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Looking for Human Capital in the Long-Run. Historical Education Data and its Use in Economics and Economic History

In economics, human capital and education has long been identified as one of the main drivers of economic growth. While economists rely heavily on detailed micro-level education data for empirical research, economic historians struggle to collect equally detailed data from past periods hidden in numerous archives. In that sense, they face similar challenges to education historians interested in sources going beyond traditional normative texts.

Education historian Michael Sanderson outlined the similarities between education and economic history in his 2007 article, calling them „the good neighbours", and by alluding to earlier observations that economic history was growing closer to neighbouring disciplines since the 1960s (Sanderson 2007, 429). He argued that both education and economic history were dealing with issues like the role of education and literacy in the process of industrialisation and economic growth, or its effects on social mobility and the labour market.

At the same time, he identified the key difference in the methodological approach, with econometricians and cliometricians, i. e. economic historians working quantitatively, using mathematical techniques based on theoretical models while "the historian inclines to the empirical, the narrative and the analysis of policy" (Sanderson 2007, 445). Since Sanderson's article, economic history has tended to integrate to the discipline of economics especially in the United States (Margo 2018; Fernández-de-Pinedo 2022), on the one hand. On the other, the field of economics moved its focus from economic modelling to more thorough empirical analyses, with the last two Nobel Memorial Prizes in the field going to researchers who actually contributed to understanding policy measures in the educational sector (Angrist and Lavy 1999; Angrist et al. 2019; Banerjee et al. 2007).

Their common interest in "the empirical" and "the analysis of policy" (Sanderson 2007, 445) in the field of education that utilizes complex data thus reunites economic and education historians. In that context, digital techniques may inspire an even closer collaboration of the two disciplines by providing easier access to new sources and enabling new techniques of analysis. Digitalisation projects in education history

may thus find a broader audience by providing information on historical developments in a digital form adaptable to economic (history) analyses – and vice versa. The article first gives an overview of how education has shaped economic theory regarding the concept of human capital, and its fruitful application in economic history studies on educational development in the past few years. It then outlines the methodology generally used in quantitative econometric and cliometric analyses, and the data usually used in them – as well as their respective pitfalls. Next, two current digitisation projects in economic history focusing on education – one from an editor's and the other from a user's perspective – are presented, before finishing with a "wish list" for the ideal digitised source and a short conclusion.

1 Education in Economics Literature

Even though the concept has been criticised in other disciplines (e. g. Grassl 2019; Marginson 2019), human capital has been a key issue in economics since Gary Becker's seminal work in the 1960s, in which he initiated research on

> "a different kind of capital. Schooling, a computer training course, expenditures on medical care, and lectures on the virtues of punctuality and honesty are capital too in the sense that they improve health, raise earnings, or add to a person's appreciation of literature over much of his or her lifetime. Consequently, it is fully in keeping with the capital concept as traditionally defined to say that expenditures on education, training, medical care, etc., are investments in capital" (Becker 1993, 15).

In his studies, Becker showed both theoretically and empirically how investment in education yields a return, i. e. improves earnings, not only for the individual, but also for society as a whole (Becker 1993). Together with Jacob Mincer (1974), he developed the foundation for human capital theory on the microeconomic, or the individual level.

1.1 Education and Growth in Economic Theory

On an aggregate macroeconomic level, education has long been identified as one of the main drivers of economic growth in economic theory. This theory is based on a relatively simple model originally developed by Nobel laureate Robert Solow in the 1950s. Solow's model (1957) assumes that total output Y is a function of capital input K, labour input L, and technical change A. Y thus measures everything produced in an economy, and K and L are "physical" units of capital and labour. Solow then defines technical change as "any kind of shift in the production function. Thus slowdowns, speedups, improvements in the education of the labour force, and all sorts of things will appear as ‚technical change'" (Solow 1957, 312). When measuring the change of Y over time as economic growth, the accumulated change of the traditional inputs capital and labour turns out to

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be smaller than total economic growth. Consequently, A quantifies the residual growth in total output of a firm, industry, or national economy.

While Solow's (1957) model assumed technical change to be exogenous, i. e. occurring outside economic mechanisms, both Robert Lucas (1988) and Paul Romer (1990) further developed growth theory to include endogenous technical change, where that technical change is also driven by economic forces. Both argue that aggregate economic development benefits from external ("spillover") effects of human capital accumulation and research. In retrospect, Solow judged that "[…] the most valuable contribution of endogenous growth theory […] is the stimulus it has provided to thinking about the actual 'production' of human capital and useful technological knowledge", and its reliance on comparable empirical data (Solow 2007, 6). Since the 1990s, Robert Barro and his colleagues collected and analysed datasets on educational attainment and their effects on economic growth, with some of the datasets going back to 1870. By using international test scores since the 1960s, they additionally created an indicator for the quality of education (Barro & Lee 2015). Hanushek and Woessmann (2015), two leading economists of education who have worked directly and productively with historical data, similarly argue that simple measures for education, like attainment, do not necessarily reflect what skills are learned at school (Hanushek & Woessmann 2015, 2), and consequently develop other measures in their 2015 book.

Finally, by enhancing traditional (endogenous) growth theory and taking a long-term perspective, Galor (2011) provides a theoretical framework integrating the regime switch from a stagnating Malthusian to a growth economy in his "Unified Growth Theory". He argues that "[w]hile the size of the population stimulates technological progress in the early stages of development, human capital formation is the prime engine of technological progress in more advanced stages" (Galor 2011, 148). Another Nobel Prize winner, Joseph F. Stiglitz, in his 2015 book on "Creating a Learning Society" also referred to Solow's theory to argue "that most of the increases in standards of living are, […], a result of increases in productivity – learning how to do things better" (Stiglitz & Greenwald 2015, 5). Overall, economists agree on the beneficial effects of education and human capital on economic development in the past 200 years.

1.2 Education in Economic History Literature

Van Zanden et al. (2014) provide a data-based global overview of the increases in standards of living since 1820, and the offset of the Industrial Revolution, including the main measures for education in economic history: literacy and years of schooling (i. e. attainment). The relationship between literacy, industrialisation, and economic growth played an important role in quantitative economic history research from an early phase (Cipolla 1969; Schofield 1973; Graff 1981; Sandberg 1982; Mitch 1992), even though the concept itself has been disputed, and results are often mixed.

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More recent studies used broader indicators for education combining attainment with enrolment i. e. the share of pupils in total population to check their impact on economic growth (Goldin & Katz 2008; Becker et al. 2011; De Pleijt 2018; Diebolt et al. 2019). Numeracy as measured by age heaping, a demographic concept looking at people who state their ages as multiples of five, has become a hotly debated topic in economic history in recent research (A'Hearn et al. 2022; Baten et al. 2022). More unusual, but still inherently educational concepts like the availability of books or subscriptions to journals have also been applied to quantify historical human capital (Squicciriani & Voigtländer 2015; Ogilvie et al. 2022).
Apart from economic growth, other important subfields of economic history research analyse how education has affected inequality and social mobility (Piketty 2014; Clark & Cummins 2015) or gender and regional disparities (Diebolt & Hippe 2019; Cappelli & Quiroga Valle 2021). Education also impacted demographic development (Becker et al. 2010; Fernihough 2017), as well as beliefs and nation building (Becker & Woessmann 2009; Boppart et al. 2013; Bandiera et al. 2019; Squicciarini 2020).

2 Methodology in Economic (History) Literature: Perception and Pitfalls

Both economics and economic history base their quantitative analyses on the idea of economic theory, which generally tries to explain the relationship – or correlations – between input(s) and outcome. This relationship is customarily formalised in a mathematical function as seen in Solow's growth model. To find causal effects, and not just correlations, the models usually rely on strong mathematical assumptions.
These models aim to imitate randomised controlled trials (RCTs), i. e. experiments done in medicine and natural sciences. There, subjects or entities are randomly assigned to at least two different groups, a treatment group and a control group. If the treatment group's outcome after either receiving some medicine, or being in a smaller class, differs significantly from the control group's health or educational performance, then the respective intervention is assumed to be causal. As such experiments are ethically difficult to implement in an educational context, economists often rely on so-called natural experiments, using regulatory changes like political decisions on reducing maximal class sizes.
With regard to data composition, economic (history) analyses use cross-sectional data, which look at different units at the same point in time. In that case, the variation in inputs between the units is assumed to drive different outcomes of the units. For example, differences in maximal class sizes in two different countries (i. e. the units) may have consequences on their PISA test results. The second dimension of datasets are time-series, in which changes in a unit over time are explored, like reducing maximal class size in a specific country. However, the "gold

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standard" of economic analyses is a combination of the two. Panel data looks at different units over time, using variation between units and within units to find causal effects. These analyses can be done both on an individual pupil, class, or school level, and on an aggregated communal or state level, i. e. on a micro- and a macroeconomic level, as seen in the economics literature.
The difficulty of these methodologies is how to find convincing tools to separate correlation from causation, i. e. to strictly distinguish between treatment and control group or to find a causal treatment when looking at time series. And even if we compare similar treatments of two units in panel data, we cannot be sure if the two units have similar starting conditions – which are necessary prerequisites to compare treatment effects. Reducing class sizes by 20% in a developing country, for example, may have different effects on educational performance than doing the same in a developed country because class sizes in developing countries are often much larger. Thus, reducing the number of pupils from 50 to 40 in a class probably cannot be compared to reducing them from 25 to 20. In addition, unobserved confounding factors, i. e. issues we cannot or do not measure like the health status of a child or attitudes toward education in certain areas or families, may distort empirical results.

3 Data Needed – and the Difficulties of Obtaining Them

As implied by the methodology, a lot of numerical data is needed in economic (history) analyses. Focusing on education, the data include indicators of school "demand" like pupil numbers, their age, and/or grades. Information on marks, degrees, diplomas as well as vocational skills may reveal both demand for education and educational outcomes.
Other essential criteria for data analysis regarding school "supply" are numbers of schools on the primary, secondary and tertiary levels, and the composition of the school subjects. Additional information on the temporal structure – e. g. how many years does primary school last, but also how many weeks and hours per week are pupils supposed to attend – may reveal important differences. Teachers' own education, skills, and their background are often taken into account, even though measuring their skills has been debated. Finally, school infrastructure may differ greatly, especially in varying historical and development contexts, where getting to school or having a sufficiently large and well-equipped classroom may be a major impediment for receiving an adequate education.
Concrete financing of education has been a rather neglected topic both in economics and in education research, probably due to the often very complex structure of public and/or private investments in education. Data on who pays for schools and education – parents individually for each child, private donations, communities and/or the state, via taxes or funds (Levy 1987; Lindert 2004) – and how much they pay constitute another desideratum.

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In order to find causal relationships, economic (history) research also heavily relies on information on the institutional background, i. e. the regulatory and organisational situation, and their changes over time. Thus, the political decision-making process with regard to education is essential for school supply and demand, like the introduction of mandatory schooling requirements in the nineteenth century in many Western countries. In addition, control variables such as pupils' and/or their parents' socio-economic background help shed some light on potentially unobserved confounding factors of educational input and outcome.
All of the data ought to cover a variety of geographical units and their development over time – and they ought to be comparable in both dimensions. However, this standardisation is, of course, a major challenge, because national educational systems and policies often differ fundamentally. And even within national systems, comparability of data series over long stretches of time is hard to achieve as changes in the system are reflected in the data. The level on which the data is aggregated may also be an impediment to thorough empirical analyses because aggregation obscures potentially important variation within units and over time. Finally, finding plausible indicators to measuring efficiency and returns of education probably remains the biggest challenge in both economic and education research, and digitisation may help by tackling this issue in both disciplines.

4 Editors' and Users' Perspective on Digitisation: Two Projects in Economic History of Education

Two current projects in economic history focus on the historical impact of education in the long run. The first one focuses on Danish sources (Ford et al. 2021) and takes on the perspective of the researcher aiming at digitising the material[1], while the second uses two digitally edited school surveys from early modern Switzerland to create some benchmark data on education in a proto-industrial area.

4.1 Digitising Danish Grade Lists: The „Leaving Their Mark Project"

In their recent working paper documenting their ongoing project, Nicolas Ford, Kristin Ranestad, and Paul Sharp state that they aim to "construct more detailed measures of human capital" (ibid., 2). They currently focus on printed grade lists of high school and university students, the earliest data beginning in 1805, and available through the mid of the twentieth century. For the digitisation process, they employ "state-of-the-art machine learning models" (ibid., 15).
Since they have information on grades in individual subjects, both on the secondary and the tertiary level, they aim at disaggregating education into knowledge

1 I am grateful to Kristin Ranestand from Lund University and to Paul Sharp from the University of Southern Denmark for helpful discussions on their ongoing project and for letting me include it in this paper.

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of science or humanities, as well as "to measure the extent to which this was actually learned" (ibid., see abstract) – at least as far as grades are able to reflect this achievement (see e. g. Lindenhayn 2018). They plan to link the grade data of individual students to census records, which will be made accessible by the LINK-LIVES platform[2], a research project currently reconstructing Danish family relations since the 18th century. In addition, they can expand the dataset with

> "information from student biographies, based on a Danish (and Norwegian) tradition of publishing books commemorating (usually) the 25th and 50th anniversary of graduation, including information on the full career of whole cohorts of graduates, including positions, travels, publications, and more." (Ford et al. 2021, 15)

By combining the information on formal education with work experience, they will be able to analyse educational mobility between generations, especially after the opening of Oslo University in 1811/13, which is usually seen as a significant milestone towards Norwegian independence.

In their paper, Ford et al. not only focus on the grade lists as sources. After sketching some findings of Danish economic and human capital history, they first provide an overview of the developments and regulations on the primary, secondary, and tertiary school level. They then summarise some major educational sources found in the Danish National Archives. As demonstrated, there are ample published materials on secondary and tertiary education, which greatly facilitates digitisation. Records on primary education, on the other hand, are mostly handwritten, but there are several reports, as well as grade lists, related to the introduction and implementation of compulsory primary education starting in 1739 (Ford et al. 2021, 7). Certainly in accordance with any education historian, they condense that "[d]igitizing this mostly handwritten, archival information would constitute a considerable challenge, but would present fascinating opportunities to consider the relationship between school/teacher quality and educational outputs over the very long run" (Ford et al. 2021, 9). Their exemplary interdisciplinary project thus combines traditional methodologies in history like documentation, source critique, and describing the historical background, with digitalisation techniques for empirical economic research.

4.2 Using Two Digitised Surveys on Switzerland: The 1771/1772 Zurich Survey and the Stapfer Enquête

The second project using Swiss data heavily relies on two source edition projects initiated by education historians, thus providing a user's perspective of digitised historical sources on education. Both of these projects focus on early-modern proto-statistical surveys on elementary education in Switzerland – probably not unlike the Danish reports of the 18th century. The first of the two is the Zurich

2 https://link-lives.dk/en/link-lives-a-research-project/[last accessed on February 22, 2022].

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School Survey 1771/1772, initiated by one of the contemporary "Learned Societies" (Schwab 2006, 33–36). It was distributed among the Protestant parsons under Zurich church authorities, i. e. in the area between the lakes of Zurich and Constance, therefore expanding beyond Zurich's immediate political dominion. The typically proto-statistical questionnaire contained 81 questions. The first part dealt with basic quantitative data like number of pupils, the duration of the school term, or teachers' salaries. Teaching methods and curricular content were then covered extensively in the second part. The third part finally inquired into the benefits of education in every-day life, while a fourth part on the election procedure of the teacher was only added to the questionnaires for the areas outside of Zurich's own dominion. Overall, answers from 157 parishes including 389 protestant elementary schools survived in Zurich's state archive. They were originally edited by Tröhler & Schwab (2006) on a CD-ROM accompanied by a collection of three essays on the origin and the historical background of the survey (Schwab 2006), on the political economy of early modern education (Rosenmund 2006, including a rough quantitative analysis), as well as on the historiography of early-modern education (Tröhler 2006). The CD-ROM not only contained the transcriptions of the individual parishes in a html and pdf format but also a full text simple html version of all transcriptions as well as some editing guidelines. This CD-ROM version then served as a basis for the online edition taken over by the State Archive of Zurich (Staatsarchiv Zürich 2012).[3] The latter additionally includes a parallel view of the scanned original documents. The landing page provides a search function for school locations and keywords, as well as a project documentation and editing guidelines.

The second survey is the so-called "Stapfer-Enquête" executed by Philipp Albert Stapfer, the Minister of Arts and Sciences of the short-lived Helvetic Republic (1798–1803). As a part of his plans for a centralised school system, he initiated a survey among all teachers of the new Republican state, which covered large parts of Switzerland. The questionnaire contains 40 questions, with their composition being reminiscent of the 1771/1772 survey. The first part deals with general demographics of local conditions, and the second with curricular content and term duration of the schools. The third part focuses on the teaching staff and their background, while the fourth part investigates the financial endowments of the schools. Some 2500 answers have survived at the Swiss Federal Archives in Berne, and have been edited online in a major project funded by the Swiss National Science Foundation, under the lead of Schmidt et al. (2015)[4]. The edition can be searched and filtered along geographical and content dimensions. The transcriptions are organised in accordance with the questionnaire's structure and can also

3 See https://www.archives-quickaccess.ch/search/stazh/suzh [last accessed on February 22, 2022].
4 See https://www.stapferenquete.ch [last accessed on February 22, 2022].

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be viewed in a split window with the scanned originals of the answers. Each of them contains meta-data information on the political and denominational structure of the school location, as well as the shelf mark of the original source in the Federal Archives. Apart from the edition per se, the website also includes using and editing guidelines, a context section with bibliographical references, a project description, and a link section. Finally, the publications section provides a list of publications connecting to the edition projects directly, and of the project members, in general, both including links to open access publications. In addition, several student papers dealing with education history, as well as media reports on the edition are available.

With the exception of Rothen's (2021) study of the teachers, the publications on the Stapfer Enquête mostly relied on samples (Brühwiler 2014; Ruloff 2017) if they included quantitative analyses, at all. Meanwhile, several studies on Zurich considered some quantitative data of both surveys to analyse aspects of teacher professionalization (Bloch Pfister 2007), school reform debates (Berner 2010), or curricular practices (De Vincenti 2015), and their changes over time. Quantitative research on the areas outside Zurich's dominion covered by both surveys has been rare, however, and has been limited geographically or thematically (Staatsarchiv Thurgau 1993; Eigenmann 1999). That is why this current dissertation project aims to explore the full quantitative potential of the two early modern surveys from an economic history perspective[5]. The quantitative analyses focus on education and agricultural structure, numerical skills of the teachers, as well as on sources and determinants of school expenses. Of course, the edited transcriptions facilitated data collection from the c. 750 answers for Zurich and Thurgau massively, as the individual scripts of the parsons and teachers are often hard to decipher, especially to a modern reader not accustomed to the German cursive used at the time. Yet, no digital tools could be used to extract the quantitative information from the transcripts because the respective numerical information is not given in any standardised way, i. e. the numbers – both in words and ciphers – had to be extracted from the text ‚*by hand*.' For further statistical analysis, they need to be organised in a tabular form. To secure transparency and reproducibility, prototypical qualitative statements from the transcripts should complement the collected data. Therefore, careful text interpretation of these early modern proto-statistical surveys is essential.

However, digital text analysis tools were used limitedly due to the lack of a standardised German orthography at the time, on the one hand, and the Helvetisms (i. e. specific Swiss words and diction), on the other – a problem typically encoun-

5 The working title of this dissertation project (by G. Wüthrich) is "'Education for the Bliss of Thousands'. A Quantitative and Qualitative Assessment of Early-modern Elementary Education in North-eastern Switzerland."

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tered when working with historical texts.[6] At least, the full text html format of the 1771/1772 Zurich survey allowed quick term searches via simple text mining. Digital text mining tools were not helpful for the Stapfer Enquête because the online edition's html structure strictly follows the questionnaire. If the teachers answered several of the questions in a combined statement, their answer is sometimes repeated in every subsection of the questionnaire, distorting results of straightforward word search or word count tools. In other cases when the teachers' texts only followed the questionnaire's structure loosely, the combined answers were simply structured as continuous texts. These inconsistencies in the digital structure and the sheer amount of the transcriptions makes simple online text mining rather cumbersome. Thus, while the digital editions of both surveys facilitate access and readability of the two surveys, information and data extraction must still be done by traditional critical text analysis due to a lack of historical and digital standardisation.

5 The "Ideal" Digitised Source on Education

To thoroughly apply traditional methodologies of historical analysis and combine them with emerging digital techniques, the ideal digitised source on education thus needs to be standardised from an economic history point of view. Some requirements clearly echo the "FAIR" principles[7] as well as the TEI guidelines, while others more specifically relate to education and economic history.

Thus, when editing archival sources online, it is convenient to know where the original sources are located through metadata, i. e. to have an archival shelf mark, possibly including a direct link to the respective institution. This is helpful not only in case parts of the source are not legible or seem to be missing, but also to get a better understanding of the context of the source with regard to provenance and transmission of the records. Because such aspects are harder to grasp with digitised records, a formal source description and criticism accompanying the digitised sources is of great help to researchers less used to working with historical sources – as is a short overview of the historical background and context of the sources, including bibliographical references. If the sources have already been used for research, a corresponding bibliography is a nice extra.

Regarding technical layout and formatting, both a high-resolution digitized image file of the original source and a transcript facilitate access to the historical information on education. A combined parallel view of both the original source and the transcript supports accessibility and text comprehension. If source texts are available in print, a corrected OCR text layer ought to be included. Both the transcriptions and the OCR text layer need to be coded in a platform-independ-

6 See Cramme & Reh in this volume.

7 See e. g. https://force11.org/info/the-fair-data-principles/[last accessed on February 22, 2022].

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ent machine-readable text format like txt, html, xlsx, csv, etc. The underlying scripting language should be clearly, easily and "well-structured". If this is not feasible due to technical constraints, simple unformatted html or txt versions of machine-readable texts are also beneficial for future research.

As seen from both the Danish and the Swiss projects[8], digitisation and documentation of historical education data facilitates access to source series for researchers in economics and education/economic history. Such digitised source editions enable the introduction of automatic data processing, web scraping, and text mining – techniques which are becoming indispensable not only in data-driven economic (history) analysis but also in digital humanities.

As such, digitisation may support the continuing shift from theoretical modelling on an aggregate level to more micro-level empirical analyses, which heavily rely on broad databases, in economic history. While current economic research concentrates on pupil, teacher, and school data on an individual level more and more by collecting data from local stakeholders and experiments, economic and education history may uncover similarly rich data by digging deep into archival resources they are both interested in, independent of their methodological approach. To thoroughly do research on education in a historical setting, such sources and data are essential – or as Solow (2007, 5) put it: "No arguments without numbers". Digitisation of historical sources on education may support economic and education history by providing both the arguments and the numbers.

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8 See also Kessler & Rothen in this volume.

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