher shortages because both the nominator and the denominator are from the same data source.

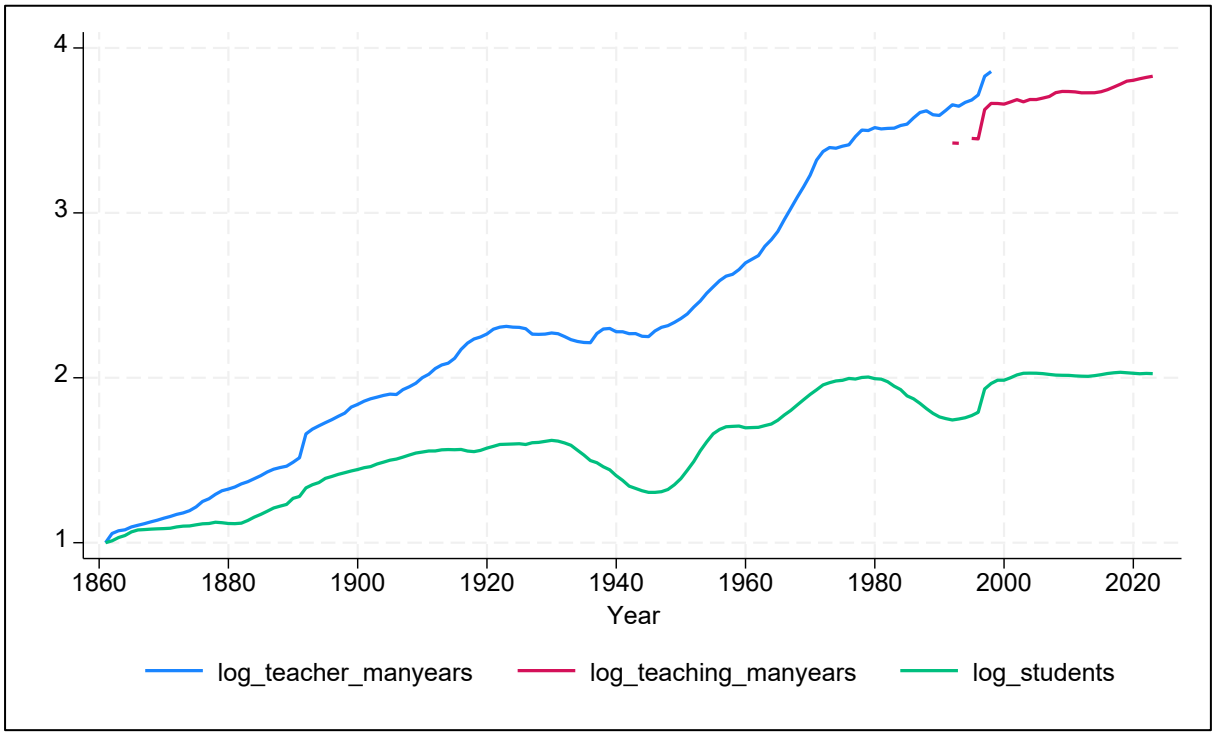

Figure 5.1. The logarithm of the number of teacher man-years, teaching man-years, and students

Figure 5.1 illustrates the massive growth in the number of teachers, previously documented by Hanushek (1986) for the US and Falch and Rattsø (1997) for Norway. The increase in four log-points implies that the amount of teaching resources in school is about 20 times higher at the end of the period than in the start of the period. There are jumps related to the reforms and new school laws in 1892-93, 1936-37, and 1997-98. The growth in the 1950s is related to the baby boom after WW2 and the growth during the 1960s is related to the gradual increase in compulsory education from 7 to 9 years.

The growth in the number of students is much smaller than the growth in teacher man-years throughout the period. The increase of one log point implies that the number of students is 2.7 times higher at the end of the period compared to the start of the period. Even in recent years, after the last reform in 1997-98, the gradual increase in the number of teacher man-years has increased despite the number of students staying constant.

[38] The number of full-time teachers plus 50% of the number of part-time teachers is 22% and 21% higher than the number of teaching man-years reported in the new database in 1997-98 and 1998-99, respectively.

5.2. Teacher education

Figure 5.2 presents the graduation rate, defined as the number of graduates from teacher education to the number of teacher man-years. When constructing this rate, it is a question of how to handle the fact that teacher man-years are measured differently after 1997, see Figure 9. In Figure 10, the denominator is upscaled after 1997 in order to make the graduation rate comparable over time. [39]

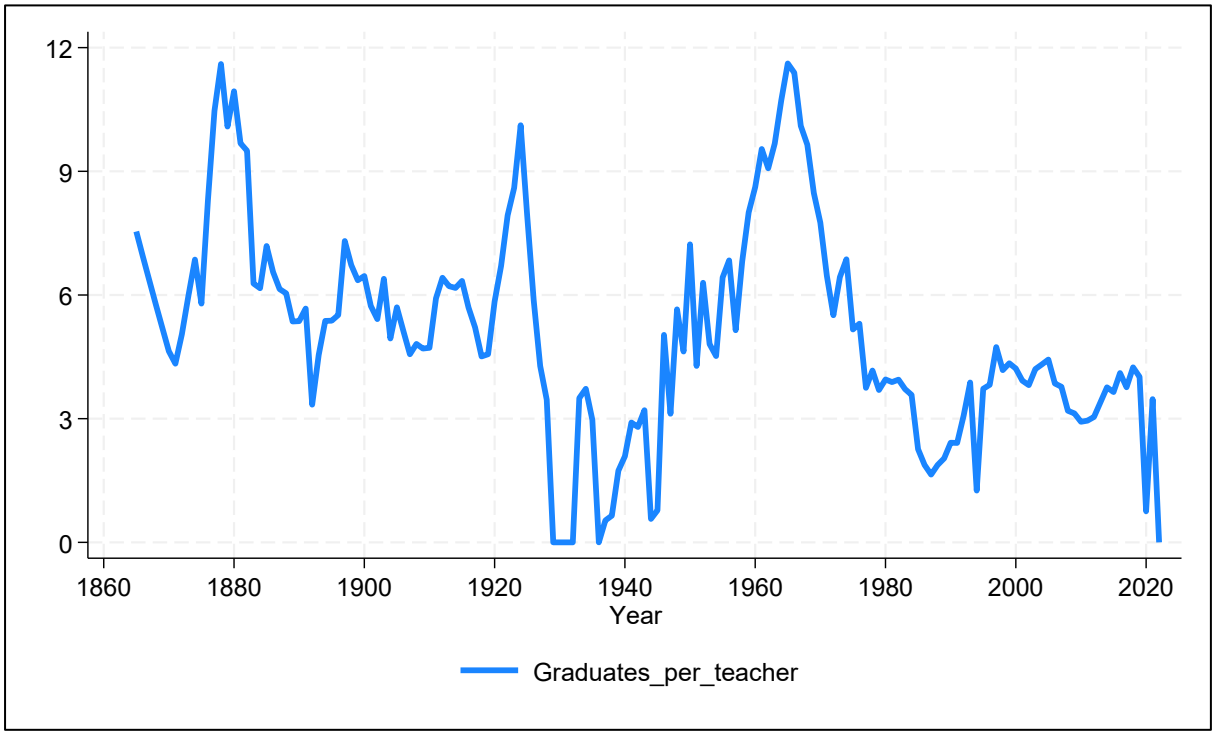

Figure 5.2. The graduation rate defined as the number of graduates per teacher man-year, percent

The graduation rate was high during the period of staffing the schools with formally qualified teachers after the new law in 1860 and became stable at about 5% from about 1890. The large fluctuation between WW1 and WW2 must be seen in relation to the development in teacher shortages presented below and the constant number of teachers during the period in contrast to the growth in all other periods in the data, see Figure 5.1. In some years teacher education did not admit new students, with the consequence of very few graduates some years later.

After WW2, teacher education expanded both in absolute and relative terms. The graduation rate peaks at 11.6% at the end of the school year 1966-67. Thereafter, the graduation rate declines and reaches 1.6% in 1986-87.

[39] One important difference in the new way of reporting man-years from the mid-1990s is that it only includes teaching tasks and not non-teaching tasks of teachers at the schools. However, teacher education must provide graduates also to the non-teaching tasks of the teachers. Thus, it seems reasonable to make a correction for the break in the data in 1997 such that teaching man-years in the school year 1997-98 and onwards are scaled up to the same level as teacher man-years measured similarly as the years prior to 1997-98. This procedure scales down the graduation rate by 1/1.22 = 18.3% from the school year 1997-98 and onwards compared to using teaching man-years as the denominator because teaching man-years are 22% lower than teacher man-years.

The decline in the graduation rate in the 1970s follows naturally from the unusually high rate in the 1960s and that the extension of schooling to 9 years was accomplished. However, the graduation rate continued to decline in the 1980s and reaches a non-sustainable level below 2%. This seems to reflect declined interest in teacher education and challenges in recruiting students. The change from a supply-constraint number of students to a demand-constraint number of students in teacher education programs seems to have happened in the early 1980s. From the school year 1981-82 to 1985-86, admission to teacher education declined by 42%.

During the last 40 years, the graduation rate has been close to 3%, except for the cases of increased duration of teacher education from 3 to 4 years in 1994-95 and from 4 to 5 years in 2020-21.[40] This is low in a historical perspective. One important explanation is probably that other kinds of qualifications than the regular teacher education for compulsory schooling have become more common. The main teacher education program presently covers about 2/3 of the qualified teachers in compulsory education. The change from 100% coverage happened gradually during the 1960s and the 1970s and as a jump in 1997-98 because of the reforms of the length of compulsory education. Another explanation is probably that the growth in the number of teacher man-years has been lower since the 1980s than in earlier periods because of stagnant number of students.

5.3. *Teacher shortages*

The information and predictions of the number of unqualified teachers in the pre-WW2 period above only cover teachers in full-time positions in rural areas. The large majority of teachers worked in rural areas, see Figure 4.1. In the yearly information from this time period, teacher qualifications have never been mentioned as a challenge for cities. In 1951-52, only 6,6% of the nonqualified teachers were employed in the cities, while the cities had 26.9% of the teachers. The share of nonqualified teachers was about 6 times larger in rural areas than in the cities. We assume that this relationship holds also for the period prior to 1951.

Second, up to 1971-72 we have only studied the situation for teachers in full-time positions. In this period, the extent of part-time teaching was relatively low, see Figure 4.9. However, the probability that part-time teachers are unqualified was much higher than for full-time teachers, see Figure 4.8. As described in Section 4.2, we assume for the pre-1971 period that the probability of being unqualified is five times higher among part-time teachers than among full-time teachers.

For years without information on unqualified teachers, the predictions are based on the approaches described in Sections 4.1.2, 4.2.2., and 4.3.2. The predictions are smoothed such that the time series match the actual observations at the end of each prediction period.[41]

[40] Notice that the denominator in the graduation rate change definition from the school year 1997-98, see the discussion in relation to Figure 5.1. All else equal, the graduation rate becomes 25% higher after the break in the data.

[41] The teacher shortage is predicted each fifth year in the period 1876-77 to 1934-35, and in the periods 1936-37 to 1943-44, 1946-47 to 1950-51, 1957-58 to 1961-62, and the school year 1975-76.

Because we spline the time series on teachers and teaching man-years by the year 1997-98, it is in principle a break in the time series. However, shortages are measured in percentages and the break in the data is related both to the nominator and the denominator. Thus, the measure of shortages should be reasonably consistent. In addition, the compulsory school starting age was reduced from the year the child turns 7 to 6 the same year. Teacher education for pre-schools with an extra course became considered a formal qualification, expanding the pool of qualified teachers. Thus, there is nevertheless a break in the time series.[42]

The comparable time series for teacher shortages, from the school year 1861-62 to 2023-24, is presented in Figure 5.3. There is a sharp decline in teacher shortages after the requirement of teacher education was introduced in 1860. By the early 1880s, teacher shortages are at a comparable level to modern times. The estimates imply a sharp increase in teacher shortages in 1892-83, the year in which the school year extension and reduction in the school starting age of the School Act of 1889 applies for the first time. The spike in 1920-21 is, based on our empirical findings in Table 4.1, a result of a major increase in teacher demand. Our predictions imply that the spike continues to 1922-23, before shortages decline rapidly and to basically zero in the late 1920s.[43]

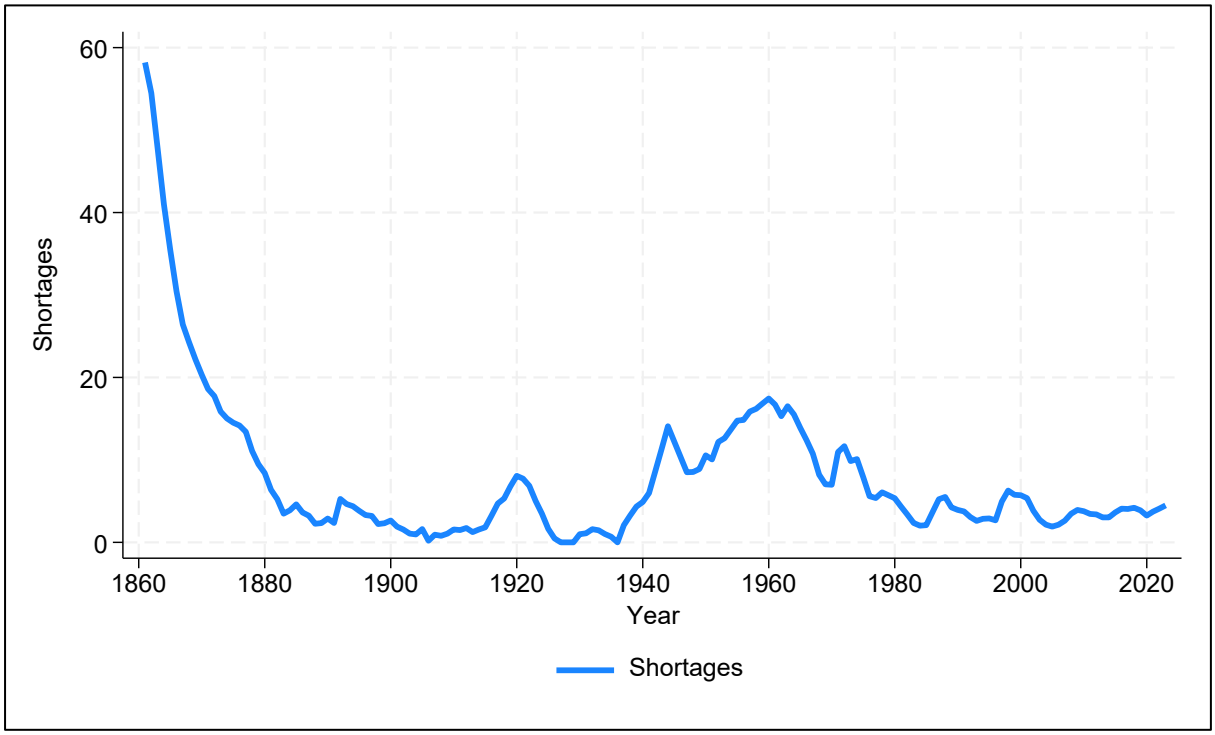

Figure 5.3. Teacher shortages, percent

[42] In the splining years, the teacher shortages based on teaching man-years is 3.5% in 1996-97 (prior to the spline) and 4.9% in 1997-98 (after the spline). The corresponding numbers based on teachers in full-time and part-time positions are 2.7% and 3.4%. The difference might be due to the fact that teaching man-years is based on actual teaching, while the older data include, e.g., principals and teachers in other leader positions. The latter is expected to include less unqualified teachers, which might explain the higher measured shortages after the spline.
[43] The model predicts a negative number of unqualified teachers in 1927-28 to 1929-30, which is overridden and set to zero in our predicted time series.

Teacher shortages increased dramatically during WW2. After an adjustment right after the war, shortages continued to increase and reached the highest level at 18.5% in 1960-61 (our prediction) and 17.6% in 1963-64 (data observation). The major increase in teacher demand after the war was not matched by a sufficient expansion of teacher education. However, teacher education doubled the capacity around 1960, leading to a major subsequent reduction in teacher shortages. After a short-term increase in teacher shortages related to the extension of compulsory education from 9 to 10 years in 1997-98, the shortages have been relatively stable in the 21th century. From 2002-03 and onwards, teacher shortages have been consistently below 4.5%.

An alternative to using model-based predictions in years with missing information is to use simple linear interpolation. Figure 5.4 presents the time series using linear interpolation together with our estimated time series for the relevant time period. Our estimated teacher shortages provide some time variation that is not captured by the simple interpolation.

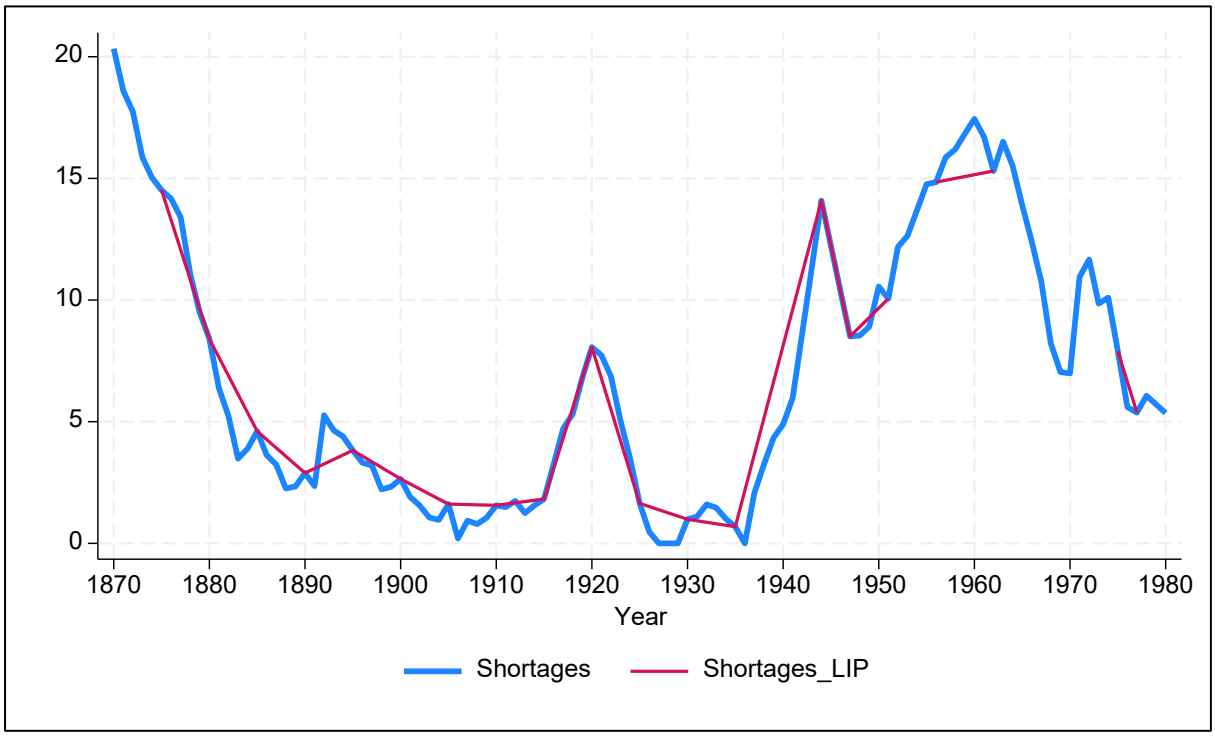

Figure 5.4. Estimated yearly teacher shortages (blue line) and linear interpolations for years without observations (red line)

6. County level data for the period 1870-71 to 1935-36.

As described above, actual data to compute teacher shortages are only available at 5-year intervals between the school years 1870-71 and 1935-36. The publications from the Ministry of Education in the period, which are used to calculate statistics at the national level, additionally contain data at the county level. This section presents the development in teacher shortages, teacher demand, the number of students, the number of schools, and the share of

ambulatory schools in this period in different counties (*Amt,* later denoted *Fylke*).[44] The statistics only capture the rural areas, which include the majority of the students and teachers, see Figure 4.1.

Figures 6.1 and 6.2 present the development in the number of teachers and students, respectively. In all counties, the number of teachers and students increased during most of the period. As to the distribution of teachers, the most significant change is the large increase in the county of Akershus (the county bordering the capital city of Oslo) and the stagnation in all other counties after 1920. It is a similar pattern for the number of students.

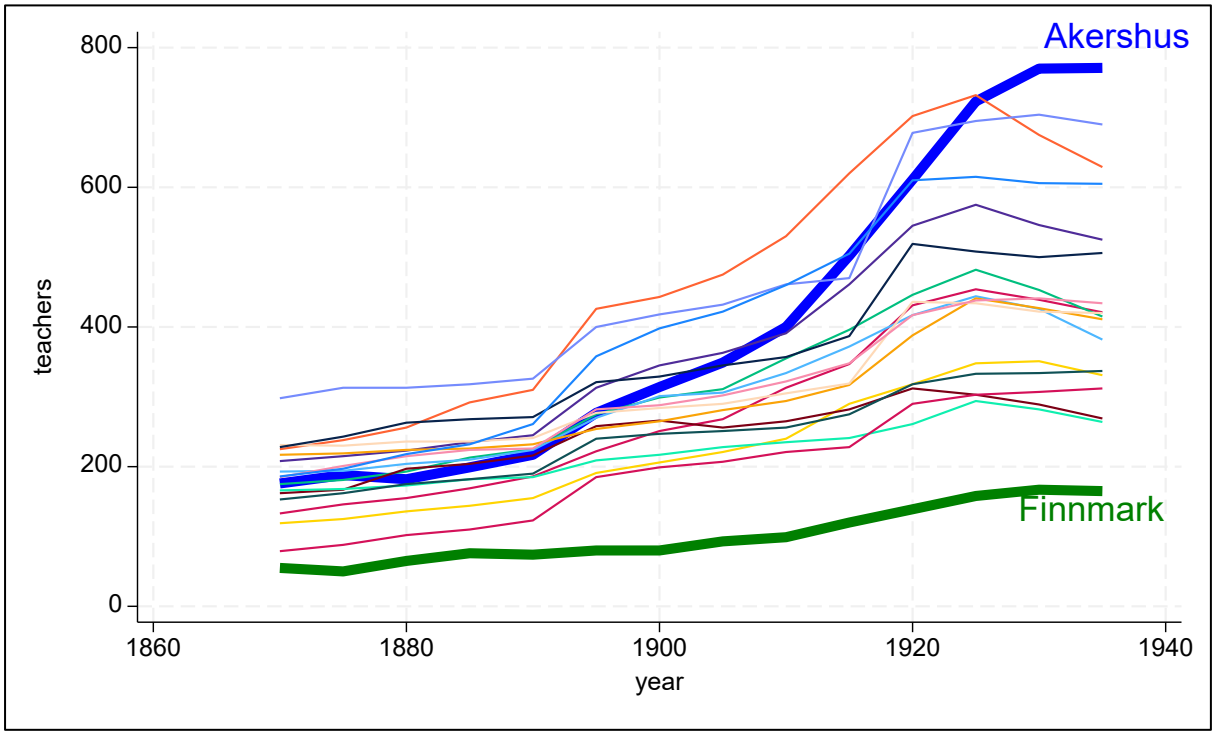

Figure 6.1. The number of teachers at the county level

The change in the geographical distribution of teachers and students reflects the overall change in the geographical distribution of the population due to the industrialization of the country with a reduction in the number of people employed in farming and fisheries and increased employment in manufacturing industries.

Figure 6.3 presents the development in teacher shortages from 1870 to 1935 by county. The figure shows that most counties had a large amount of teacher shortages in 1870, in accordance with the aggregated time series above. However, the variation was quite large across counties. The county of Vest-Agder experienced the highest shortages, while the shortages were the smallest in the county of Troms in Northern Norway. The fact that a teacher college was

[44] The 18 counties are (using the county names as of 1918): Akershus, Østfold, Vestfold, Buskerud, Oppland, Hedmark, Telemark, Aust-Agder, Vest-Agder, Rogaland, Hordaland, Sogn og Fjordane, Møre og Romsdal, Sør-Trøndelag, Nord-Trøndelag, Nordland, Troms, and Finnmark, see also the description and data sources in Appendix A5.

established in Troms as early as 1826 can perhaps explain the relatively low shortages in the northern part of the country at the beginning of the period.

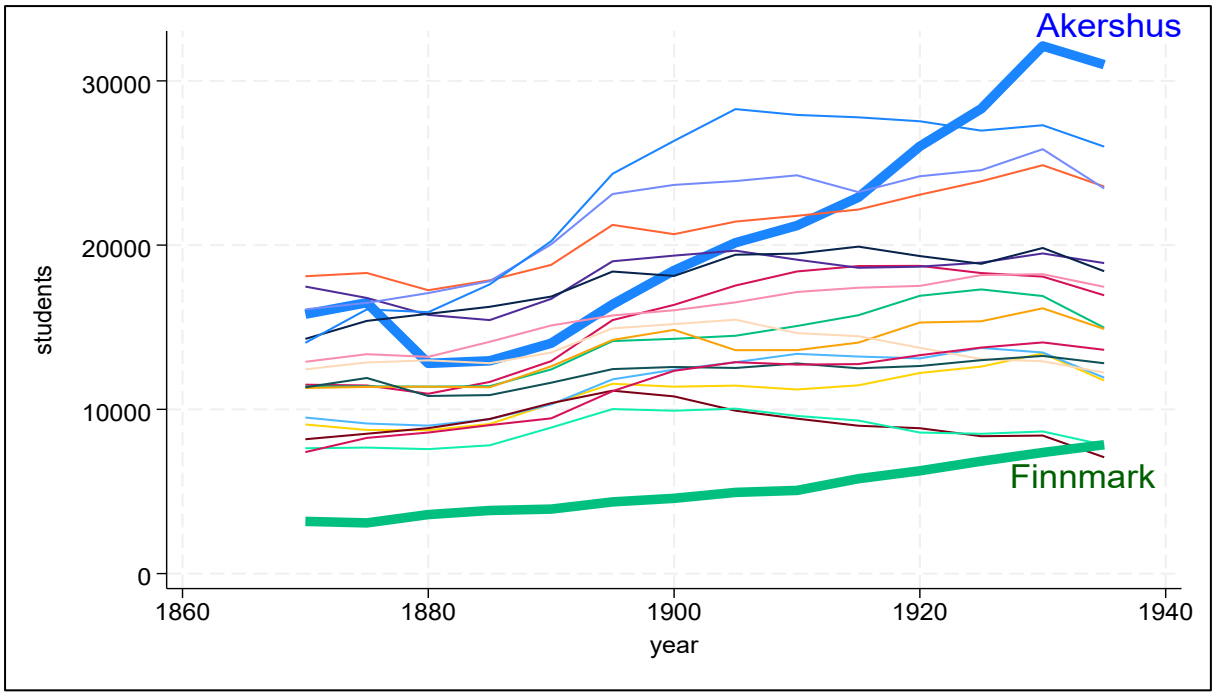

Figure 6.2. The number of students at the county level

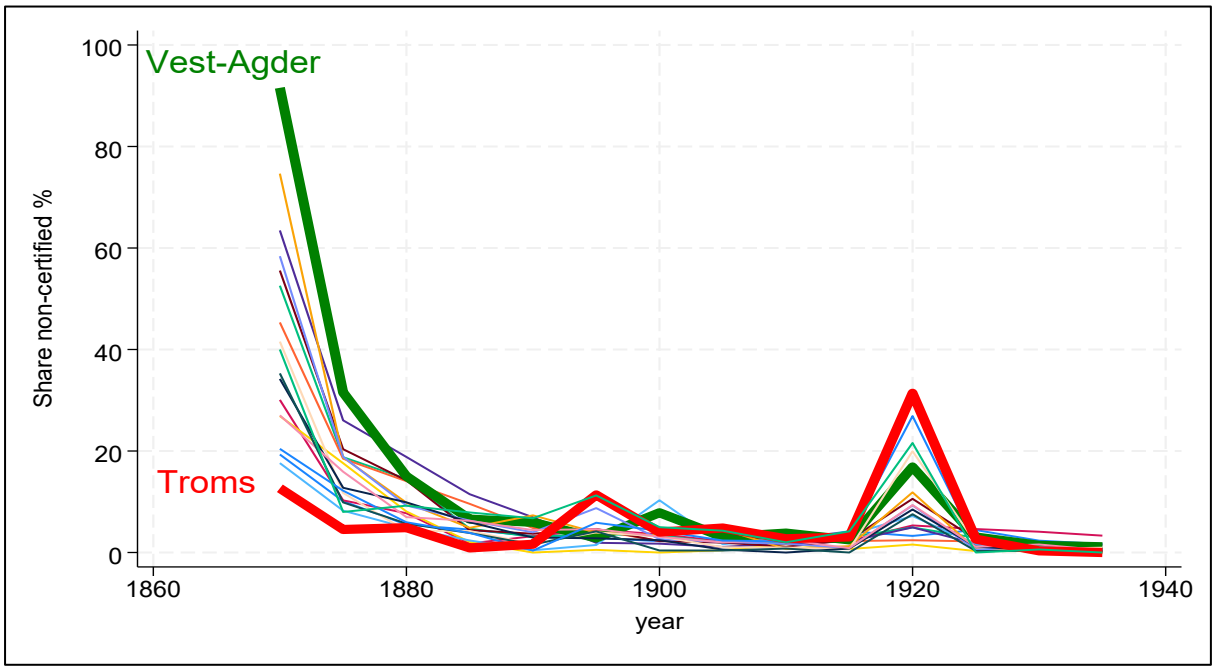

Figure 6.3. Teacher shortages at the county level

From 1870 to 1885, shortages dropped substantially in all counties due to capacity increases in teacher education programs all over the country. Shortages fluctuated somewhat in the last two decades of the 19th century. After a period with limited shortages between 1900 and 1915, teacher shortages again increased in 1920, while it was almost eliminated by 1935. It should

be noted that the distribution of teacher shortages across counties changed substantially during the period 1870-1935. While shortages were lowest in Troms in 1870-1880, this county experienced the largest increase in shortages from 1915 to 1920.

Figure 6.4 shows the development in the number of schools (*Kretser*) across the counties. The overall picture is that the number of schools was quite stable in the period, which likely reflects that the settlement pattern in rural areas remained scattered up to WW2. Large investments in the building of roads and bridges with increased transportation possibilities took place after WW2.

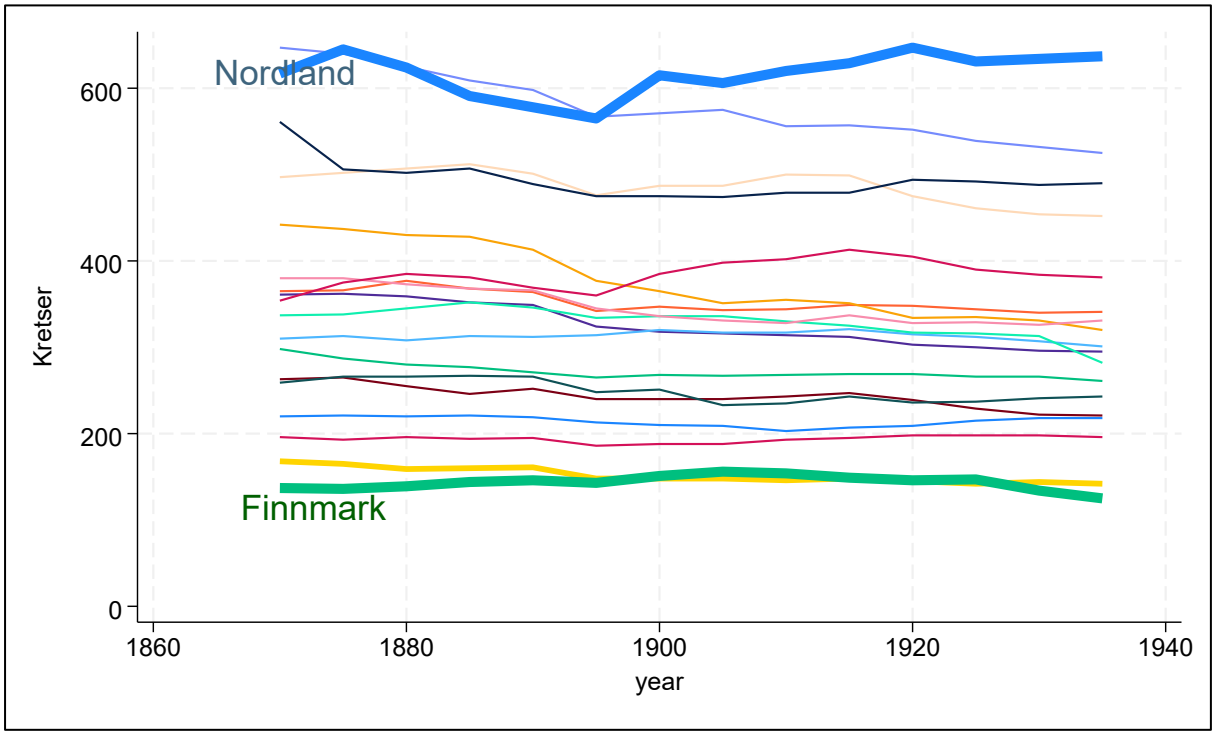

Figure 6.4. The number of schools at the county level

As discussed in Section 3 above, a substantial share of primary education services in the first half of the 19th century were provided by ambulatory schools (*Omgangsskoler*) without specific school buildings. Although the 1860 School Act states that teaching should take place in permanent school buildings, it took several decades before it was fully implemented. Figure 6.5 presents the share of schools organized as ambulatory schools. From a situation where ambulatory schools were the major school type in most counties in 1870, almost all primary schooling took place in permanent schools in the 20th century. This reflects the large expansion in school-building triggered by central government subsidies of school building initiated with the 1860 School Act. It is a large variation across the counties in the 19th century, and ambulatory schools were particularly uncommon in the northernmost county of Finnmark. This fact may be an additional reason for the low share of teacher shortage in Finnmark in the 19th century.

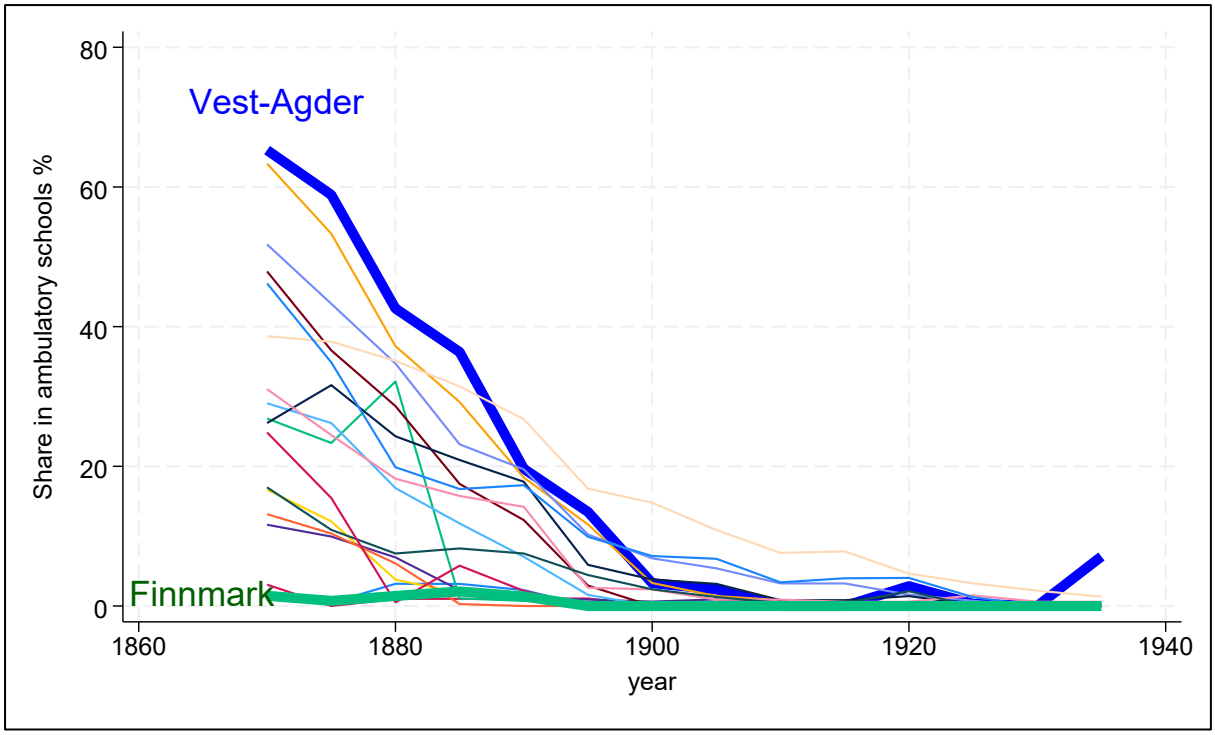

Figure 6.5. The share of ambulatory schools at the county level

7. Concluding comments

This paper documents the construction of a historical data set for Norwegian compulsory education covering more than 160 years from 1861 to 2024. The data include the number of students and teachers, teacher shortages measured by the share of teachers without the formal qualifications determined by law, and the number of admissions and graduates from teacher education institutions. In addition to the national time series, we also present panel data at the county level at a five-year frequency covering the period 1870-1935.

The construction of the data series is based on a historical description of the development of the compulsory education system, including school finance and teacher wage-setting institutions, in addition to the system for teacher education. The School Act of 1860 required that teachers should have formal teacher education or similar qualifications in order to be appointed to permanent teaching positions. At this point, the law has basically been unchanged, including the most recent School Act implemented in 2024. This rule has historically governed the collection of data, which makes us able to construct a consistent data series of teacher shortages.

The national time series document that after an initial period with large teacher shortages, shortages have fluctuated around 5-6%. But we also document periods with large deviations from this average level. The deviations seem partly related to changes in teacher demand and the capacity of teacher education. The size of teacher education in terms of the number of

admissions and graduates varies from zero around 1930 to graduation cohorts exceeding 10% of the teacher man-years in the 1960s.

The data constructed in this paper provides the basis for more detailed empirical analyses of the relationship between teacher shortages, fluctuations in teacher demand, and teacher supply as determined by the size of the teacher education.

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Appendix A: Data sources and data adjustments

A1. Sources for teacher qualifications

Table A1 summarizes the available information on unqualified teachers, while Table A2 summarizes the main assumptions made to make a consistent yearly time series on teacher shortages.

Table A1. Available information on teacher qualifications shortages. Year refers to the start of the school year

Information	Period
The number of full-time teachers without the required qualifications in rural areas	1861-1875, 1880, 1885, 1890, 1895, 1900, 1905, 1910, 1915, 1920, 1925, 1930, 1935
Estimates of the Ministry of Education	1944, 1947
The total number of teachers without the required qualifications, including both full-time and part-time teachers	1951-1956
The number of full-time teachers without the required qualifications	1962-1971
The number of full-time teachers and the number of part-time teachers without the required qualifications	1972-1975, 1977-1980, 1982-1991
The number of teaching man-years without the required qualifications, excluding non-teaching activity	1992-1993, 1994-2023

Table A2. The assumptions made to create a coherent time series on teacher shortages in terms of teacher man-years. Year refers to the start of the school year

Assumption	Period
Interpolating the number of full-time unqualified teachers in rural areas using the model $\Delta^5 Unq_t = 129.9 + 0.39 * \left(\Delta^5 D_t + \sum_{t=-4}^{0} \left(T_{t-1} - G_{t-1} \right) \right)$	1876-1879, 1881-1884, 1886-1889, 1891-1894, 1896-1899, 1901-1904, 1906-1909, 1911-1914, 1916-1919, 1921-1924, 1926-1929, 1931-1934, 1936-1941
Number of teachers in the cities is 10% of the number of teachers in rural areas	1861-1867
Number of teachers in the cities linearly interpolated	1869-1870, 1871-1875
The share of unqualified teachers in the cities is 1/6 of the share in the rural areas	1861-1950
The share of unqualified teachers among part-time teachers is 5 times larger than among full-time teachers	1861-1971
The share of part-time teachers is 2%	1861-1914
The share of part-time teachers is 4%	1915-1938
Full-time teachers have on average 100% position	1861-1996
Part-time teachers have on average 33.3% position	1861-1972
Part-time teachers have on average 40% position	1973
Part-time teachers have on average 50% position	1974-1996
Linear interpolation of the share of unqualified teacher man-years	1942-1943, 1945-1946
Interpolating the number of full-time unqualified teachers using the model $\Delta Unq_t = -113.1 + 0.41 * \Delta D_t + 0.041 * D_{t-1} - 0.64 * \frac{1}{3} * \sum_{t=-2}^{0} G_{t-1}$	1948-1950, 1957-1961, 1976
Using teaching man-years, excluding non-teaching tasks of teachers and leaders	1997-2023

A2. The period 1861-62 to 1935-1936

The ***source*** for all data is yearly publications from the Ministry of the Church and Education (https://www.ssb.no/a/histstat/publikasjoner/histemne-21.html).

I. The following adjustments are made for ***schools***

- For the cities, information on students is not available prior to the school year 1875-76, except for the years 1852-53, 1867-68, and 1870-71. Data for the intervening years are linearly interpolated.
- For the cities, information on teachers is not available prior to the school year 1875-76, except for the years 1867-68 and 1870-71. Data for the intervening years are linearly interpolated. Prior to 1867-68, it is assumed that the share of teachers in the cities is equal to the share in 1867-68.
- For the cities, information on teacher qualifications is not available. It is assumed that the share of unqualified teachers is 6 times larger in rural areas than in urban areas.
- The number of part-time positions is not reported in the period. Part-time teaching was rare prior to WW2. It is assumed that the number of part-time teachers was at 2% of the number of full-time teachers prior to 1915-16, and at 4% thereafter.

- The total number of man-years is set equal to the number of teachers in full-time positions plus one third of the number of teachers in part-time positions.

II. The following adjustments are made for ***teacher education***

- Data on students in ordinary teacher education is reported yearly from 1875-76, and data is in addition available for 1866-67 and 1870-71. The length of the ordinary programs was two years in the 1800s and expanded in years during the 1900s.
- Data on graduates from ordinary teacher education (Lærerseminarer) starts in 1871-72. The number of graduates for 1866-67 to 1870-71 is interpolated based on the number of students.
- In 1902, teacher education admitted students both to the old 2-year program and to the new 3-year program. No information exists for admission this year. The number of students in their second year in the following school year is used to predict the admissions.
- Data for a specific teacher education program for grades 1-4 in the period 1873-74 to 1920-21 is meager. There is yearly information on graduates from 1873-74 to 1885-86 and five-year averages for the period 1891-92 to 1920-21. The program accounted for about 1/3 of the graduates from 1880 to 1905, declining to about 5% from about 1910. Admission is assumed to be equal to the number of graduates.
- No information exists for the one-year program from 1886-87 to 1890-91. The number of graduates was similar before and after this period, and it is assumed a similar number of graduates in the period.
- In the period 1920-21 to 1926-27, some students with a gymnasium degree were enrolled in a one-year program. From 1936-37, the program was extended to two years and accounted for about half of the total admissions.

A3. The period 1951-52 to 2023-24

There are several different ***sources*** for the period. The collection of data moved in 1951 from the Ministry of the Church and Education to Statistics Norway. Statistics Norway has reported data in various formats up to about 2000. Since the mid-1990s, online databases are available.

In the period 1951-52 to 1956-57, the publication "Statistics on Education" mainly followed the same structure as in the previous years (https://www.ssb.no/a/histstat/publikasjoner/histemne-21.html). From 1962-63, data on compulsory education and teacher education are presented in different publications.

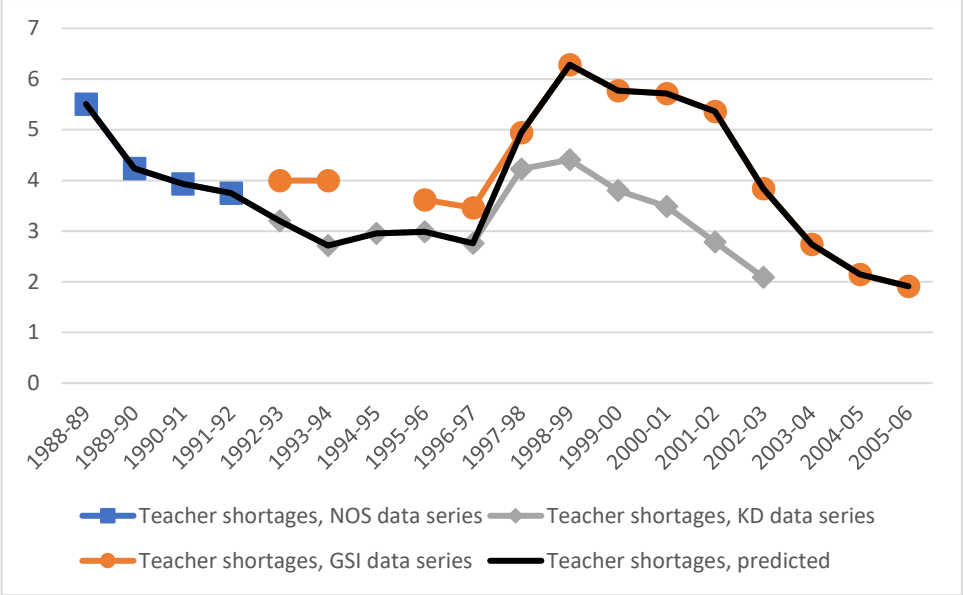
- Schools
  - Up to 1991-92, the reporting of data mainly followed the old structure with similar information (*NOS*). The publication changed name from "Statistics on Education" to "Educational Statistics. Primary Schools" in 1962-63. The publication continued up to 1998-99. (https://www.ssb.no/a/histstat/publikasjoner/histemne-21.html, https://www.ssb.no/a/histstat/publikasjoner/ereg77-96.html#04 and https://www.ssb.no/utdanning)
  - In the period 1992-93 to 2002-03, "Educational Statistics" does not include information on teacher qualifications. The digital database *Kommunedatabasen* (*KD*) includes information on the number of teachers in full-time and part-time positions and teacher qualifications at the municipal level (https://kommunedatabasen.sikt.no/) . The aggregated number of teachers and students are very close to the numbers in Education Statistics, but not identical. The information is used to calculate the share of unqualified teachers.

- The digital database *GrunnSkolens Informasjonssystem* (*GSI*) started in 1992-93 and is the present data collecting system for compulsory schools (https://gsi.udir.no/). In addition to the number of students, the database includes the number of teaching man-years, specified by teacher qualifications, but without distinguishing between full-time and part-time positions. Teaching man-years accounts for 94% of total teacher man-years in 1995-96, decreasing to 90% in 2022-23.

- Teacher education
  - Up to 1959-60, the data is published in the same publications as for compulsory education (Statistics on Education).
  - From 1962-63, information is published in "Educational Statistics. Vocational Schools" (1962-63 to 1970-71), "Educational Statistics. Vocational Schools and Colleges" (1971-72 to 1974-75 and "Educational Statistics. Universities and Colleges" (1975-76 to 1995-96) with somewhat varying structure.
  - From 1996-97, the data are from the digital database on higher education (DBH), administrated by a directorate (https://dbh.hkdir.no/).

I. The following adjustments are made for ***schools***.

- No information exists for the school year 1961-62. All variables are linearly interpolated.
- Information on teacher qualification is missing for the period 1957-58 to 1961-62 and for the school year 1976-77. See the main text for the calculation of predictions for these years.
- Information on part-time teacher positions is missing for the school years 1960-61 and is linearly interpolated. Part-time teachers account for 14% of all teachers in 1959-60 and 12% in 1962-63.
- In the period, 1972-73 to 1975-76, the share of part-time teachers increased from 15.3% to 28.5%. At the same time, the number of full-time female teachers *decreased* by 8.7%, while the number of full-time male teachers *increased* by 8.2%. There was a change in the tariff agreement that gave the workers the right to choose a position somewhat below 100%. This seems to have been exploited by females. It is assumed that the average part-time position increased from 1/3 to 1/2 from 1972-73 to 1974-75, using average part-time position of 40% in 1973-74.
- The number of students and teacher man-years are from *NOS* up to 1996-97 and from *GSI* from 1997-98.
  a. The data sources have consistent measures of the number of students. The difference is ±0.3% during the period 1992-93 to 1996-97.
  b. GSI has in its first years some major shortcomings for teachers and includes no information on teachers in 1994-95.
  c. The two data sources have different measurements of teachers. The main difference is that *GSI* only includes man-years in teaching while *NOS* only includes the number of teachers. The average size of the positions in *NOS* is unknown, and teachers do more than teaching (leadership positions, leaves, etc.). Thus, there is a break in the time-series for teacher man-years in 1997-98.
- Teacher shortages are calculated based on *NOS* up to 1991-92, based on *KD* in 1992-93 to 1996-97, and based on *GSI* from 1997-98. The figure below presents the measure of teacher shortages (in percent) from the two sources in the overlapping period.



II. The following adjustments are made for ***teacher education***

- The data only include the main teacher education program for compulsory schooling. The extension from 7 to 9 years of schooling during the 1960s implied that some other types of teacher education qualified for teaching in grades 7 to 9.
- Information on the number of graduates is missing for 1956-57 to 1970-71. Otherwise, the information on the number of graduates is complete.
- After WW2, some teacher education institutions implemented a practice year in the two-year program, which in essence is a three-year program. In this program, the students worked in schools in their second year and were not registered as students. The information on the number of students on this program has limitations. It is calculated based on the information for some specific schools and the yearly number of students in each class. The information is only available up to 1956-57.
- From 1957-58, the data are less detailed. Admission to the 2-year and 4-year programs are not reported separately. However, it is reported how many were formally qualified for the 2-year program. This number is used to distinguish between admission to the 2-year and 4-year programs in 1957-58 to 1961-62. There is no information on the share of the students at the formal 2-year program that in essence had a three-year program. It is assumed that this number is constant during the period.
- 1960-61 and 1961-62: No data exist. Total admission is linearly interpolated, and it is assumed that the share of students on the 4-year programs is 30%, comparable to the years close in time (variation from 25% to 36% in the period 1950-51 to 1965-66).
- 1986-87: Information on admission is missing. The number of students in their second year in the forthcoming school year, adjusted for observered normal dropout rate of 10%, is used.
- 1989-1990 and 1990-91: The information only includes the sum of students in their two first year of studies. It is assumed a dropout of 10% from year 1 to year 2.
- 1991-92: Information on the number of students is missing. The sum of the number of students in year 1 and 2 is linearly interpolated, and it is assumed dropout of 10%.
- 1992-93: The information only includes the sum of students in their two first year of studies. It is assumed a dropout of 10% from year 1 to year 2. Notice that teacher education extended from a 3-year program to a 4-year program.

- From 2008-2009, the data source introduces an distinguishen between admission and enrollment. The latter is measured later in the first semester and is a more precise measure. Enrollment is close to 5% lower in the following years. Enrollment is reported from 2008-2009.
- In 2017-2018, teacher education was extended from a 4-year program to a 5-year program.

A4. The period 1936-1937 to 1950-51

The ***source*** for all data is yearly publications from the Ministry of the Church and Education (https://www.ssb.no/a/histstat/publikasjoner/histemne-21.html). This is the same source as for the whole period 1860-1960.

The publications continued to be published two years after the end of the school year up to the statistics for the school year 1942-43, and were published with three years delay thereafter. Although the Ministry reports some struggle with collecting the data, the data series for the number of teachers and students, and the information for teacher education, seems consistent. The exception is the situation in the most northern part of the country (Finnmark), where information is missing for the school years 1942-43 to 1945-46. Notice that the statistics simply count numbers. They are uninformative about the extent of actual schooling.

I. The following adjustments are made for ***schools***

- The number of students and teachers in Finnmark is predicted based on information on the development in other areas and the difference between the reported information in 1941-42 and 1946-47. The predictions take into account the increase in other areas due to the forced evacuation in 1944. The changes in percent are reported in the table below. They are small because Finnmark is a small county in terms of population.

School year	Students	Teachers
1940-41	+0.03%	0
1941-42	+0.09%	+0.05%
1942-43	+2.87%	+2.39%
1943-44	+2.87%	+2.39%
1944-45	+1.99%	+2.21%
1945-46	+2.64%	+1.56%
1946-47	+0.14%	-0.12%

- The number of qualified teachers in rural areas is only reported in 1935-36, and for both rural and urban areas in 1951-52. However, in their report for the school year 1945-46, the Ministry of Education reports that the need for extra teachers was about 1800-2000 teachers at the end of the war (spring 1945), which was reduced to 1200 in 1947-48.[45] It is assumed that the number of unqualified teachers was 1800 in 1945-46 and 1200 in 1947-48 and include both full-time and part-time positions. As for the periode after 1951, it is assumed that

[45] The exact wording is «Etter frigjøringen var det et meget stort behov for lærere i folke- og framhaldsskolen. Behovet var anslått til mellom 1 800 og 2 000 lærere. Blant annet ved en forsert utdanning av lærere på den 2-årige linjen for studenter, var behovet ved utgangen av 1947-48 betydelig mindre. En regner likevel med at folke- og framhaldsskolen på dette tidspunkt trengte ytterligere ca. 1 200 utdannete lærere.» (Source is Norges Offisielle Statistikk XI 95: Skolestatistikk 1947-48, page 7.)

the share of unqualified teachers was 5 times larger in the group of part-time teachers than for full-time teachers.

II. No adjustments are made for ***teacher education***

A5. Panel data for the period 1870-1871 to 1935-36

The ***source*** for all data is yearly publications from the Ministry of the Church and Education (https://www.ssb.no/a/histstat/publikasjoner/histemne-21.html).

For the county (*amt*, *fylke*) named *Møre og Romsdal* the yearly publications from the Ministry, reported data for two subregions (*fogderi*): *Sunnmøre* and *Romsdal og Nordmøre.* The numbers from these two subregions are summed together to obtain the data for the county named *Møre og Romsdal*.

The list below shows number (idfylke) used in the data file and the corresponding names of the counties before and after 1918 The names after 1918 are used in the county figures in the text.

idfylke	Before 1918	After 1918
1	Akershus	Akershus
2	Smålenene	Østfold
3	Buskerud	Buskerud
4	Jarlsberg og Larvik	Vestfold
5	Kristians	Oppland
6	Hedemarken	Hedmark
7	Bratsberg	Telemark
8	Nedenes	Aust-Agder
9	Lister og Mandal	Vest-Agder
10	Stavanger	Rogaland
11	Søndre Bergenhus	Hordaland
12	Nordre Bergenhus	Sogn og Fjordane
13	Romsdal	Møre og Romsdal
14	Søndre Trondhjem	Sør-Trøndelag
15	Nordre Trondhjem	Nord-Trøndelag
16	Nordland	Nordland
17	Tromsø	Troms
18	Finnmarken	Finnmark

Appendix B: The time series data

The fall in which the school year starts	Number of students, cities	Number of students, rural	Number of students, total	Number of full-time teachers, cities	Number of full-time teachers, rural	Number of full-time teachers, males	Number of full-time teachers, females	Number of full-time teachers, total
1861		192077	217383.40		2805			3148.05
1862		193498	219907.67		2966			3328.74
1863		196789	224301.93		3015			3383.73
1864		198467	227083.20		3033			3403.94
1865		202406	232125.47		3087			3464.54
1866		204001	234823.73		3118			3499.33
1867	31926	203456	235382	385	3148	3461	72	3533
1868		203766	236036.33		3165			3572.67
1869		203867	236481.67		3178			3608.33
1870	32959	203800	236759	453	3199	3521	131	3652
1871		204409	237337.80		3211			3690.40
1872		206314	239212.60		3232			3737.80
1873		207524	240392.40		3239			3771.20
1874		207822	240660.20		3265			3823.60
1875	32808	209461	242269	585	3326	3599	312	3911
1876	32826	210981	243807	646	3397	3652	391	4043
1877	33703	210543	244246	659	3450	3688	421	4109
1878	38213	207922	246135	739	3482	3746	475	4221
1879	39074	206320	245394	792	3522	3771	543	4314
1880	39318	204926	244244	828	3530	3780	578	4358
1881	41114	202916	244030	831	3582	3805	608	4413
1882	41590	203154.50	244744.50	874	3623	3831	666	4497
1883	42098	206621.00	248719.00	898	3659	3839	718	4557
1884	44959	208885.50	253844.50	949	3692	3850	791	4641
1885	45783	212274	258057	1006	3720	3868	858	4726
1886	48963	214091.00	263054.00	1059	3774	3897	936	4833
1887	50525	217780.00	268305.00	1097	3819	3906	1010	4916
1888	52250	219094.00	271344.00	1121	3845	3918	1048	4966
1889	52995	221203.00	274198.00	1137	3869	3930	1076	5006
1890	53850	230628	284478	1221	3907	3941	1187	5128
1891	55371	232356	287727	1252	4017	3994	1275	5269
1892	58871	244203	303074	1449	4641	4320	1770	6090
1893	62128	246848	308976	1552	4716	4345	1923	6268
1894	64158	248906	313064	1617	4778	4374	2021	6395
1895	67217	253916	321133	1680	4838	4402	2116	6518
1896	69466	255433	324899	1738	4901	4439	2200	6639
1897	71577	257440	329017	1819	4957	4496	2280	6776
1898	73313	259060	332373	1899	5007	4552	2354	6906
1899	75599	260226	335825	2088	5077	4656	2509	7165
1900	77303	261518	338821	2133	5150	4670	2613	7283
1901	79094	263485	342579	2206	5221	4723	2704	7427
1902	82440	262439	344879	2281	5254	4776	2759	7535
1903	84309	266095	350404	2313	5298	4804	2807	7611
1904	85460	268876	354336	2354	5336	4832	2858	7690
1905	87841	270698	358539	2350	5400	4865	2885	7750
1906	89620	271401	361021	2392	5341	4801	2932	7733
1907	90129	275155	365284	2434	5530	4951	3013	7964
1908	92941	277052	369993	2495	5611	5039	3067	8106
1909	94609	279823	374432	2575	5704	5116	3163	8279
1910	96602	280121	376723	2725	5838	5220	3343	8563

1911	97276	281800	379076	2819	5923	5294	3448	8742
1912	97968	281204	379172	2959	6092	5416	3635	9051
1913	98431	283364	381795	3043	6208	5507	3744	9251
1914	97681	284690	382371	2976	6373	5571	3778	9349
1915	98876	283201	382077	3087	6480	5633	3934	9567
1916	98366	284259	382625	3151	6946	5908	4189	10097
1917	96784	282117	378901	3157	7337	6076	4418	10494
1918	95773	281862	377635	3240	7517	6225	4532	10757
1919	95832	284643	380475	3201	7688	6245	4644	10889
1920	96436	289339	385775	3253	7838	6080	5011	11091
1921	99647	290306	389953	3334	8082	6436	4980	11416
1922	100972	293438	394410	3363	8195	6458	5100	11558
1923	100366	294612	394978	3385	8228	6475	5138	11613
1924	99723	295830	395553	3322	8236	6449	5109	11558
1925	99024	297103	396127	3261	8280	6420	5121	11541
1926	97862	296450	394312	3221	8227	6454	4994	11448
1927	98504	300096	398600	3025	8050	6339	4736	11075
1928	97601	301820	399421	2980	8083	6382	4681	11063
1929	97373	304462	401835	2993	8087	6432	4648	11080
1930	96877	307485	404362	3019	8139	6423	4735	11158
1931	95576	306963	402539	2991	8115	6526	4580	11106
1932	92946	305152	398098	2872	8045	6478	4439	10917
1933	90259	302223	392482	2788	7926	6416	4298	10714
1934	85905	295044	380949	2718	7879	6343	4254	10597
1935	81922	287939	369861	2644	7887	6298	4233	10531
1936	78043	279750	357793	2596	7921	6393	4124	10517
1937	74912	278160	353072	2619	8500	6724	4395	11119
1938	72105	272463	344568	2655	8763	6848	4570	11418
1939	69512	268751	338263	2627	8831	6830	4628	11458
1940	64223.00	262195.32	326418.32	2497	8712	6751	4458	11209
1941	61413.05	255692.40	317105.45	2469.20	8751.19	6759.39	4461.01	11220.39
1942	58461.03	247849.09	306310.12	2377.98	8706.09	6736.56	4347.51	11084.07
1943	57603.20	244474.40	302077.60	2387.14	8677.25	6699.51	4364.88	11064.39
1944	56881.19	240976.41	297857.60	2342.72	8556.24	6600.76	4298.21	10898.97
1945	58348.23	236638.55	294986.77	2308.84	8530.81	6386.10	4453.55	10839.65
1946	60083.54	234857.82	294941.35	2510.06	8698.90	6568.36	4640.59	11208.96
1947	71414	224789	296203	3063	8372	6612	4823	11435
1948	73890	226284	300174	3096	8404	6630	4870	11500
1949	77318	231577	308895	3242	8454	6638	5058	11696
1950	81116	239522	320638	3341	8584	6727	5198	11925
1951	87790	249630	337420	3530	8629	6784	5375	12159
1952	93655	262000	355655	3720	8973	6956	5737	12693
1953	102753	276581	379334	3959	9224	7169	6014	13183
1954	109420	291125	400545	4256	9544	7467	6333	13800
1955	116232	304546	420778	4542	9779	7678	6643	14321
1956	118968	313109	432077	4740	10097	7849	6988	14837
1957	119687	319382	439069	4885	10304			15189
1958	120037	320112	440149	4911	10382			15293
1959	118736	322251	440987	4888	10852			15740
1960	114199	322107	436306	4872	11591			16463
1961			*436966.50*					*16889.50*
1962	113096	324531	437627	4773	12543	8567	8749	17316
1963	114333	327816	442149	4979	13356	9033	9302	18335
1964	147351	299129	446480	6467	12569	9333	9703	19036
1965	163990	292819	456809	7170	12851	9830	10191	20021
1966	169480	302023	471503	7564	13855	10656	10763	21419
1967	175401	309351	484752	8110	14808	11511	11407	22918

1968	192496	308628	501124	9196	15328	12367	12157	24524
1969	199219	318344	517563	9735	16363	13325	12773	26098
1970	203977	330218	534195	10296	17633	14321	13608	27929
1971	207860	341472	549332	10934	19454	15341	15047	30388
1972	228016	338040	566056	12193	19853	16101	15945	32046
1973	229420	344205	573625					31364
1974			579685			17070	12764	29834
1975			581956			17429	11837	29266
1976			588634			17613	11268	28881
1977			586530			18312	12088	30400
1978			592081			18747	12517	31264
1979			593767			18609	11959	30568
1980			587812			18773	12045	30818
1981			586141			18669	11455	30124
1982			576910			18638	11387	30025
1983			561586			18490	11502	29992
1984			550136			18441	12354	30795
1985			529607			18256	13203	31459
1986			520190			18062	14943	33005
1987			505942			17751	16653	34404
1988			490111			17336	17399	34735
1989			476300			16761	17260	34021
1990			466180			16406	17555	33961
1991			461372			16746	18670	35416
1992			457525			16788	20095	36883
1993			460247			16165	20059	36224
1994			463882			15880	21760	37640
1995			469998			15812	22154	37966
1996			479272			16188	23197	39385
1997			552199			16818	26295	43113
1998			570803			16911	28061	44972
1999			582281					
2000			582287					
2001			590985					
2002			601342					
2003			607383					
2004			607881					
2005			607517					
2006			606083					
2007			603106					
2008			600626					
2009			599999					
2010			599669					
2011			597729					
2012			596704					
2013			596222					
2014			598560					
2015			602107					
2016			606455					
2017			609212					
2018			610980					
2019			609223					
2020			607397					
2021			605637					
2022			606889					
2023			606065					

The fall in which the school year starts	Number of part time teachers, cities	Number of part time teachers, rural	Number of part time teachers, total	Number of teachers, males	Number of teachers, females	Number of teachers, total	Number of teaching man-years
1935							
1936							
1937							
1938		482					
1939		482					
1940		546					
1941		502.00					
1942		520.00					
1943		591.00					
1944		543.00					
1945		654.00					
1946		711.00					
1947		788					
1948		955					
1949		1075					
1950		1245					
1951	165	1426	1591			13750	
1952	158	1449	1607			14300	
1953	168	1448	1616			14799	
1954	178	1573	1751			15551	
1955	199	1699	1898			16219	
1956	239	1830	2069			16906	
1957							
1958	254	2276	2530			17823	
1959	347	2256	2603			18343	
1960							
1961							
1962	391	1879	2270			19586	
1963	461	1917	2378			20713	
1964	663	1945	2608			21644	
1965	854	1863	2717			22738	
1966	1080	2087	3167			24586	
1967	1069	2274	3343			26261	
1968	1171	2483	3654			28178	
1969	1353	2716	4069			30167	
1970	1515	2985	4500			32429	
1971	1751	3839	5590			35978	
1972	1935	3873	5808			37854	
1973			8594			39958	
1974			9655			39489	
1975			11646			40912	
1976			13012			41893	
1977			13571			43971	
1978			14856			46120	
1979			16036			46604	
1980			16921			47739	
1981			17678			47802	
1982			18129			48154	
1983			18296			48288	
1984			17965			48760	
1985			17304			48763	

1986	17294			*50299*	
1987	17293			51697	
1988	17495			52230	
1989	16883			*50904*	
1990	16653			*50614*	
1991	16398			*51814*	
1992	16464			53347	35777
1993	16982			53206	35710
1994	16270			53910	
1995	16933			54899	36785
1996	16983			56368	36672
1997	21023			64136	43803
1998	20428			65400	45480
1999					45465
2000					45284
2001					45887
2002					46538
2003					45921
2004		16474	39955	56429	46567
2005		17330	41877	59207	46565
2006		17591	43903	61494	46973
2007		17371	45010	62381	47424
2008		17557	46266	63823	48553
2009		17263	46481	63744	48909
2010		16917	46854	63771	48885
2011		16778	46612	63390	48778
2012		16316	46581	62897	48493
2013		16171	46691	62862	48504
2014		15985	46894	62879	48525
2015		15830	47146	62976	48822
2016		15904	47820	63724	49425
2017		15941	48279	64220	50240
2018		16229	48740	64969	51107
2019		16209	49299	65508	52052
2020		16067	48812	64879	52325
2021		16345	48970	65315	52822
2022		16529	48758	65287	53257
2023		16618	48843	65461	53638

The fall in which the school year starts	Number of full-time unqualified teachers, cities	Number of full-time unqualified teachers, rural	Number of full-time unqualified teachers, total	Number of part-time unqualified teachers	Number of unqualified teachers, both full- and part-time	Number of unqualified teaching manyears	Predicted number of teacher man-years	Predicted teacher shortages in percent	Predicted teacher shortages, linear interpolations
1861		1737					3169.04	58.203	58.203
1862		1719					3350.93	54.473	54.473
1863		1532					3406.29	47.758	47.758
1864		1323					3426.63	40.998	40.998
1865		1166					3487.64	35.501	35.501
1866		1010					3522.66	30.445	30.445
1867		885					3556.55	26.423	26.423
1868		820					3596.48	24.245	24.245
1869		757					3632.39	22.193	22.193
1870		701					3676.35	20.333	20.333
1871		647					3715.00	18.603	18.603
1872		624					3762.72	17.742	17.742
1873		562					3796.34	15.865	15.865
1874		539					3849.09	15.029	15.029
1875		532					3937.07	14.518	14.518
1876							4069.95	14.169	13.296
1877							4136.39	13.406	12.074
1878							4249.14	11.081	10.852
1879							4342.76	9.478	9.630
1880		339					4387.05	8.408	8.408
1881							4442.42	6.379	7.648
1882							4526.98	5.232	6.888
1883							4587.38	3.482	6.129
1884							4671.94	3.891	5.369
1885		200					4757.51	4.609	4.609
1886							4865.22	3.627	4.266
1887							4948.77	3.235	3.923
1888							4999.11	2.257	3.580
1889							5039.37	2.337	3.236
1890		135					5162.19	2.893	2.893
1891							5304.13	2.353	3.079
1892							6130.60	5.267	3.264
1893							6309.79	4.647	3.450
1894							6437.63	4.385	3.636
1895		225					6561.45	3.821	3.821
1896							6683.26	3.314	3.587
1897							6821.17	3.207	3.353
1898							6952.04	2.220	3.119
1899							7212.77	2.321	2.885
1900		172					7331.55	2.651	2.651
1901							7476.51	1.907	2.444
1902							7585.23	1.553	2.236
1903							7661.74	1.063	2.029
1904							7741.27	0.965	1.822
1905		111					7801.67	1.615	1.615
1906							7784.55	0.201	1.604
1907							8017.09	0.930	1.594
1908							8160.04	0.792	1.584
1909							8334.19	1.058	1.574
1910		118					8620.09	1.564	1.564
1911							8800.28	1.490	1.615

1912					9111.34	1.743	1.667
1913					9312.67	1.245	1.719
1914					9411.33	1.562	1.771
1915		148			9694.56	1.822	1.822
1916					10231.63	3.242	3.071
1917					10633.92	4.714	4.320
1918					10900.43	5.322	5.569
1919					11034.19	6.799	6.817
1920		770			11238.88	8.066	8.066
1921					11568.21	7.732	6.782
1922					11712.11	6.857	5.497
1923					11767.84	5.027	4.212
1924					11712.11	3.483	2.928
1925		164			11694.88	1.643	1.643
1926					11600.64	0.476	1.512
1927					11222.67	0.000	1.382
1928					11210.51	0.000	1.251
1929					11227.73	0.000	1.120
1930		96			11306.77	0.990	0.990
1931					11254.08	1.099	0.928
1932					11062.56	1.601	0.867
1933					10856.85	1.465	0.805
1934					10738.29	1.011	0.744
1935		63			10671.41	0.682	0.682
1936					10657.23	0.000	2.172
1937					11267.25	2.080	3.661
1938					11578.67	3.248	5.150
1939					11618.67	4.340	6.639
1940					11391.00	4.894	8.129
1941					11387.72	5.978	9.618
1942					11257.40	8.645	11.107
1943					11261.39	11.332	12.596
1944				1800	11079.97	14.085	14.085
1945					11057.65	12.226	12.226
1946					11445.96	10.366	10.366
1947				1200	11697.67	8.506	8.506
1948					11818.33	8.538	8.893
1949					12054.33	8.897	9.281
1950					12340.00	10.555	9.669
1951				1733	12689.33	10.056	10.056
1952				2173	13228.67	12.181	12.181
1953				2322	13721.67	12.635	12.635
1954				2658	14383.67	13.697	13.697
1955				3006	14953.67	14.761	14.761
1956				3175	15526.67	14.848	14.848
1957					15955.50	15.865	14.924
1958					16136.33	16.196	15.000
1959					16607.67	16.832	15.077
1960					17293.67	17.444	15.153
1961					17683.17	16.712	15.229
1962	231	2039	2270		18072.67	15.305	15.305
1963	223	2374	2597		19127.67	16.512	16.512
1964	405	2109	2514		19905.33	15.514	15.514
1965	400	1972	2372		20926.67	13.899	13.899
1966	384	1852	2236		22474.67	12.401	12.401
1967	374	1705	2079		24032.33	10.754	10.754
1968	365	1328	1693		25742.00	8.210	8.210

1969	360	1174	1534			27454.33	7.039	7.039
1970	403	1218	1621			29429.00	6.987	6.987
1971	650	2054	2704			32251.33	10.955	10.955
1972	746	2315	3061	2710		33982.00	11.666	11.666
1973			2199	3077		34801.60	9.855	9.855
1974			1989	3023		34661.50	10.099	10.099
1975			1397	2750		35089.00	7.900	7.900
1976						35387.00	5.600	6.637
1977			933	2131		37185.50	5.374	5.374
1978			1201	2294		38692.00	6.068	6.068
1979			1060	2289		38586.00	5.713	5.713
1980			951	2306		39278.50	5.357	5.357
1981			671	2178		38963.00	4.342	4.342
1982			430	1777		39089.50	3.373	3.373
1983			267	1308		39140.00	2.353	2.353
1984			284	1043		39777.50	2.025	2.025
1985			376	923		40111.00	2.088	2.088
1986			839	1374		41652.00	3.664	3.664
1987			1262	1974		43050.50	5.224	5.224
1988			1267	2257		43482.50	5.509	5.509
1989			836.00	1929		42462.50	4.240	4.240
1990			722.00	1885		42287.50	3.936	3.936
1991			675.00	1920		43615.00	3.749	3.749
1992			579.56	1607	1430	45115.00	3.066	3.066
1993			459.50	1409	1428	44715.00	2.603	2.603
1994			544.12	1527		45775.00	2.857	2.857
1995			545.98	1603	1330	46432.50	2.903	2.903
1996			515.77	1530	1268	47876.50	2.675	2.675
1997			1047.14	2188	2167	43803	4.947	4.947
1998			1191.72	2371	2858	45480	6.284	6.284
1999					2625	45465	5.774	5.774
2000					2589	45284	5.717	5.717
2001					2460	45887	5.361	5.361
2002					1786	46538	3.838	3.838
2003					1258	45921	2.739	2.739
2004					1000	46567	2.147	2.147
2005					890	46565	1.911	1.911
2006					1007	46973	2.144	2.144
2007					1248	47424	2.632	2.632
2008					1686	48553	3.472	3.472
2009					1924	48909	3.934	3.934
2010					1846	48885	3.776	3.776
2011					1682	48778	3.448	3.448
2012					1644	48493	3.390	3.390
2013					1470	48504	3.031	3.031
2014					1471	48525	3.031	3.031
2015					1772	48822	3.630	3.630
2016					2020	49425	4.087	4.087
2017					2034	50240	4.049	4.049
2018					2145	51107	4.197	4.197
2019					2020	52052	3.881	3.881
2020					1701	52325	3.251	3.251
2021					1969	52822	3.728	3.728
2022					2178	53257	4.090	4.090
2023					2405	53638	4.484	4.484

The fall in which the school year starts	Number of admissions, one year program	Number of admissions, two years program	Number of admissions, three years program	Number of admission, four years program	Number of admisstions, five years program	Number of admissions	Number of students in teacher education	Graduates from ordinary teacher education	Predicted of graduates from teacher education	Expected number of graduates
1861										
1862										
1863										
1864										
1865							503		262.99	
1866									244.48	
1867									225.97	
1868									207.46	
1869									188.95	
1870							343		170.44	
1871								108	161	
1872								126	190	
1873								118	227	
1874								140	264	
1875	245	185	0	0	0	365	474	116	228	
1876	327	172	0	0	0	405	544	135	338	512
1877	390	227	0	0	0	486	646	141	433	562
1878	571	208	0	0	0	565	772	181	493	798
1879	447	239	0	0	0	521	748	200	438	655
1880	438	221	0	0	0	474	714	218	480	677
1881	342	212	0	0	0	408	636	234	430	563
1882	482	218	0	0	0	474	682	174	430	694
1883	168	217	0	0	0	301	500	204	288	386
1884	210	197	0	0	0	302	485	183	288	427
1885	300	198	0	0	0	348	538	192	342	497
1886		197	0	0	0	337.00	379	179	319.00	333.00
1887		214	0	0	0	354.00	383	174	304.00	332.00
1888		175	0	0	0	315.00	346	182	302.00	349.00
1889		177	0	0	0	317.00	321	160	270.00	310.00
1890		158	0	0	0	298.00	442	170	277.00	419.00
1891	136.80	97	0	0	0	233.80	401	164	300.80	431.60
1892	136.80	146	0	0	0	282.80	399	68	204.80	370.60
1893	136.80	238	0	0	0	374.80	554	150	286.80	419.60
1894	136.80	228	0	0	0	364.80	615	209	345.80	511.60
1895	136.80	308	0	0	0	444.80	735	216	352.80	501.60
1896	130.60	377	0	0	0	507.60	861	238	368.60	569.20
1897	130.60	392	0	0	0	522.60	941	368	498.60	638.20
1898	130.60	362	0	0	0	492.60	899	337	467.60	653.20
1899	130.60	338	0	0	0	468.60	843	328	458.60	623.20
1900	130.60	348	0	0	0	478.60	826	343	473.60	599.20
1901	89.80	378	0	0	0	467.80	845	339	428.80	527.60
1902	89.80	*360*	*240*	0	0	689.80	1070	321	410.80	557.60
1903	89.80	0	276	0	0	365.80	1043	400	489.80	539.60
1904	89.80	0	290	0	0	379.80	992	293	382.80	419.60
1905	89.80	0	261	0	0	350.80	1045	355	444.80	455.60
1906	14.80	0	264	0	0	278.80	984	384	398.80	319.60
1907	14.80	0	266	0	0	280.80	917	351	365.80	290.60
1908	14.80	0	283	0	0	297.80	946	378	392.80	293.60
1909	14.80	0	312	0	0	326.80	1061	377	391.80	295.60
1910	14.80	0	430	0	0	444.80	1254	392	406.80	312.60
1911	27.80	0	400	0	0	427.80	1394	493	520.80	367.60

1912	27.80	0	427	0	0	454.80	1451	557	584.80	485.60
1913	27.80	0	411	0	0	438.80	1427	551	578.80	455.60
1914	27.80	0	381	0	0	408.80	1345	553	580.80	482.60
1915	27.80	0	370	0	0	397.80	1298	587	614.80	466.60
1916	36.60	0	365	0	0	401.60	1345	546	582.60	454.20
1917	36.60	0	352	0	0	388.60	1239	518	554.60	443.20
1918	36.60	0	454	0	0	490.60	1300	455	491.60	438.20
1919	66.60	0	556	0	0	622.60	1502	467	503.60	455.20
1920	106.60	0	607	0	0	713.60	1757	620	656.60	597.20
1921	110	0	702	0	0	812	2054	776	776	666
1922	118	0	767	0	0	885	2353	929	929	725
1923	162	0	658	0	0	820	2449	1012	1012	864
1924	157	0	475	0	0	632	2155	1185	1185	924
1925	155	0	410	0	0	565	1785	927	927	813
1926	145	0	355	0	0	500	1426	681	681	620
1927	0	0	0	0	0	0	829	480	480	410
1928	0	0	0	0	0	0	382	388	388	355
1929	0	0	0	0	0	0	0	0	0	0
1930	0	0	0	392	0	392	392	0	0	0
1931	0	0	0	390	0	390	783	0	0	0
1932	0	0	0	304	0	304	1094	0	0	0
1933	0	0	0	0	0	0	1093	380	380	392
1934	0	0	0	0	0	0	714	400	400	390
1935	0	0	0	0	0	0	316	317	317	304
1936	0	90	0	32	0	122	122	0	0	0
1937	0	73	0	72	0	145	237	60	60	90
1938	0	169	0	182	0	351	529	75	75	73
1939	0	166	0	213	0	379	835	202	202	201
1940	0	181	0	180	0	361	989	238	238	238
1941	0	125	0	117	0	242	989	331	331	363
1942	0	179	0	64	0	243	775	315	315	338
1943	0	0	0	20	0	20	528	361	361	359
1944	0	0	0	20	0	20	194	63	63	117
1945	0	564	97	248	0	909	1076	86	86	64
1946	0	287	99	243	0	629	1449	576	576	584
1947	0	317	96	279	0	692	1468	365	365	404
1948	0	200	32	157	0	389	1472	668	668	664
1949	0	519	62	248	0	829	1839	558	558	539
1950	0	288	31	150	0	469	1832	892	892	830
1951	0	560	150	249	0	959	1896	543	543	507
1952	0	357	150	192	0	699	1936	833	833	839
1953	0	252	430	254	0	936	2025	660	660	657
1954	0	348	500	255	0	1103	2194	650	650	651
1955	0	332	260	252	0	844	2304	961	961	970
1956	0	306	200	281	0	787	2363	1062	1062	1086
1957	0	647.35	176.55	353.10	0	1177			821	821
1958	0	871.80	145.30	435.90	0	1453			1099.35	1099.35
1959	0	991.90	76.30	457.80	0	1526			1329.35	1329.35
1960	0	1175.07	0	503.60	0	1678.67			1490.3	1490.3
1961	0	1181.93	100	549.40	0	1831.33			1687.27	1687.27
1962	0	1247	132	605	0	1984	4667		1639.73	1639.73
1963	0	1452	208	692	0	2352	5364		1850.60	1850.60
1964	0	1618	103	667	0	2388	6117		2133.40	2133.40
1965	0	1765	128	639	0	2532	6694		2431.00	2431
1966	0	1633	194	576	0	2403	6760		2560.00	2560
1967	0	1650	249	592	0	2491	6836		2428.00	2428
1968	0	1501	299	514	0	2314	6808		2483.00	2483

1969	0	1391	326	413	0	2130	6621		2326.00	2326
1970	0	1262	516	318	0	2096	6493		2282.00	2282
1971	0	822	830	147	0	1799	5012	2085	2085	2102
1972	0	1238	767	121	0	2126	5100	1872	1872	1751
1973	0	1473	857	118	0	2448	5695	2239	2239	2386
1974	0	1077	1163	91	0	2331	5691	2380	2380	2387
1975	0	724	1393	59	0	2176	5334	1812	1812	2055
1976	0	36	1662	28	0	1726	5079	1877	1877	2005
1977	0	59	1576	24	0	1659		1394	1394	1520
1978	0	0	1658	30	0	1688		1613	1613	1780
1979	0	0	1671	30	0	1701		1426	1426	1604
1980	0	0	1634	30	0	1664		1552	1552	1682
1981	0	64	1584	29	0	1677		1515	1515	1701
1982	0	62	1527	0	0	1589		1543	1543	1728
1983	0	0	1124	0	0	1124		1455	1455	1676
1984	0	0	1021	0	0	1021		1423	1423	1556
1985	0	0	965	0	0	965	2877	907	907	1124
1986	0	0	1135.20	0	0	1135.20		782	782	1021
1987	0	0	1240	0	0	1240	3048	708	708	965
1988	0	0	1432	0	0	1432	3452	816	816	1135.20
1989	0	0	1376.20	0	0	1376.20		865	865	1240
1990	0	0	1787.42	0	0	1787.42		1022	1022	1432
1991	0	0	2490.83	0	0	2490.83		1052	1052	1376.20
1992	0	0	0	2282.61	0	2282.61		1389	1389	1787.42
1993	0	0	0	2509.90	0	2509.90		1734	1734	2490.83
1994	0	0	0	2370.25	0	2370.25		575	575	0
1995	0	0	0	2560.25	0	2560.25		1730	1730	2282.61
1996	0	0	0	2669.50	0	2669.50		1830	1830	2509.90
1997	0	0	0	2565.00	0	2565.00		2075	2075	2370.25
1998	0	0	0	2745.50	0	2745.50		1900	1900	2560.25
1999	0	0	0	2959.25	0	2959.25		1975	1975	2669.50
2000	0	0	0	2883.25	0	2883.25		1910	1910	2565.00
2001	0	0	0	3135.00	0	3135.00		1800	1800	2745.50
2002	0	0	0	2864.25	0	2864.25		1775	1775	2959.25
2003	0	0	0	2878.50	0	2878.50		1930	1930	2883.25
2004	0	0	0	2897.50	0	2897.50		2010	2010	3135.00
2005	0	0	0	2151.75	0	2151.75		2065	2065	2864.25
2006	0	0	0	2194.50	0	2194.50		1810	1810	2878.50
2007	0	0	0	1914.25	0	1914.25		1790	1790	2897.50
2008	0	0	0	1940	0	1940		1550	1550	2151.75
2009	0	0	0	2270	0	2270		1530	1530	2194.50
2010	0	0	0	2645	85	2730		1430	1430	1914.25
2011	0	0	0	2605	125	2730		1440	1440	1940
2012	0	0	0	2610	155	2765		1475	1475	2270
2013	0	0	0	2685	135	2820		1650	1650	2645
2014	0	0	0	2690	140	2830		1825	1825	2690
2015	0	0	0	3030	155	3185		1780	1780	2735
2016	0	0	0	2530	230	2760		2030	2030	2840
2017	0	0	0	50	2760	2810		1890	1890	2825
2018	0	0	0	50	3155	3205		2170	2170	3170
2019	0	0	0	35	3055	3090		2090	2090	2685
2020	0	0	0	75	3080	3155		395	395	280
2021	0	0	0	115	2730	2845		1835	1835	2810
2022	0	0	0	70	2435	2505		2230	2230	3190
2023				85	1965	2050				3130

Appendix C. The county panel data

idfylke	year	schools	ambulatory shools	students	share ambulatory schools	teachers	teachers noncertified	share noncertified teachers
1	1870	220	4	15797	.0181818	176	34	.1931818
1	1875	221	1	16495	.0045249	188	19	.1010638
1	1880	220	7	12801	.0318182	182	10	.0549451
1	1885	221	7	12959	.0316742	199	9	.0452261
1	1890	219	5	14027	.0228311	217	7	.0322581
1	1895	213	0	16394	0	277	8	.0288809
1	1900	210	0	18457	0	314	7	.022293
1	1905	209	0	20147	0	349	9	.025788
1	1910	203	0	21192	0	400	10	.025
1	1915	207	0	22914	0	502	21	.0418327
1	1920	209	0	26018	0	611	20	.0327332
1	1925	215	0	28310	0	723	32	.04426
1	1930	218	0	32127	0	770	18	.0233766
1	1935	218	0	30988	0	771	13	.0168612
2	1870	196	6	11503	.0306122	133	40	.3007519
2	1875	193	0	11455	0	146	15	.1027397
2	1880	196	2	10952	.0102041	155	12	.0774194
2	1885	194	2	11671	.0103093	169	3	.0177515
2	1890	195	2	12936	.0102564	186	6	.0322581
2	1895	186	2	15436	.0107527	222	10	.045045
2	1900	188	0	16364	0	251	9	.0358566
2	1905	188	0	17540	0	268	6	.0223881
2	1910	193	0	18397	0	313	8	.0255591
2	1915	195	0	18725	0	347	8	.0230548
2	1920	198	0	18738	0	431	23	.0533643
2	1925	198	0	18300	0	454	21	.0462555
2	1930	198	0	18085	0	439	18	.0410023
2	1935	196	0	16947	0	421	14	.0332542
3	1870	298	80	11386	.2684564	175	92	.5257143
3	1875	287	67	11401	.2334495	181	34	.1878453
3	1880	280	90	11387	.3214286	193	28	.1450777
3	1885	277	3	11414	.0108303	213	10	.0469484
3	1890	271	2	12431	.0073801	225	7	.0311111
3	1895	265	1	14160	.0037736	275	10	.0363636
3	1900	268	0	14294	0	299	10	.0334448
3	1905	267	0	14482	0	311	6	.0192926
3	1910	268	0	15077	0	355	7	.0197183
3	1915	269	0	15732	0	396	12	.030303
3	1920	269	0	16917	0	446	22	.0493274
3	1925	266	1	17302	.0037594	482	14	.0290456
3	1930	266	1	16900	.0037594	453	7	.0154525
3	1935	261	0	14972	0	415	3	.0072289
4	1870	168	28	9079	.1666667	119	32	.2689076
4	1875	165	20	8748	.1212121	125	22	.176
4	1880	159	6	8731	.0377358	136	11	.0808824
4	1885	160	3	9110	.01875	144	3	.0208333
4	1890	161	2	10341	.0124224	155	0	0
4	1895	148	0	11558	0	191	1	.0052356
4	1900	148	0	11382	0	206	0	0
4	1905	148	0	11446	0	221	1	.0045249
4	1910	146	1	11211	.0068493	240	4	.0166667
4	1915	148	0	11466	0	290	2	.0068966
4	1920	145	0	12216	0	318	5	.0157233

4	1925	142	0	12605	0	348	1	.0028736
4	1930	144	0	13407	0	351	1	.002849
4	1935	142	0	11756	0	331	1	.0030211
5	1870	361	42	17478	.1163435	208	132	.6346154
5	1875	362	36	16785	.0994475	215	56	.2604651
5	1880	359	25	15753	.0696379	223	42	.1883408
5	1885	352	8	15437	.0227273	235	27	.1148936
5	1890	349	4	16728	.0114613	245	17	.0693878
5	1895	324	3	19018	.0092593	313	6	.0191693
5	1900	318	2	19362	.0062893	345	6	.0173913
5	1905	316	3	19663	.0094937	363	4	.0110193
5	1910	314	1	19114	.0031847	391	7	.0179028
5	1915	312	1	18621	.0032051	461	10	.021692
5	1920	303	0	18688	0	545	27	.0495413
5	1925	300	0	18937	0	575	10	.0173913
5	1930	296	0	19495	0	546	5	.0091575
5	1935	295	0	18908	0	525	8	.0152381
6	1870	365	48	18107	.1315068	225	102	.4533333
6	1875	366	38	18304	.1038251	238	44	.184874
6	1880	377	23	17255	.061008	256	36	.140625
6	1885	368	1	17859	.0027174	292	28	.0958904
6	1890	364	0	18800	0	310	15	.0483871
6	1895	342	0	21233	0	426	19	.0446009
6	1900	347	0	20668	0	443	10	.0225734
6	1905	343	0	21433	0	475	10	.0210526
6	1910	344	0	21783	0	530	19	.0358491
6	1915	349	0	22167	0	620	14	.0225806
6	1920	348	0	23072	0	702	17	.0242165
6	1925	344	0	23893	0	732	16	.0218579
6	1930	340	0	24868	0	675	7	.0103704
6	1935	341	0	23569	0	629	0	0
7	1870	310	90	9503	.2903226	193	34	.1761658
7	1875	313	82	9140	.2619808	194	16	.0824742
7	1880	308	52	9008	.1688312	204	10	.0490196
7	1885	313	37	9407	.1182109	210	5	.0238095
7	1890	312	22	10301	.0705128	224	1	.0044643
7	1895	314	5	11828	.0159236	270	4	.0148148
7	1900	320	0	12419	0	301	31	.10299
7	1905	317	0	12871	0	306	5	.0163399
7	1910	317	0	13381	0	334	10	.0299401
7	1915	321	2	13217	.0062305	372	13	.0349462
7	1920	315	0	13104	0	417	30	.0719424
7	1925	312	0	13743	0	444	7	.0157658
7	1930	307	0	13463	0	426	3	.0070423
7	1935	301	0	11932	0	382	1	.0026178
8	1870	263	126	8181	.4790874	162	90	.5555556
8	1875	265	97	8516	.3660377	167	34	.2035928
8	1880	255	73	8857	.2862745	197	28	.142132
8	1885	246	43	9417	.1747967	204	9	.0441176
8	1890	252	31	10379	.1230159	216	8	.037037
8	1895	240	7	11138	.0291667	258	12	.0465116
8	1900	240	0	10791	0	266	6	.0225564
8	1905	240	0	9920	0	256	5	.0195313
8	1910	243	1	9436	.0041152	265	3	.0113208
8	1915	247	0	9004	0	282	7	.0248227
8	1920	239	0	8854	0	312	33	.1057692
8	1925	229	0	8366	0	303	8	.0264026

8	1930	222	0	8405	0	289	4	.0138408
8	1935	221	0	7083	0	269	2	.0074349
9	1870	337	220	7634	.652819	166	152	.9156626
9	1875	338	199	7675	.5887574	168	53	.3154762
9	1880	345	147	7579	.426087	173	26	.150289
9	1885	352	128	7813	.3636364	182	12	.0659341
9	1890	346	68	8892	.1965318	185	11	.0594595
9	1895	334	45	10016	.1347305	209	6	.0287081
9	1900	336	11	9920	.0327381	217	17	.078341
9	1905	336	8	10044	.0238095	228	7	.0307018
9	1910	330	0	9602	0	235	9	.0382979
9	1915	325	0	9320	0	241	6	.0248963
9	1920	317	9	8589	.0283912	261	44	.1685824
9	1925	316	1	8511	.0031646	294	9	.0306122
9	1930	313	0	8654	0	282	4	.0141844
9	1935	282	20	7835	.070922	264	3	.0113636
10	1870	442	280	11301	.6334842	217	162	.7465438
10	1875	437	233	11366	.5331808	219	41	.1872146
10	1880	430	160	11381	.372093	224	22	.0982143
10	1885	428	125	11348	.2920561	226	11	.0486726
10	1890	413	76	12618	.1840194	232	17	.0732759
10	1895	377	44	14227	.1167109	254	10	.0393701
10	1900	365	12	14841	.0328767	265	9	.0339623
10	1905	351	5	13603	.014245	281	13	.0462633
10	1910	355	3	13608	.0084507	294	2	.0068027
10	1915	351	1	14065	.002849	317	4	.0126183
10	1920	334	0	15288	0	388	46	.1185567
10	1925	335	0	15366	0	441	3	.0068027
10	1930	331	0	16154	0	427	1	.0023419
10	1935	320	0	14895	0	411	0	0
11	1870	647	335	16090	.5177743	298	174	.5838926
11	1875	640	277	16484	.4328125	313	59	.1884984
11	1880	625	217	17083	.3472	313	29	.0926518
11	1885	609	141	17806	.2315271	318	20	.0628931
11	1890	598	117	20049	.1956522	326	13	.0398773
11	1895	567	58	23114	.1022928	400	35	.0875
11	1900	571	39	23668	.0683012	418	11	.0263158
11	1905	575	31	23902	.053913	432	9	.0208333
11	1910	556	18	24251	.0323741	461	8	.0173536
11	1915	557	18	23228	.032316	470	4	.0085106
11	1920	552	9	24196	.0163043	678	63	.0929204
11	1925	539	4	24566	.0074212	695	4	.0057554
11	1930	532	0	25844	0	704	8	.0113636
11	1935	525	0	23449	0	690	4	.0057971
12	1870	497	192	12437	.3863179	231	96	.4155844
12	1875	502	190	12856	.3784861	230	27	.1173913
12	1880	507	178	12986	.3510848	236	10	.0423729
12	1885	512	161	12811	.3144531	236	10	.0423729
12	1890	501	134	13462	.2674651	241	4	.0165975
12	1895	476	80	14932	.1680672	277	11	.0397112
12	1900	487	72	15193	.1478439	284	9	.0316901
12	1905	487	53	15459	.1088296	290	3	.0103448
12	1910	500	38	14647	.076	305	3	.0098361
12	1915	499	39	14456	.0781563	319	2	.0062696
12	1920	475	22	13749	.0463158	436	87	.1995413
12	1925	461	15	13057	.032538	434	8	.0184332
12	1930	454	10	12930	.0220264	422	3	.007109

12	1935	452	6	12239	.0132743	420	4	.0095238
13	1870	561	147	14291	.2620321	228	78	.3421053
13	1875	506	160	15387	.3162055	243	31	.127572
13	1880	502	122	15819	.2430279	263	26	.0988593
13	1885	507	106	16246	.209073	268	16	.0597015
13	1890	489	87	16868	.1779141	271	8	.0295203
13	1895	475	28	18394	.0589474	321	9	.0280374
13	1900	475	18	18125	.0378947	329	8	.0243161
13	1905	474	15	19416	.0316456	345	2	.0057971
13	1910	479	4	19485	.0083507	357	0	0
13	1915	479	4	19908	.0083507	387	3	.0077519
13	1920	494	7	19334	.01417	519	44	.0847784
13	1925	492	1	18864	.0020325	508	6	.011811
13	1930	488	2	19828	.0040984	500	2	.004
13	1935	490	1	18413	.0020408	506	2	.0039526
14	1870	380	118	12898	.3105263	185	50	.2702703
14	1875	380	93	13359	.2447368	201	32	.159204
14	1880	373	68	13198	.1823056	215	15	.0697674
14	1885	368	58	14116	.1576087	224	14	.0625
14	1890	366	52	15108	.1420765	226	10	.0442478
14	1895	345	9	15718	.026087	282	13	.0460993
14	1900	336	8	16036	.0238095	288	9	.03125
14	1905	331	3	16517	.0090634	302	6	.0198676
14	1910	328	3	17147	.0091463	322	8	.0248447
14	1915	337	2	17407	.0059347	348	3	.0086207
14	1920	328	2	17519	.0060976	417	39	.0935252
14	1925	329	5	18177	.0151976	438	5	.0114155
14	1930	326	2	18231	.006135	441	7	.015873
14	1935	331	2	17460	.0060423	434	2	.0046083
15	1870	259	44	11346	.1698842	153	54	.3529412
15	1875	266	29	11910	.1090226	162	16	.0987654
15	1880	266	20	10816	.075188	175	10	.0571429
15	1885	267	22	10869	.082397	182	7	.0384615
15	1890	266	20	11624	.075188	190	3	.0157895
15	1895	248	11	12453	.0443548	240	10	.0416667
15	1900	251	6	12583	.0239044	247	1	.0040486
15	1905	233	3	12522	.0128755	251	1	.0039841
15	1910	235	1	12796	.0042553	256	2	.0078125
15	1915	243	1	12500	.0041152	275	0	0
15	1920	236	5	12641	.0211864	318	24	.0754717
15	1925	237	0	12996	0	333	1	.003003
15	1930	241	0	13254	0	334	1	.002994
15	1935	243	0	12808	0	337	1	.0029674
16	1870	617	285	14053	.4619125	186	38	.2043011
16	1875	645	225	16086	.3488372	197	24	.1218274
16	1880	624	124	15918	.198718	218	13	.059633
16	1885	591	99	17612	.1675127	232	9	.0387931
16	1890	578	100	20240	.1730104	261	1	.0038314
16	1895	565	56	24347	.099115	358	21	.0586592
16	1900	615	44	26349	.0715447	398	17	.0427136
16	1905	606	41	28284	.0676568	422	10	.0236967
16	1910	620	21	27929	.033871	460	10	.0217391
16	1915	629	25	27783	.0397456	505	17	.0336634
16	1920	647	26	27543	.0401855	610	164	.2688525
16	1925	631	8	26973	.0126783	615	11	.0178862
16	1930	634	0	27300	0	606	5	.0082508
16	1935	637	0	25999	0	605	4	.0066116

17	1870	354	88	7398	.2485876	79	10	.1265823
17	1875	375	58	8264	.1546667	88	4	.0454545
17	1880	385	2	8590	.0051948	102	5	.0490196
17	1885	381	22	9041	.0577428	110	1	.0090909
17	1890	369	8	9453	.0216802	123	2	.0162602
17	1895	360	0	11109	0	185	21	.1135135
17	1900	385	0	12348	0	199	8	.040201
17	1905	398	1	12873	.0025126	207	10	.0483092
17	1910	402	0	12724	0	221	6	.0271493
17	1915	413	0	12758	0	228	7	.0307018
17	1920	405	0	13300	0	290	91	.3137931
17	1925	390	0	13763	0	303	8	.0264026
17	1930	384	0	14077	0	307	1	.0032573
17	1935	381	0	13625	0	312	0	0
18	1870	137	2	3180	.0145985	55	22	.4
18	1875	136	1	3088	.0073529	50	4	.08
18	1880	139	2	3595	.0143885	65	6	.0923077
18	1885	144	3	3843	.0208333	76	6	.0789474
18	1890	146	2	3927	.0136986	74	5	.0675676
18	1895	143	0	4366	0	80	9	.1125
18	1900	151	0	4584	0	80	4	.05
18	1905	156	0	4945	0	93	4	.0430108
18	1910	154	0	5066	0	99	2	.020202
18	1915	149	0	5779	0	120	5	.0416667
18	1920	146	0	6260	0	139	30	.2158273
18	1925	147	0	6845	0	158	0	0
18	1930	134	0	7374	0	167	1	.005988
18	1935	125	0	7846	0	165	0	0