BEYOND 4.0

THE IMPORTANCE OF EDUCATION AND TRAINING POLICIES IN SUPPORTING TECHNOLOGICAL REVOLUTIONS: A COMPARATIVE AND HISTORICAL ANALYSIS OF UK, US, GERMANY, AND SWEDEN (1830-1970)

by Chiara Natalie Focacci and Carlota Perez

TRANSFORMATION OF THE MODES OF PRODUCTION AND TRANSFORMATIONS OF SOCIAL POLICY

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Introductory note

Deliverable 7.3 – on the history of the states' role in facilitating technological transformations is composed of two of different working papers: 7.3a (pages 2-34) and 7.3b (pages 35-60).

The first paper, "The Importance of Education and Training Policies in Supporting Technological Revolutions: A Comparative and Historical Analysis of UK, US, Germany, and Sweden (1830-1970)" is focused on education and training program.

The second paper "Transformation of the modes of production and transformations of social policies" focuses on the role of the welfare and social security.

These papers cover Tasks 7.3 and 7.4. Further summaries of each paper are provided in the 'document summary' before each paper.

Document summary

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Major technological innovations are not sufficient to enable socio-economic progress without governments creating the institutional framework – in particular via education, welfare and training programs - required for the absorption of the new technical possibilities these innovations create. To support this claim, we provide a comparative historical view of how four different countries tackled the challenge of adapting to three successive technological revolutions with varying degrees of success. We look at the relationship between the welfare, education and training policies implemented by the governments of the United Kingdom, Germany, the United States, and Sweden and their socio-economic results. The historical period studied spans from 1830 to 1970. This, according to the neo-Schumpeterian view we follow, covers the second, third and fourth technological revolutions, namely, the Age of Iron, Coal, and Railways, the Age of Steel and Heavy Engineering, and the Age of the Automobile and Mass Production; the current Age of Information and Telecommunications being the fifth.

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1. Introduction: technological revolutions and government policy for education and skills

Most recent studies of education and vocational training and their impact on technological progress focus on the second half of the twentieth century (Dumciuviene, 2015; McCowen and Schendel, 2015; Pelinescu, 2015; Dana et al., 2021). This paper attempts to fill the historical gap by providing a longer time perspective focusing on successive – and therefore different – revolutions and how various governments confronted the knowledge and skills destruction produced by each major upheaval and the creation of the new capabilities required in each case.

When identifying technological revolutions, we follow the neo-Schumpeterian view (Freeman and Perez, 1988; Freeman and Louçã, 2001; and Perez, 2002). This dating is similar to that of 'long waves' proposed by some economists but in contrast to the recently popularised periodisation by Klaus Schwab (2016)[1] and the notion of Industry 4.0. According to this perspective, the world is now mid-way along the diffusion path of the fifth technological revolution, the Age of Information and Telecommunications technologies, beginning with the microprocessor in the early 1970s and including the most recent new systems such as AI, robotics, or nanotechnology (Table 1), sometimes in coexistence with human work (Focacci, 2021). That interpretation has identified a historically recurrent pattern not only in innovation time per se (Rycroft, 2006), but in how technological revolutions propagate (Perez, 2002). Each one emerges in response to the maturity of the previous one, leading to a period of financialised 'creative destruction' when the new technologies replace the old, more or less ruthlessly, in increasingly unequal prosperity. The frenzy of the financial winners leads to bubbles ending in crashes, followed by recessionary periods. The ills underlying the previous prosperity are then revealed and explode in resentment, revolts and populism. It is this disruption of the peace that serves as an alarm call to set up policies that will overcome the main ills of the earlier period. This is also in line with the argument by Kanger and Sillak (2020) that 'meta-regimes' follow specific patterns. The subsequent 'golden age' unleashed by such policies is the time when governments shape the direction of the technologies, trying to spread the benefits of the new productivity potential across society. The whole process, from the initial radical innovations of the revolution until its last technology systems reach maturity, exhausting their potential for further productivity gains, new products and market growth can be called a 'great surge of development', or simply a 'surge'. This is defined by Perez (2002) as 'the process by which a technological revolution and its paradigm propagate across the economy, leading to structural changes in production, distribution, communication and consumption as well as to profound and qualitative changes in society'.

[1] For a detailed discussion, please see the first paper of this BEYOND4.0 project's work package (WP7), Perez and Murray Leach (2021).

Table 1 – Five successive technological revolutions, 1770s to 2000s

Technological revolution (surge)	Popular name for the period	Core country or countries	Big bang initiating the revolution	Year
FIRST	The 'Industrial Revolution'	Britain	Arkwright's mill opens in Cromford	1771
SECOND	Age of Steam and Railways	Britain (spreading to Continent and USA)	Test of the 'Rocket' steam engine for the Liverpool-Manchester railway	1829
THIRD	Age of Steel, Electricity and Heavy Engineering	USA and Germany forging ahead and overtaking Britain	The Carnegie Bessemer steel plant opens in Pittsburgh, Pennsylvania	1875
FOURTH	Age of Oil, the Automobile and Mass Production	USA (with Germany at first vying for world leadership), later spreading to Europe	First Model-T comes out of the Ford plant in Detroit, Michigan	1908
FIFTH	Age of Information and Telecommunications	USA (spreading to Europe and Asia)	The Intel microprocessor is announced in Santa Clara, California	1971

Source: Perez (2002) Table 2.1, p. 11.

The reason why such revolutions deserve the name is their transformational power in terms not only of new technologies and leading industries but also in the new forms of organisation, lifestyles, and something even more consequential –a change of techno-economic paradigm (Perez, 1984 and 2002). Essentially, it is a new and different common sense for best practice, influencing the direction of investment and innovation. Such a shift involves a massive change in the required skills throughout the surge.

Thus, one of the main features of each revolution is a combination of jobs and skills destruction and creation. As put by Su et al. (2022), 'the labor market can serve as a leading indicator for innovation and development'. The higher levels of productivity in the new industries, by definition, require less workers and different skills, sometimes lower, sometimes higher. The second technological revolution, the Age of Iron, Coal, and Railways, for instance, required, on the one hand, unskilled workers and children to serve the machines in the textile factories, displacing the remaining piece work artisans of traditional textile production; and on the other, skilled workers such as iron smelter handlers, railroad specialists, telegraph operators, and accountants, on the other. The Age of Heavy Engineering, or third technological revolution, required truly skilled, highly educated workers in

heavy engineering industries, as well as many others for simplified posts, soon to be redesigned with the time and motion studies developed by Frederick Winslow Taylor in the late 1890s and published in his 1911 book *The Principles of Scientific Management* (Taylor, 1911), later to be called Taylorism. Something similar is happening in the current fifth revolution, with the demand for very highly skilled personnel for the highly technical coding and management jobs and the radical deskilling or outright elimination of many other jobs. In between them, the fourth revolution, or the Age of the Automobile and Mass Production, was characterised, in contrast, by the massive deskilling of the labour force, due to the Fordist assembly line, introduced by Ford in 1913, but also by the multiplication of innovative engineering fields to design the processes, supervise the workers and manage the growing non-assembly industries such as electricity and chemicals. Whatever the case, in each technological revolution, there is a major uprooting of people, a disruption of communities and a separation of winners from losers in capabilities, territories, and welfare conditions (Freeman and Louçã 2001).

At the same time, each revolution leads to a shift in lifestyles creating new needs and new demands, some of which are fulfilled with the new technologies, others with the revival of old skills, and many with low productivity work. They are a central feature of the successive golden ages, such as the urban lives of the Victorian Boom, the cosmopolitan lives of the Belle Epoque and the suburban lives in the post-war boom. These changes accompany and result from the government policies that give direction to the revolutions in the aftermath of the midway recessions. They create many of the replacement jobs and the supplementary demand that will lead to a period of widespread prosperity and greater – perhaps full – employment (Perez and Murray Leach, 2018).

According to that interpretation, the post-Covid19-pandemic world faces a major transformative moment, when massive institutional innovation will be required to change the playing field by proactively giving direction to the now well-known technologies. Not only is there an economic reconstruction due to the many sectors that were affected, but the pandemic revealed the social inequality, the precarious working conditions of many, as well as the lack of production resilience from the pattern of globalisation. The re-directionality has historically involved policy innovations that reduce the social tensions generated by the 'creative destruction' nature of the first half of the diffusion process. Among them, adequate and subsidised education and training policies occupy an important place, together with welfare measures.

Our paper focuses on the education and training (and re-skilling) policies applied in the past 150 years, responding to successive technological revolutions, and touches upon welfare when appropriate and related. It draws on the experience of four countries, chosen for specific reasons. Firstly, it focuses on the UK because it was the leader, or the prime mover of capitalist development, and the core of the first two revolutions and therefore set the precedents for the economic absorption and shaping of major technological change. Secondly, it focuses on the US and Germany because they went from being followers, after Britain, to forging ahead by using a range of government policies from protection and subsidies to massive and specialised education. Finally, it focuses on Sweden because it became an early follower in the third revolution and, by the fourth revolution, had become a pioneer in issues of welfare and worker training and education. In particular, this paper will follow each of the chosen countries – UK, Germany, US and Sweden – looking at government involvement in education, training, and welfare.

A foretaste of the comparisons is provided by Table 2, which shows the levels of basic literacy in each of the countries studied at the beginning of the 'golden ages' of each period. Even though Britain was already the industrial leader in 1850 (a year before the famous Great Exhibition), its literacy level was lower than that of the other three countries studied, which accelerated their pace, intensifying education and training, counting on basic education.

Table 2 – Literacy Rates for UK, Germany, US, Sweden (1850-1950)

Country	1850 Start of Victorian boom in UK	1900 Start of Belle Epoque in Europe Progressive Era US	1950 Start of Post-War boom US and gradually also Europe
UK	61.3	97	100
Germany	95	100	100
US	78	89.3	97.4
Sweden	90	100	100

Source: Steckel & Floud (1997) (The characterisation of the dates is ours)

Each of these results reflects public decisions and helps to bring attention to different elements of the challenges facing governments today. Although it is not possible to make a single direct causal connection between educational interventions and the economic and social results, we can indeed note the recurring growth advantage of those countries where the government was more active in capability building. On this subject, Mazzucato and Kattel (2020) recently showed the crucial role played by governments with extensive capabilities to learn and adapt in governing a crisis such as the current pandemic. This observation also reinforces the findings of several recent studies showing how better economic results can be achieved with better education (Marquez-Ramos and Mourelle, 2019; Hanushek and Woessmann, 2020; Xu et al., 2020), key to increase the capacity of systems to evolve.

The rest of the paper is structured as follows. Section 2 summarises the situation at the starting line of intense industrialisation in the 1870s when the Age of Steel and Heavy Engineering takes off. It aims to provide a comparative historical context across the four countries studied. At the time, Britain, as the industrial pioneer, had already experienced two technological revolutions, whereas the other three were imitating and trying to catch up. In the subsequent four sections (Sections 3-6), we shall trace the actions each state took from the 1870s in the education and training spheres and how they propelled or hindered their ongoing development during the successive technological revolutions. Section 6 concludes and considers the lessons from the historical analysis for today's challenges.

2. The uneven alignment at the starting line (1830-1870)

The UK — The pioneering workshop of the world

During the 2nd technological revolution, the Age of Coal, Iron, and Railways, the UK was still leading the way as the so-called 'workshop of the world', with the US and Germany determined to copy what made the island so successful. In 1820, the UK's GDP reached $36 billion, against the $26 and $12 observed, respectively, in Germany and the US. GDP per capita was also much higher in the UK ($1,707) compared to Germany ($1,058) or the US ($1,257) (Maddison, 2003). The original network of canals of the first industrial revolution had been overtaken by new railway and telegraph networks, which connected all parts of the country efficiently and quickly.

It should be noted that, in contrast with France and Germany, there were no high-level engineering education in Britain. Much of the design and work was performed by engineers who learned under renowned masters (often in Europe) rather than in universities. Some of them, like George Stephenson or Isambard Kingdom Brunel, became as famous as current 'rock stars' (Brindle, 2006; Maggs, 2016). As indicated by the Institution of Civil Engineers (ICE), founded in London in 1818 and granted Royal Charter in 1828, "civil engineering hadn't really become an official profession yet" though there was training in the army and navy. Equally, the Institution of Mechanical Engineers, created in 1847, became an institution for sharing knowledge and experience among practitioners in the world of iron, steam engines and railways. However, regarding the Navy's shipbuilding sector, Britain did exceed in terms of higher engineering skills training (Arnold, 2000; Baim, 2005; Milburn, 2016). Although the more complex tasks were performed in the public sector, a private shipbuilding industry grew at its side, serving private trade and military procurement.

While private investment in railways and industry flourished, city government taxes (and federal funds given to the cities) contracted out the building of roads, gas lighting, sewers and other service infrastructures to enable the flourishing of firms. In parallel, the 1846 repeal of the Corn Laws – the hated protective tariffs on cereals that made bread expensive – led the landowning aristocrats to shift to more lucrative crops or to collaborate with the financiers. As a consequence, political power gradually fused with financial capital and its interests (Cain and Hopkins, 2014). Investment was also encouraged by the growing banking networks, facilitating payments and access to credit everywhere. The UK's rested on the education of its elites, thanks to the universities of Oxford and Cambridge, which offered highly specialised and quality education to the aristocracy, the members of the church, the leaders of the government and the higher-class military. On the other hand, through the East India Company, the British learned the Chinese tradition of 'professionalising' the civil service and gradually implemented the meritocratic principle in its selection system (Robins, 2012). Unfortunately, while this was sufficient to let the prevailing industries of the second revolution thrive, it was not revolutionary enough, nor did it count on the appropriate higher education to keep up with what proactive latecomers were able to do with the science-based, heavy engineering, possibilities of the following technological revolution.

The US — Unifying the country with war and law in the Age of Coal, Iron and Railways

While the UK was prospering in the Victorian Boom of the second revolution, the US was still a developing country, sharply divided internally. The South was aristocratic, strongly connected to the UK through its exports of cotton and tobacco, preferring to import its industrial products in exchange. It differed from the still relatively 'wild' West characterised by pioneering farmers. Yet, they both coincided in opposing the protectionist Northeast, determined to industrialise, using tariff protection to keep prices high and confronting the British industrial and financial domination in the world market. For this purpose, it was clear from early on that education and training would play an important role.

As could be expected, given its clear industrial orientation, the pioneer in guaranteeing mass education had been one of the North-Eastern states. As early as 1837, the Secretary of Education in Massachusetts inaugurated state-wide professional teachers. In 1852, the state passed the first universal public education law recognising the government's role in providing education for agricultural and industrial purposes. The example was later followed by other Northern states. This was reinforced by Lincoln, in 1862, granting federal lands to the states, with the express purpose of funding research and endowing higher education in the technical areas, from agriculture to industry, a focus that contrasted with the British tradition of liberal arts. That was the origin of the so-called Land-Grant universities, of which the Massachusetts Institute of Technology (MIT) was one of the first. In 1869, again, it was Massachusetts that created the National Society for the Promotion of Industrial Education to prepare 'all men, women, and children' for a new type of instruction to avoid having American manufacturers 'competing disadvantageously with those of Europe' (Struck, 1930). Other states and the federal government gradually followed suit. This was in parallel to the emergence of scientific curricula at military academies such as New York's West Academy, where colonel Thayer (1817-1833) had been one of the first ones to introduce studies of civil engineering (Shell, 2002), making military graduates responsible for dams, dykes, and the first railways all over the country.

While British industry saw itself as the unquestionable factory of the world, American manufacturers felt the pressure of competition and were determined to learn and surpass. The frequent international exhibitions in Europe and America, helped both industrialists and the government to see the technological frontier and to acknowledge the role of industrial education in benefitting employment and the growth of the economy. Yet, the North American powerhouse only managed to transform its entrepreneurial attitude into national leadership in 1865, when the Civil War achieved political union. In 1869, the railways coming from the East and the West finally joined, guaranteeing the physical union as well. Ironically, it was mainly British capital that funded much of the railroads, which served to unify the national market and help the US forge ahead. The boom that followed, similar to one in Germany, collapsed in 1873. But, in the US case, the recession did not lead to a loss of confidence in the unfettered free market, especially because the government promoted competition inside the country while it guaranteed protection against imports and, soon also, the knowhow going into their system of technical education.

Germany — A taste of free markets without abandoning the learning tradition

During the 2nd technological revolution, Germany was not yet a state, but a loose federation of states otherwise known as Deutscher Bund. In 1834, Prussia had led the formation of a customs union –the Zollverein – among the many German-speaking states, which only became a tighter Confederation in 1867. But such loose agreements lacked the necessary territorial stability to develop economically and technologically. It was in 1871, after the victory in the Franco- Prussian war, when the Empire was created following the unification of the country by von Bismarck, that businessmen founded the Deutsche Bank and introduced what were very lax joint-stock laws. From then on, funded by the war reparations, the push to imitate 'Manchester capitalism' (the term used for British-style free-market competition) flourished and soon became an investment bubble. The boom ended in a major crash. The prolonged recessions that followed ended up questioning the superiority of the free market and moved Germany into so-called 'coordinated capitalism' (Hall and Soskice, 2001), involving the collaboration of banks and industry, state intervention and promotion of cooperation, later including cartels, and also farmer associations, worker organisations and so on, across the economy and society.

Due to the Prussian determination to claim political and intellectual leadership –be it for 'mercantilist impulse, […] military power, or incorporation of new people and territories' (Schleunes, 1979)– there had been a strong and active tradition of giving importance to science, technical skills, and education in general. Education for children aged up to 14 had been obligatory, municipally funded, and free for poor citizens in the state since 1763. As early as 1821, Prussia already had its first technical school in Berlin, while in 1825, the first Institute of Technology in Karlsruhe was established, inspired by the Parisian École Polytechnique. In parallel, research laboratories emerged everywhere during the 1830s (Pombo and Ramirez, 2002). Soon after, the foundation of the Association of German engineers in 1856 paved the way for education with direct contact with the industrial world. Both scholars and the government acknowledged the advantages of promoting a scientific approach in education —including the teaching of courses such as mathematics, geometry, modelling, and the natural sciences at the simplest industrial Handwerkerschulen— 'to create a new and more attractive career path for the [...] middle class' (Greinert, 2005). Investment in technical education grew in harmony with the increase in demand for technical professions, such as engineers. This was also in line with Prussia's intentions to dispose of excellent engineers as civil servants (Klein, 2015). Contrary to the UK, it was the states who owned mineral rights in Germany. This meant, on the one hand, that private entrepreneurs were required to obtain permission to exploit them, as well as had to be supervised; and on the other hand, that the earliest engineering schools had to be mining academies. In general, the number of engineers with higher technical education in the German territory grew from 166 in 1835 to 11,856 in 1870 (Stanfors, 2003). Once unified under Prussian leadership, this emphasis on human capital put Germany in a good position to, first, copy existing British technologies and, later, once having 'caught up', to forge ahead in science, technology, and engineering.

Sweden – Looking ahead from rural beginnings

Inspired by Germany, the government of Sweden began taking measures from the mid-19th century to transform its basically rural economy into an industrialised one. It supported and collaborated with all providers of technical instruction 'to push the professional interests of engineers —and other technical figures— in the society further forward' (Ahlström, 1982).

First, school building was encouraged everywhere in the country. The 1842 Elementary School Act in the region of Sundsvall, for instance, required each school district to establish at least one permanent school 'either alone or in cooperation with another parish' (Westberg, 2015). These were accessible to everyone and funded either through taxation in money and in-kind or loans from individuals and banks. Second, a 'systematized' technical education was in place as early as the late 18th century (Sjöstrand, 2013). In 1827, the KTH Technological Institute was established in Stockholm, with the introduction in the 1830s of numerous engineering courses —such as topography and road construction— in higher education. As a result of both public and private initiatives, in the 1860s, students could study engineering already at the upper secondary level schools or start apprenticeships in private institutions such as the school of the Swedish Handicraft Association, which opened in 1845. In contrast with the UK, in Sweden, 'the fear of a shortage of engineers with adequate competences resulted in increased demands for alternative educational pathways and reformed programs in lower education'. Technical education was to be provided one way or the other.

According to Gerschenkron (1962), initial economic backwardness can result in more rapid rates of growth later on due to the fact that latecomers are able to exploit technological advances, be it machinery, production methods, or lifestyles, without needing to destroy industries with obsolete techno-economic paradigms. The UK was undoubtedly leading the way in the Age of Iron, Coal, and Railways. However, the advantages of the latecomers emerged quickly when the second surge reached maturity and Germany, the US, and soon Sweden caught up. In the sections below, we show that the culture of education installed and developed in those countries, together with the appropriate welfare measures, played a significant role in confirming, or rather accelerating, such a turn of events.

These four countries faced the 2nd technological revolution from very different starting points. The UK as the leader and most advanced, and the other three beginning to catch up. The following sections will look at each of them in turn, seeing how their attitude and actions in relation to education and training before the 1870s and then facing the third and fourth revolutions (from 1870 to 1970) determined their socio-economic results.

3. The UK and education as a means of control

2nd surge 1830-1870 – becoming the workshop of the world with apprenticeships

Following the 1st surge, or First Industrial Revolution beginning in 1771 with the emergence of the first machines and factories, the 1825 repeal of the Bubble Act, which finally allowed joint-stock companies in manufacturing, retail, and trade, and the 1830 opening of the Liverpool-Manchester railway line promoted by the mechanised cotton industries of the North-West, meant that the way was open for the second technological revolution in Britain. Railway networks became national, the telegraph overcame distance, and the population in the cities grew exponentially around the new manufacturing, driving the construction industry. Although the growth rates of just over 2% during the Victorian boom between 1850 and 1870 were not very impressive compared to those of other countries in similar golden ages, they were the highest at the time. But the underlying transformation can be seen in the changing sectoral shares. Agriculture decreased from 22.1% of GDP in 1841 to 14% in 1871. It was, of course, industry and services (including railways) that were taking over (Church, 1975).

The major changes of the second technological revolution were undoubtedly political. The Reform Act of 1832, pushed by the Whigs, a political party that opposed absolute monarchy in favour of constitutional monarchism, reduced the political power of the aristocracy, increasing the voting population by 50%. The political transformation culminated with the Repeal of the Corn Laws in 1846 —which ended landowners' tariff protection— and with the creation of the Liberal Party in 1859.

The beginning of the railway age in 1829, with 'Rocket' steam engine test for the Liverpool-Manchester railway, can also be seen as a shift in political ideology, from what was still a mercantilist parliamentary democracy led by the aristocrats and the imperial merchants, to a liberal free market economy increasingly led by the financiers and the industrialists. In 1834 the Poor Laws, as mentioned above, obliged individuals to sell their work in the market or go to the workhouses so that, following a new capitalist ideology (Polanyi, 1944), education merely became 'an agency of social control' (Sanderson, 1991). Thus, while politics modernised, the labour force was progressively deskilled. Where industrial, or technical, education was provided —especially at the end of the 1830s to educate children in the workhouses and in 1841-52 with the School Sites Acts— this was to 'produce a level of education of practical use in the workplace' (Stephens, 1998). On the one hand, the new machines made work simple enough not to require specialised training or high levels of technical education. On the other hand, where specific skills were needed – including for manufacturing railway equipment, driving the trains, and managing the service – these were provided privately by the railway companies. At the end of the period, the 1870 Elementary Education Act did not make education free or compulsory, reflecting the government's lack of understanding of the importance of investment in human capital (Cronin, 2001). The 'strong emphasis on social control' typical of the early British education system (Carpentier, 2003) would lay the foundations for an elitist type of formation, later reflected in the routes shaped by Oxford and Cambridge (Williams and Filippakou, 2010).

During the 2nd technological revolution, a man was considered skilled if he, 'whether apprenticed or not, was capable of earning his livelihood at it and had become a competent workman' (Cronin, 2001). The concept of skill in the UK was more about character and behaviour and not necessarily related to education as such. So, the government was still reluctant to take on the necessary responsibilities to modernise and structure education innovatively. In-house apprenticeships were inherited as a regularised practice from the Middle Ages. Given that they were the only means to give men the right to work in a particular trade or guild, they were recognised as a proper institution. At this time, however, the British government was not yet actively committed to the provision of education, as education was still associated with religion. Competition and poaching of trainees only became an issue, with the much higher skills required in the following technological revolution. With industrialisation, the repetitive activity of assembling finished machine components became more and more common in British firms, so that not even apprenticeships, originally thought to increase workers' skills, were considered essential anymore (Cronin, 2001). In fact, many of the mills, especially textile, were handled by children.

The presence of rigid institutions strengthened by the governing elites' lack of social openness towards new technical figures (Focacci, 2019) safeguarded an obsolete system of production — based on learning-by-doing and non-scientific methods (Zamagni, 1999), which was sufficient for its success in the Victorian boom. The expression 'tinkerers' is often used to refer to the engineers and innovators of the time. When the shift from simple manufacturing and machine-tending to the science-based industry in the Age of Heavy Engineering occurred, Britain was not ready and inevitably lost its leadership position to highly educated competitors.

3rd surge 1870-1914 – Deskilling and technical education foretaste

In parallel with the bicycle and the typewriter allowing individuals to gain contact with the technical world in practical terms, the new cosmopolitan culture of theatre and journalism was accompanied by an industrialisation process based on cheap steel, electricity, and engineering. In 1907, the distribution of employment still showed manufacturing with a relative dominance (33.5%), followed by agriculture, which remained at 22.2%, the rest being transport, mining, finance and services. But, most importantly, within manufacturing, only 6.9% were in metals and 2.8% in chemicals. The majority were still in the industries mechanised in the second surge: textiles (38.6%) and food, drink and tobacco (8.8%) (Broadberry, 1997). Meanwhile, the US and Germany were racing ahead in the metallurgical, electrical and chemical industries, producing the required scientists, engineers and technically trained workers. As could be expected, then, British productivity also remained comparatively low. It is estimated that in 1909 an American engineer was almost twice as productive as a British one (Broadberry, 1997).

Regarding worker welfare, it is interesting to note that, in this period, several Quaker companies, among them Barclays and Rowntree, provided what was called 'welfare capitalism' (King, 2014). It included housing, education, and childcare. This was in line with the Quaker idea that 'once it is impossible for a family to own their immediate means of production, the owners of such means have various ethical obligations to their workers' (King, 2014).

By contrast, the British government acted much later and only set up a timid version of the welfare state—introducing limited versions of old age pensions (1908), a minimum wage (1909), public

employment agencies (1910), and sickness insurance (1911). In this area, it was also behind Germany and other European countries. In fact, the strong free market ideology that prevailed allowed agriculture to decline significantly, facing cheaper imports, let the protected industries of the US and Germany race ahead without much British competition and made it difficult to create a safety net for the majorities. It took almost ten years for the Liberal party to succeed in those partial elements of the welfare state, when, led by Lloyd George, it engaged in fierce parliamentary battles with strong resistance from the House of Lords.

There were also limited measures in the direction of educating children. The 1876 Elementary Education Act, for instance, prohibited employing children younger than 10; the 1880 Mundella Act guaranteed their obligatory education, and the 1902 Education Act created Local Education Authorities to oversee local school maintenance. Having said that, British liberalism was not as committed to education as their American counterparts, who were very conscious of the need to catch up with the British and, from the 1880s onwards, became more focused on the social question (Leonhard, 2007). In the UK, liberals had much greater faith in the power of the market and were less prone to state intervention. Action was missing with respect to offering the technical instruction necessary for the new industries and technologies –according to the Royal Commission on Scientific Instruction, 'it had not been the policy of the State in this country to aid or interfere with the education of the middle classes' (Stephens and Roderick, 1971). The terms of the statement are significant in themselves; government responsibility for strengthening human capital was not envisaged. Thus, philosopher Huxley warned that 'the latter years of the [19th] century promise to see [the country] in an industrial war of far more serious importance than the military wars' (Stephens and Roderick, 1971).

There were also isolated efforts by enthusiastic teachers such as Spencer, who in 1871 contributed to the establishment of an association for geometrical teaching. Similarly, while Oxford and Cambridge concentrated on educating aristocrats, military leaders, the clergy and the rising bourgeoisie, other universities emerged trying to fill the gap for the excluded, be they of other religions (such as Jews or some of the rebellious protestant sects) or no religion at all. University College London, for instance, created in 1826 as a secular alternative, still faced many legal obstacles to be able to award degrees and even to be considered legally as a 'university'. However, it gradually evolved and by the 1890s, it was emulating the Germans with high-level education in science and engineering.

At the technical level, the government did begin to introduce reforms. The 1889 Technical Instruction Act, however, was ambiguous. It stated that grants would be administered locally under the supervision of the Science and Art Department, with no specification of technical education, which had no clear skill profile nor an autonomous institution of reference. Neither were their funds a central concern. In fact, technical instruction ended up being funded by 'whiskey money'. Not knowing the destiny of the proceeds of a tax on alcohol – included in the 1890 Local Taxation Act – Parliament destined it to technical education. It was only in 1902 that the government recognised the crucial need for technical education and funds and enacted laws for local governments to identify and provide training in the required skills in their area (Cronin, 2001).

The lack of a proactive government was accompanied by ill-coordinated dynamics in British firms. New technologies in the working place, including 'screw-cutting, milling machines and the turret lathe', did not lead to the implementation of advanced technical education on the part of the state.

On the contrary, they disfavoured the use of skilled engineering labour, made obsolete the institution of apprenticeship –one of the few institutions that provided vocational training, and encouraged the exploitation of low-skilled workers. The passive government and the traditional entrepreneurial system could count on a pool of 'process boys' specialised in a single repetitive operation and ignorant with respect to the 'fundamental principles of the trades in which they [were] engaged'. All this implicitly favoured traditional industries and discouraged the new ones based on science and engineering, leaving the British economy behind (Cronin, 2001).

But the lack of adequate education and training was related to the overall context. British industry itself was not prepared for a dramatic change in its ideology of production, characterised by the family firm and self-sufficiency. As explained by Payne (1967), 'the industrial structure of the United Kingdom had become so well established that further change was rendered extremely difficult', as were 'the possibilities of diversification, or branching out into entirely new lines of production'. Thus, the old industries prevailed, not requiring highly skilled labour. A London County Council report in 1909 observed that only 28.5% of the male working population entered skilled jobs and that even fewer (3.6%) required higher education. As a result, by 1910, in England, the number of university students in science and technology was about an eighth of that of Germany (Green, 1995). So, in a way, the government was responding to what industry required.

4th surge 1914-1970 — the formalisation of education

Following the First World War, the economic position of the UK was well behind latecomers Germany and the US. In heavy industry, for instance, between 1925-1939, there were only 630 large-sized plants (with more than 250 workers) in the UK, compared to 750 in Germany and 920 in the US (Broadberry, 1997). Economic production in the staple industries declined during WW1 in favour of munitions and shipbuilding, which increased by a third in this period (Gregory, 2008). In parallel, the UK lost its international consumers, especially for coal: pre-WWI export volumes were still not recouped by 1929 when they were 80% of the export level in 1913 (Carter and Mears, 2011). Overall, it was the UK that paid the highest price for the war: the gross cost of WWI was equal to $44,029 million for Britain, compared to $32,080 for the US, $25,813 for France, $12,414 for Italy, and $40,150 for Germany (Broadberry, 1988). This naturally led to extraordinary levels of unemployment and mainly so for coal miners, 'railwaymen, transport workers, printers, dockers, ironworkers and steelworkers' (Medlicott, 1967).

Machines based on special-purpose materials or processes for the cotton, steel, and iron industries (Sayers, 1950) technically improved after the First World War, when domestic productivity rose by 75% between 1914 and 1938. In parallel, new industries emerged, such as automobile manufacturing, electrical engineering, and chemicals. However, 'British industry could not make the qualitative changes in technology, work organisation, and firm structure that were required to increase productivity in the long run' (Edgerton, 1996). Some progress was made after World War Two, following which the UK did not suffer as much as the other countries: the gross costs this time were equal to $93,445 million for the UK, compared to $234,752 for Germany and $315,800 for the US (Broadberry, 1988). During the 1950s-1960s recovery, several industries were nationalised, including steel, iron, gas, coal, and electricity. Demand for technical skills had increased during the war when aircraft production had been given priority. But despite that, in 1950, the proportion of

university students in the arts (37.2%) was still higher than in science (21.1%) or technology (15.8%) (Edgerton, 1996).

During the fourth surge of development, with the affordable free-moving automobile, the process of urbanisation widened towards suburbia. With much cheaper land –compared to the third surge and the prior urbanisation–, mass-produced components, more permissive land-use planning rules and accessible mortgages, a building boom ensued. The post-war construction boom and the demands of the new suburban lifestyle (Perez and Murray-Leach, 2018) led to the multiplication of semi-skilled jobs in building and the emergence of many relatively unskilled ones in the service sector. This allowed compensation for the job losses in manufacturing due to the introduction of the assembly line. At the same time, growing companies in all sectors required increasing layers of highly skilled managers as well as technical personnel to design and supervise production processes. But Britain was still behind.

At the beginning of the 20th century, according to British Liberal Prime Minister Lloyd George, German schools, 'not the[ir] arsenals' or submarines, represented the greatest international enemy of the country (Phillips, 2002). This was the time when the European model of formalised education, so envied by British scholars, began to gain relative momentum in the UK. First, the 1918 Fisher Act, extended the power of Local Authorities and allowed young workers to be entitled to day-release for education. Then the 1938 Spens Report encouraged the categorisation of secondary schools into 'grammar schools for the academically able; technical schools for those with a practical bent; and new 'modern' secondary schools for the rest' (Gillard, 2001). In 1944 with the Education Act, the three official categories of education we are familiar with today, namely, primary, secondary, and tertiary, were established.

This was also the time when serious welfare measures were introduced in the UK. The Beveridge Report presented in 1942, recommending social insurance and protection for all to fight 'Want, Disease, Ignorance, Squalor and Idleness' led to the founding of the National Health Service, providing free healthcare for all. Compared to the minimum intervention of the government during the previous technological revolutions, the progress achieved during this period was significant.

For quite a long time, however, technical education remained undervalued, in line with the traditional British cultural dichotomies between technology and literature, aristocracy and the middle-class (Edgerton, 1996). Only in a limited number of sectors were technical graduates required. From 1926 to 1937, class entries in motor car engineering increased from 4,002 to 12,606 and, in electrical engineering, from 14,527 to 25,944 (Thoms, 1976). Nevertheless, according to Sanderson (1988), even after World War Two, 'education continued to be a factor in poor economic performance'. The 'failure to develop the junior and secondary technical schools' led to a significant shortage of skilled labour in this period, when employers were still unaccustomed to hiring university graduates. Surprisingly, following WWII, technical schools decreased significantly, from 319 in 1948 to 266 in 1960. As a result, in 1961, 20,000 vacancies for engineering craftsmen remained unfilled, intensifying the pattern observed in the interwar period. By contrast, the number of students obtaining university degrees had significantly increased compared to the First World War levels; the 4,357 first degrees registered in 1920 almost quadrupled to 17,337 in 1950 (Bolton, 2012). However, the 'old-fashioned regard for the arts as more gentlemanly' encouraged polytechnics to resemble universities keeping the predominance of science over technology also

during the fourth technological revolution (Sanderson, 1988). In 1950, 90% of the English 'mechanical engineers' still did not possess a university degree (Locke, 1984).

In parallel, little advance was made with regard to training. With the 1964 Industrial Training Act, called by some 'a failed revolution' (Pemberton, 2001), an Industrial Training Board was established for each industry to provide guidance with respect to the quality and quantity of training offered in firms. However, employers still managed with difficulty to provide training to their apprentices or allow employees to leave work to study during their day off (Sanderson, 1988). In other words, technical education in formal educational institutes, such as schools and universities, was not sufficiently compensated by vocational education at the firm level. Attitudes toward education changed significantly between the second and the fourth technological revolutions in the UK.

While welfare reforms were implemented, several authors have pointed out (Cronin, 2001; Carpentier, 2003; Williams and Filippakou, 2010) that, during the 2nd and 3rd surges, education was still perceived as the formation of the ruling classes. In other words, it can be claimed that it was used as an elitist instrument for social control (Sanderson, 1991), rather than economic growth. This changed in the era of the 4th technological revolution, when technical professions, such as those related to engineering, started to become encouraged thanks to the formalisation of institutions providing rigorous technical education and the increase in demand for them on the part of employers.

4. The US forging ahead with protection and education

3rd surge 1873-1917 — Vocational education at the service of industrial growth

Between 1870 and 1913, the average annual rate of growth of productivity per hour worked in the US was 1.92%, against 1.22% in the UK, the original workshop of the world (Maddison, 2003), so that, by the end of the third surge, the US had already caught up with the UK (Table 3).

Table 3 – Labour productivity in US industrial sector as per cent of UK (1839-1911)

1839/41	1849/51	1859/61	1869/71	1879/81	1889/91	1899/01	1909/11
159.8	162.7	152.8	145.1	146.3	167.8	170.9	186.5

Source: Broadberry & Irwin (2004)

The US government was focused on promoting industrial development across the whole country, now unified. High tariff barriers were erected, both for federal revenue – since no federal income tax existed before the late 1910s – and to protect companies while they competed nationally and gradually reached competitiveness in the world market. The other form of support for both agriculture and industry was the creation of universities for research and education. Recent

experience in Asia has shown that both governments and businesses in catching-up countries are acutely aware of the need to implement their own variants of tariff barriers to protect their markets, as well as acquire the technological capabilities possessed by the leaders. In the case of the early United States, the labour shortage made it all the more urgent to apply whatever technologies could increase the productivity of the available workforce. Engineering education was an obvious route to follow. The lack of federal income in the US made government use the vast expanses of land acquired during the conquest of the West and in various wars and purchases to fund the universities. The teaching, research and extension services of these institutions across the country became an essential part of the forging ahead process.

Originally, the Morrill Land-Grants Act approved in 1862, during the Civil War, mainly benefitted the Northern and Western states. But the representatives of the industrial North wanted the Southern states to accelerate the mechanisation and modernisation of agriculture. Hence, in 1890, an extension of the Morrill Act (this time with cash) was directed at the South and included making higher education available to all races, initiating a slow and difficult process that would take decades to unfold.

The accent on engineering gave impressive results. In 1866 there were perhaps 300 graduates from five colleges; by 1911, 21 colleges were graduating about three thousand engineers a year (compared to Germany's eighteen hundred). It is estimated that 38,000 were already in the workforce.

Given the heavy engineering nature of the third technological revolution, there was high demand for engineers and other technical professions. And, due to the continental size of the country, building infrastructures were giant projects, and the availability of vast demand allowed standardised high-volume production leading to mammoth plants with complex management hierarchies before they appeared in Europe (Engwall and Zamagni, 1998). As a result, the various engineering specialisations became highly attractive, and courses such as accounting, business mathematics, and marketing became more and more popular choices of education at university, whatever the profession. Furthermore, manual training was increasingly considered 'essential' by professors at technical universities — such as Woodward of the O'Fallon Polytechnic Institute at Washington University in St. Louis (Engwall and Zamagni, 1998)— to prepare engineers and industry managers, or better yet, engineer-managers.

At the same time, workers were being trained mostly in apprenticeships inside the companies but also in many private educational initiatives. But labour became scarce as the economy grew, so immigration was encouraged and facilitated. The years between the mid-1870s and the mid-1890s were of constant deflation due to globalisation and the productivity of the new technologies, so much did prices decrease that the period was known as 'the great depression' until the 1930s took over the term (Hobsbawm, 1989; Friedman and Schwartz, 1971; Musson, 1959). In those years, around 12 million immigrants arrived in the United States, mainly from Europe, especially Germany, Ireland and Britain, so that by 1900 they represented about 16% of the population (Anderson, 2021). Some were skilled, but many weren't. There was competition for the skilled ones and in-house training for unskilled nationals and foreigners. Soon, poaching skilled workers became a serious problem, and companies proposed that the government do the training. This was behind many training initiatives at the state level, but it took until 1917 for the Federal government to provide funds for vocational training across the country.

Evidence that reskilling the population had become the government's priority was reflected in the fact that public expenditure for education overtook expenditures for health and welfare in this period. In an 1898 report, the president of the National Association of Manufacturers declared that the largest return to the American industries 'would come from the establishment of educational institutions which would give [them] skilled hands' (Kliebard, 1999). As new professions such as typists, bookkeepers, or educators required the issuance of special certificates, educational facilities for industrial studies became state-supported in several states, especially after 1900, while many employees were also trained internally in firms (Rosenbloom and Sundstrom, 2009). In 1905, Massachusetts pioneered setting up a Commission on Industrial and Technical Education concerning skilled trades such as machine shops, printing, and construction (Struck, 1930). It was followed in 1917 by its federal equivalent. In the American ideology, vocational and managerial training, more than technical education as such, had become the key instrument to achieve economic success. In the 20th century, as argued by Professor John Franklin Bobbitt, University of Chicago, in 1912, education was designed to guarantee a matching 'between individual capacities and job requirements' (Kliebard, 1999).

Up until 1904, the UK net output per worker was equal to £84.6 (Broadberry and Carsten, 2007). By 1909, labour productivity in America was twice that of the UK in most sectors. On this subject, Broadberry (1997) found that American workers in metal manufacturing and engineering were, respectively, 2.88 and 2.03 times more productive. Meanwhile, employment had decreased in agriculture and mining, while increasing significantly in industry, transport, commerce, distribution, finance, and services.

4th surge 1917-1970 — the time for differentiated education and training

In 1913, Henry Ford successfully implemented the continuous assembly line, which produced cars much faster than in shops and at a cheaper cost. His method inaugurated the mass production revolution that would destroy many of the jobs and skills that had been required for the fabricating industries, while continuous processing in chemicals, textiles, canning and bottling would do the same for the workers in non-assembly industries.

Mass consumption was soon encouraged by the credit system, at first provided directly by the automobile and radio companies and later by the credit card, beginning with the Diner's Club in the 1950s and followed by several others, widening their reach. But paradoxically, what led the US to become the pioneer and emblem of the consumer society were the many welfare- and union-supporting measures that increased wages and maintained regular incomes with unemployment insurance and pensions. Most importantly for our purposes, during the fourth technological revolution, the US government multiplied the public education system at all levels, including university-based professionalism, vocationalism and basic education for minimum-skill jobs. In parallel, the domestic economy kept being protected; first, with the 1921 Emergency Tariff in favour of local agriculture, and then, after the catastrophic crash of 1929, with the 1930 Smoot-Hawley Tariff Act imposing historically high duties on imports of agriculture and 20,000 industrial products. Only with the 1948 GATT agreement, when the US economy was already leading the world in productivity and had little competition, would tariff barriers be practically eliminated to promote free international trade.

Welfare and education reforms in this period were significant. In 1917, the Smith-Hughes Act established a Federal Board for Vocational Education and required the creation of vocational education boards in each state. In terms of worker protection, compensation for medical costs and workplace accidents had been adopted in 44 of the 48 states by 1930. With the landslide victory of Franklin Delano Roosevelt in 1933, the depression was initially faced with the National Industrial Recovery Act aimed at agreements on fair wages and prices. Soon after, the 1935 Wagner Act legalised the unions, established collective bargaining and allowed strikes as an accepted practice. The 1938 Fair Labour Standards Act then succeeded in setting minimum wages and maximum hours for most workers. It established the 40-hour week and 1.5 pay for overtime.

The federal government's intervention in education for industrial purposes explicitly aimed to reskill workers who had been 'displaced by machines or new processes' (Dorn, 2007). The 1917 Smith-Hughes Act enforced the formation of vocational education boards in each state along with the establishment of a Federal Board for Vocational Education. By 1921, expenditures in federally funded vocational education programmes had increased from $2.68 million to $10.65 million (Goldin, 2001). But the more intense efforts in spreading education to all were made after WWII, beginning with the so-called GI Bill, which guaranteed scholarships for all returning soldiers to further their education, including the university level. Further funding was made available to vocational education programs with the 1946 George-Barden Act for agriculture. A decade later, the 1956 Health Amendment provided specialised education for nursing, while the 1963 Vocational Education Act assisted first-time job seekers or adults interested in retraining.

Given the experience of unemployment in the 1930s, a new type of assistance, focused on human capital investment gradually became the norm in the US. Following the Second World War, vocational education became an instrument to fight unemployment 'without delay' (Kliebard, 1999) among the millions of veterans returning, as well as a way to retrain the workers being shed by the defence industry. Roosevelt's interventions took into account the specific needs of American businesses while supporting workers' rights and spurring national progress. Whether it was the significant investment in human capital, the complementary creation of government agencies, the huge electrification projects or the introduction of funds in favour of innovative agricultural machines, government intervention fostered the sectoral change observable in the US in the 20th century. Between 1930 and 1950, employment in agriculture dropped from 20.9 to 11%, while more Americans found jobs in the distribution sector (the rate increased from 11.7 to 18.7%) or started working for the government (from 7.2 to 10.1%) (Broadberry, 1997).

By the 1960s, when the gains in productivity attainable with further Fordist techniques –including assembly lines, semi-skilled workers, and dedicated machinery– were exhausted, a new threat to manufacturing jobs appeared with the introduction of robots for specific tasks in assembly lines. At the same time, the highly skilled jobs with machine tools in the workshops were being replaced by numerical control machine tools. This was also due to the dramatic contrast between better private schools and the more popular but worse state schools. If, on the one hand, 'the legacy of depression had served to heighten the country's sensitivity to the issues of unemployment and economic growth', on the other hand, 'the dawn of the Atomic Age had witnessed the implementation of a new technology that threatened to replace men with machine' (Roth Kremen, 1964). A new type of assistance focused on human capital investment was progressively becoming the norm in the US. It then reached its peak with John Kennedy's Manpower Development and Training Act of 1962, put

in place to retrain unemployed individuals given the emerging automation. In parallel, in-house training proceeded as before. Detroit's Packard Motor Car Company trained over 300 people for technical and skilled occupations, Dayton's Computing Machine Company provided training programmes on how to use the new machine tools and so on (Dorn, 2007).

But, while manufacturing was shedding labour at the bottom, it required more white-collar staff to manage the giant corporations, soon becoming multi-national. Equally, more labour was needed in the multiple growing activities that served the mass consumption society. Given this, the US government invested in training for commercial skills (including insurance and real estate), and communications (including bookkeepers, secretaries, accountants, typewriters), all of which were also needed in the still-growing public sector.

It is important to note the essential principle behind Taylorist and Fordist methods —the first based on optimising movements and tools in the "one best way", the second based on splitting work into simple steps along a moving assembly line — was the separation of mind and hand. The knowledge and skills of blue-collar workers were to be controlled by management, who would determine the one best way, decide on the speed of the assembly line and otherwise define every other aspect of work, reducing the skills required and the time to learn them. Thus, labour in manufacturing was meant to be easily trained and replaceable. Inevitably then, during the 4th surge, the American educational system evolved to separate the leaders from the workers by providing a very sophisticated scientific, technological, and general education at the top and a very poor, standard education for the majority. This was in line with the Fordist principle that the blue-collar workers should 'leave their brain at home' and was justified, too, by the low levels of training that retail and other simple service jobs required. In parallel, technical education for skilled jobs, including machine tool operators or printing workers, was mainly provided in-company, while public training focused on the service vocations and the main education system, from kindergarten to college. The system had several exit points, especially at 16, which was then the age limit of compulsory schooling. This basic education ladder was generally in the hands of state and local governments. The route to leadership was increasingly private, beginning with kindergarten, with its pinnacle at the top universities, which led the world league and increasingly attracted students from abroad. Ironically, the most advanced production methods provided by mass production ended up in an elitist system, which, though centring on science and engineering and management, became essentially similar to that of the traditional elitist system in the UK.

Having overtaken Britain after WWI, the US went on to lead the world as the financial, military and industrial power that helped the allied victory in WWII and funded much of the reconstruction of Europe. It led to the subsequent post-war boom and, after exhausting the mass production revolution by the early 1970s, led both the information revolution and the globalisation process. Government efforts in adapting education and training to the specific needs of the economy were an important element in the success.

5. Germany: moving forward with science, education and cooperation

3rd surge 1870-1919 — From agriculture to industry with the help of cartels

During the Age of Steel and Heavy Engineering, Germany increased its tradition of corporatist organisation, with all industries and social groups tending to organise in cooperative organisations for mutual support and bargaining with others. Along these lines, the main industries organised in cartels to control prices and quantities. The government both approved and encouraged such a form of group protection. Instead of obstructing productivity and innovation, as many would expect, cartels helped to increase production volumes and productivity within the country by avoiding price competition at home while keeping exports competitive in both quality and cost. Cooperation between banks and companies – and of both with the education and training system – was encouraged by the state and led to Germany's leadership in electricity, chemistry and capital goods, all science-based industries. Exports soared in volume, growing at an average rate of 4.1% per year, from 1870 to 1913, gradually reducing the difference with the UK that grew at 2.8% (Maddison, 2003).

Table 4 – Labour productivity in Germany's manufacturing sector as percent of UK (1895-1935),

1870	1913	1929	1938	1950	1973	1989
92.6	119.0	104.7	107.1	96.0	118.6	105.1

Source: Broadberry (1997)

After victory in the Franco-Prussian war, recently unified Germany set up a central bank, legalised joint-stock companies with lax regulation and promoted what became a major financial boom, in an unprecedented free-market experience, leading to a boom and a crash in 1873. The seven years of recession that followed convinced Chancellor Bismarck of the need to return to a proactive state to protect its industries and working population from extreme economic risks. Among the many reforms implemented, there was an even stronger commitment to the German tradition of technical education. This particular revolution required much more advanced and demanding skills than the previous ones. As a result of the modern technical approach taken by education institutions, the number of engineers with higher technological education went from 11,856 in 1870 to 32,166 in 1890, reaching 59,738 in 1910 (Stanfors, 2003). With such technical support, the industry was soon able to replace agriculture as the largest sector in the economy.

The growth of industry came with rapid urbanisation and worker organisation. Together with tariff protection, Bismarck recognised the need to foster industrial peace by giving the workers not only training but also security. Unwilling to give the workers any power to form unions or to engage in collective bargaining or anything that would make them confront the owners, he concentrated on the health issues. In 1884 he passed the 1884 Damages Liability Law —making firms liable for any industrial accident— and this was soon followed by convalescent and sickness insurance and later

by old age pensions paid half by employers, half by the workers and a top-up by the government. Thus, Bismarck's Germany became the pioneer of the Welfare State.

To avoid an excessive divide between the rural East and the industrialised West, farm research was promoted with financial and regulatory support to help it adapt to technical progress (Grimmer-Solem, 2003). But the central piece of the German industrial transformation was public education and training. Given that the third revolution was about the flourishing of the electrical, chemical and other science-based industries, the German government soon saw that advance was 'increasingly dependent on public educational and research facilities' (Pierenkemper and Tilly, 2004). By 1891 the government had accepted full responsibility for vocational training, which was reflected in the financial support granted to both the *Fachschulen* (specialised schools) and the *Technische Hochschulen* (Institutes of Technology).

A large number of studies were produced by the government on the relevance of the scientific method within industries. With the prevailing technologies at the turn of the 20th century, in Germany, there was a general acknowledgement that on-the-job training was not sufficient to make advancements in electricity, mechanics, or chemistry. Advances were only possible by preparing highly educated engineers and researchers. As early as 1900, the country possessed 'the first industrial educational complex in the Western world' (Locke, 1984). Germany became the place to go for advanced training among engineers and scientists from the US.

Officially recognised associations, such as the German Committee for Technical Education, founded in 1908, were born to institutionalise vocational training for future workers and provide intermediation with technical schools which focused on engineering courses.

By 1899, technical universities were 'on equal footing' with classical universities and the salaries of highly trained technicians recognised this. This resulted in a steady increase of students in higher technical education in this period, from 5,000 in the 1870s to 15,000 in 1900 (Stanfors, 2003). The government widely encouraged the use of the scientific method based on 'mathematical precision, automatic processes, and scientific management' in German companies. This meant trying to combine the deskilling methods of Taylorism with the high skilling requirements of science-based industries. The system assured the required training.

4th surge 1919-1970 — Skilled work for two post-war reconstructions

Germany assimilated the fourth industrial revolution with two periods of destruction, corresponding to the two world wars. Following the defeat in the first war, the enormous reparations that the young Keynes (1919) rightly considered catastrophic and ominous led to uncontrollable hyperinflation and economic chaos. This made the task of the recently created republic almost impossible, and the difficulties experienced by the majorities opened the way to Hitler and his fascist nationalist party. He soon denounced the debts and engaged in intense industrialisation, at first preparing for war and then even more intensely during the war. After the second defeat, another industrialising effort – in what became West Germany – led to the 'German miracle' lasting until the mid-1970s, when all Western countries entered a period of stagflation due to the maturity and exhaustion of the mass production revolution. We will look at each of the three periods in turn.

The Weimar Republic (1918-1933)

At the end of the First World War, Germany replaced the Wilhelmine empire with a democratic system. But the Weimar Republic faced massive financial reparations to the winners, leading to hyperinflation and depression. In 1923, one US dollar was equal to 4,200,000,000,000 marks (Fischer, 2010). Desperate attempts to raise taxes – a wealth tax in 1923 and a sales tax increase in 1930 – worsened things. In 1932, more than 6 million people were unemployed. In the middle phase of the Weimar Republic, welfare bills for the unemployed and social insurance recipients still constituted one-third of local government expenditures (Raphael, 2017). 'In no other period of the 20th century did the costs of welfare weigh so heavily on the shoulders of local authorities as in [these] years'. In parallel, assistance to the young segment of the population was also offered, together with investments in health care and public works: care of the poor soon replaced welfare in the legal terminology (Raphael, 2017). Regarding education, the Weimar Republic established a four-year elementary school system (*Grundschule*) that was both free and universal (Foght, 1918). Upon a small fee, pupils could attend the *Mittelschule* for an additional two years. However, no actual reforms were implemented with respect to higher education: amid an economic crisis, it was not the government's priority. Following major public spending, the German economy was in desperate condition, despite only paying a small portion of the war reparations.

Nazi Germany - Hitler's national-socialist dictatorship (1933-1945)

While the Weimar government struggled to protect industry with exchange controls to curtail imports and to offer a demand-stimulus policy by financing public works, the leader of the National-socialist Party, Hitler, offered socialisation of the market, and the intensification of exchange controls and trade restrictions, invoking a strong nationalism (Gourevitch, 1984). The world has been in recession since the crash of 1929 in the US. By the end of 1934, unemployment had dropped more sharply than anywhere else. Populism had reached the German folk, and so had the leader's obsession with expanding training to strengthen the country.

Reskilling the labour force by investing in technical and specialised training became one of the German tactics to assert supremacy. First, Hitler granted industry and trade chambers the same powers as the *Handwerk* chambers to offer and certify training to industrial workers. Second, the National-socialist government supported the expansion of training workshops —which went from 167 in 1933 to 3,304 in 1940— and vocational education to train both apprentices and skilled workers —numbering 244,250 in 1940— in preparation for war (Thelen, 2004). While teenagers and young adults had the possibility to work as apprentices in firms for a certain number of days per week, they were also allowed to attend courses in the so-called *Berufsschulen;* professional schools normally run by the government or firms themselves. In parallel, guidelines by institutions such as the German Institute for Technical Education were followed thoroughly by firms —and almost militarily by engineers (Greinert, 2005)— becoming increasingly relevant for modernising the economy. What was initiated during the Wilhelmine period continued during Hitler's dictatorship. Indeed, vocational training, including courses in physics, mathematics, technical drawing, astronomy, and handiwork intensified (Thelen, 2004), but not to the benefit of the workers. Taylor's scientific management and Ford's moving assembly line, copied from America since the 1920s, were at the core of the new work organisation, according to Hitler's idea of

'rationalisation', which meant the application of Taylor's systematic organisation methods, not just in the industrial companies, but also in military training (Drucker, 1999). The incorporation of Fordist methods was mainly done with the cooperation of the German subsidiaries of Ford and General Motors by a complicated set of regulations, including the prohibition of exporting profits, with the result that only by investing in Germany was it possible to grow (Neumann, 1942; Link, 2020). And the 1930s depression was a difficult time in America and Europe.

The post-war German miracle (1950-1970s)

After the defeat and destruction in WWII, the German economy had to be reconstructed. By 1950, employment in manufacturing, construction, transport, and distribution had increased by about 2%, and in government, it went from 4.3 to 6.9%. By contrast, it had significantly dropped in agriculture by 10% (Broadberry, 1997). Between 1950 and 1959, GDP rose annually by 8%, faster than in any other European country, and away from peasant farming (Eichengreen and Ritschl, 2008), and so did exports (Alt and Schneider, 1962). Germany was in the midst of its *Wirtschaftswunder*, or economic miracle. This was guided by Ludwig Erhard, Bavarian minister of trade and industry in 1945, Federal minister of economic affairs between 1949 and 1963, and chancellor from 1963 until 1966.

Although the miracle was based on a strong welfare state and free markets, the public provision of education and training played a central role in supporting and promoting innovation, productivity and high tech. German schools maintained the dual system of vocational training and general education, and schools were still monitored at the state level. Regarding skilled work, the infrastructure created in favour of 'smart' education remained in place also. This was intensified with the Vocational Training Act of 1969, which established a strong network between the Federal Government and the *Länder*, or states.

It is important to note that, contrary to the US, the German industry maintained a high proportion of small- and medium-sized high-technology firms, the so-called *Mittelstand,* specialised in capital goods and complex products. It also had large companies in the processing industries – metallurgy, chemicals etc. – that required a highly skilled workforce. And so did the many in-house R&D laboratories common in large German firms.

Thus, although mass production methods were being applied at the Volkswagen plant and other large companies, the proportion of manufacturing requiring higher skills was significant and dynamic, so that the percentage of the workforce with at least an intermediate level of qualification continued to grow, surpassing that of workers without any qualification. By 1978 the proportions were 60.9% and 35.5%. As a result, labour productivity measured as GDP per employee compared with the UK (UK=100) went from 66 in 1950 to 112 in 1973 (Broadberry, 1997).

Since the post-war period, the Federal government has been committed towards legislation in favour of good living conditions for everyone in the country, including educational matters. The German *Länder*, more specifically, have always been fully responsible for schools, universities, and education, considered a state, rather than federal, responsibility. For the purpose of our analysis, the historical evidence suggests that one of the essential elements upholding the German industrial

survival and success throughout these turbulent periods was the unwavering support of its education and training policies and practices by all political parties and by all of society.

6. Sweden and education for the Folkhemmet

3rd surge 1870s-1910s — Industrialising while protecting all the people

As early as the 1860s, Sweden began to change from a rural society into an industrialised and dynamic country. But the process was slow, and the hope for better lives led many to migrate. It is estimated that more than a million Swedes went to America between 1850 and 1910 (Einhorn and Logue, 1989).

Guild monopolies were abolished when the country formed the Scandinavian Monetary Union with Denmark in 1873. Swedish society nurtured a tradition of social solidarity that gave importance to guaranteeing the *Folkhemmet*, or the People's Home, as Per Alvin Hanssen, the Social Democratic leader, called it in 1928. The term referred to the political concept embraced by the Swedish Democratic Party, as well as the Swedish welfare state itself, to guarantee social reforms for a society where everyone would take care of one another, like in a big family. This deep-seated tradition contributed to the development of enviable welfare reforms, together with development policies. Between 1870 and 1910, the growth rate in Sweden was significant in all sectors of the economy, albeit from a very small base. The manufacturing sector grew at 5% annually, transport and communication at 3.9%, and private services at 2.7% (Schön, 2008), with employment rising steadily.

As observed by Hort (1990), Sweden, in contrast with Germany, made an immediate shift from worker's insurance to people's insurance, following its solidaristic tradition. In this regard, in 1884, a mere four years after Bismarck began introducing careful welfare measures protecting workers in Germany, Adolf Hedin urged in parliament for a "new type of state involvement directed towards the labouring classes" (Hort, 1990). His first worker's insurance bill provided occupational injury insurance, work accident regulations, and insurance for older workers as top priorities. The fact that the social insurance bill passed without opposition in the Swedish Parliament is emblematic of the fertile ground for social reform that was present in the country (Hort, 1990) both in the political world and outside of it. Next to student organisations such as Uppsala's Verdandi, an increasingly large number of scholars, including economists Knut Wicksell, Gustav Cassel, and social scientist Pontus Fahlbeck, wrote about factory legislation, welfare, and education (Hort, 1990). As a result of such commitment, following the 1882 Statute of Schooling, by 1895, 99.9% of the Swedish population could read and write (de Vylder, 1996).

Most importantly, however, as is the case in most countries striving to catch up, the Swedish government understood that to become internationally competitive, education should serve the country's science-based industries with the highest potential for industrial growth (Ahlström, 1982) and, therefore, should become as scientific as possible. As a result of mass investment in training and education by the state, the number of engineers with a higher technical education degree almost tripled from 1,121 in 1870 to 3,145 in 1910 (Ahlström, 1982).

In addition to insurance and mass education, the Swedish government was able to prepare a workforce qualified for any type of job with *ad hoc* schools and universities. At the end of the 19th century, Sweden had already overcome the problem of a mismatch of skills while following an egalitarian political ideology.

4th surge 1910s-1970s — The social democratic paradigm reaches its full potential

The fourth technological revolution did not start successfully for Sweden. Throughout the 1920s unemployment was high, around 10-12% (Ekdahl and Johansson, 1996), and conflicts in the labour market frequent. The election of the Social Democrats in 1932, however, paved the way for a new era of compromise. As the government guaranteed employment, while employers and trade unions "maintain[ed] industrial peace, set wage rates, and promot[ed] technical efficiency" (Ekdahl and Johansson, 1996), Sweden was advancing towards its golden age. It was in the 1930s when Sweden strengthened and diversified its steel industry as an important basis for further industrialisation. By the 1970s, the country was one of the richest in the world, with its gross national product per capita being surpassed only by the US (Ekdahl and Johansson, 1996). Between 1950 and 1975, apart from agriculture, all industrial sectors were growing significantly, especially transport and communication (4.4%), private services (4.3%), and public services (4.0%) (Schön, 2008). Its technological leadership in copper, gold and iron mining, established for centuries, was an important support for its advanced metallurgical industry (Liedholm Johnson and Ericsson, 2015; Tengborg and Sturk, 2016).[2]

With respect to welfare, in 1913, the Swedish government eliminated the Poor Law Commission and established the National Board of Social Welfare together with the Employment Commission. Soon after, thanks to reformist labour politician Gustav Möller, Swedes older than 67 were provided with pensions as early as 1935 (Hort, 1990). In parallel with social reforms, Sweden's government provided a highly proactive approach to providing skills to the workforce. They introduced the 1938 Saltsjobaden Agreement, which encouraged 'the institutionalisation of Swedish corporatism and vocational education training' (Dobbins and Busemeyer, 2015). The 1943 National Vocational Training Board favoured the labour force's 'adaptability' by boosting training in firms; and the 1955 reform on municipalities granted them 'a much prominent role in policy making' with respect to vocational schools and apprenticeships to satisfy local industrial needs (Dobbins and Busemeyer, 2015).

An essential feature of the Swedish success from the 1950s was the adoption of the Rehn Meidner model (Erixon, 2018). It involved consensus building between government, unions and businesses to encourage innovations that would increase productivity. This was achieved by increasing wages across each sector, favouring high-productivity companies and forcing the less productive ones to improve or go out of the market. Support for alternative investment and retraining of the displaced workers would follow. Consequently, the model simultaneously achieved 'full employment, price stability, growth and equality' (Erixon, 2018). By the 1970s, Sweden had succeeded in increasing the

[2] Its expertise had already been confirmed in the early 1930s by successfully exploiting the low-grade Aitik copper deposit (Vikström, 2016).

standard of technical instruction, maximising social welfare and minimising inequality while nurturing giant global corporations and becoming one of the world's richest countries.

7. Conclusions

Every technological revolution has disrupted existing economic systems and forced changes in production, work, and lifestyles. The introduction of a massive set of new technologies, however, requires the proactive intervention of the state to bring about all its potential social and economic benefits. Over time, governments have been challenged by the need to set up a new institutional framework so that new techno-economic paradigms can be successfully absorbed and their benefits distributed more fairly across society.

In this article, we have illustrated how governments in the UK, the US, Germany, and Sweden have operated to reskill their population in line with the new inventions, industries, and professions, as well as providing welfare measures to protect it from jobs and skills losses. Indeed, as rightly illustrated by Kohlgrüber et al. (2021) in the BEYOND4.0 project's Work Package 6, 'any policy has consequences which go beyond the pure change of the skills mix of workers'. Specifically, we argued that governments' attitude towards education –including engineering and other technical specialisations– reflected their degree of interest in achieving 'scientific' industrial progress that would lead to a better future, even if this was to the detriment of traditional sectors in the short term. Future research could address the role played by the specific differences in the welfare state models and the political colour of subsequent cabinets, which were not the main focus of this analysis, but likely contributed to political actions in favour or disfavour of education and reskilling policies.

While the UK can be considered the prime mover in terms of industrialisation, its unswerving faith in the free market at all times deprived it of public support for change when it was required. The government lacked the conviction -- and therefore the decisiveness -- to implement reforms in favour of reskilling the workforce for economic growth with major technological change while other countries were forging ahead. Although mass education was progressively replaced by specialised education for industrial purposes, the UK failed to tackle social inequality and institutionalise technical education in favour of 'scientific' professions and industries. The control of education exercised by the Church of England thwarted many efforts by secular organisations or by those of other religions with legal restrictions. By the end of the third technological revolution, the UK was already lagging behind her latecomer followers. This shows that being the experimental cradle of major technological innovation is insufficient to guarantee leadership or institutional and economic progress. It is by providing the population with adequate education and skills that constant innovation and advances in productivity can be attained and a fairer society constructed. The UK case illustrated the danger that leading countries, accustomed to being ahead, may disregard the actions required to retain their front-ranking position.

The latecomer advantage of the US, for instance, together with the shortage of labour, encouraged the government to invest in human capital to catch up and forge ahead of Britain. From the beginning, the more advanced American states provided education tailored to the industrial needs of the country, distinguishing between degrees of education and potential job opportunities. Technical courses and vocational training – be it publicly or privately provided – progressively

became the core of the American education system. Nevertheless, the federal government succeeded only partially in levelling differences between states in terms of educational provision and, consequently, in the resulting economic performance.

In Germany, that same latecomer advantage was enhanced by the creation of a welfare model and the provision of a wide range of training schemes and institutions for scientific and *ad hoc* technical education. The country was particularly effective in combining compulsory education with company training, supported by qualified teachers, contributing to reducing potential mismatches in the labour market. And having worker representatives on company boards facilitated understanding of the direction and intensity of technical change and the adaptation of the workforce in skills and conditions.

The objective of equipping skilled workers for skilled work was also achieved by Sweden, whose government guaranteed the social dialogue between employers, workers, and the state. Sweden eventually became a standard-bearer for how guaranteeing a social dialogue in the labour market and providing an efficient integration between education, training, and work can lead to significant economic success for business, together with social fairness.

As illustrated by the historical narrative provided here, the attitude of governments and institutions towards human capital investment is a relevant factor for absorbing new techno-economic paradigms. This supports the argument that technological change occurs in parallel with the development of technological knowledge (Parayil, 1991), ultimately allowing for economic and social value creation (Sindhwani et al., 2022). The public sector can be a powerful reinforcement and complement to in-company innovation and training. And not just education in general, but one that guarantees the skills necessary for individuals and firms, and consequently the country, to advance with the new technologies, both socially and economically. As rightly stressed by Zamagni (2020), a true cultural revolution —which includes institutional, social, and economic change— can only be successful when work is accompanied by knowledge.

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BEYOND 4.0

TRANSFORMATION OF THE MODES OF PRODUCTION AND TRANSFORMATIONS OF SOCIAL POLICIES

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In all societies, there must be some form of redistribution on resources. Without redistribution, no society can be viable. The methods of redistribution vary according to time and place. Different historical developmental patterns have produced myriad welfare state models, the development of which has been contingent on the mode of production and cultural and political constellations. In the present welfare states, there are huge differences in the roles of the individual, family, kinship, tribe, occupation, and state. Furthermore, the roles and forms of vertical and horizontal redistribution are numerous. Consequently, socioeconomic impacts in terms of the income distribution, inequality and poverty are different.

We argue that neither the historical development of social policy nor the future solutions are dictated by changes in the mode of production. There have been, and there will be, different paths to react to these changes. Industrialism made the old agrarian social security form obsolete, and new arrangements were created. Similarly, the digital era will challenge some of the welfare programmes created during the industrial period. However, this is not a law-like phenomenon. The reactions depend on the existing systems' political power structures and institutional legacies.

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Prelude

“How much is required?”

“He's still a good worker...the winter season chops fir branches...”

“How much is required?”

“Eighty!” is the first cry.

“Mark away!”

“Seventy nine...”

“Mark away!”

And that's how they subtract "a mark" from the man's allowance, until the last shout stops at "sixty".

The person concerned has stood up on the bench to hear what was offered about him.

"They're going down, they're going down", he cried as he listened to the screams. “Yes, a little... yes, a little... it only cost sixty marks.”

The quotation was the opening section of Juhani Aho’s [1861-1921] short story published in 1886. Aho aptly describes the process of auctions of poor people that were common in Aho’s time in rural Finland. In a poor auction, parishes auctioned their paupers, usually children and older adults. In the auction, farmers set their bids, that is, the sum of the money they required from the parish for the maintenance of the poor person. The farmer who required the lowest sum won. In Aho’s story, the lowest winning bid was 60 marks. In an agrarian society, the auctioned poor were expected to participate in daily activities in the farmhouse. As a rule, children were supposed to look after smaller children, be shepherds, and help with lighter daily tasks. Older persons were supposed to contribute to other activities, such as ”chopping fir branches,” which were to be used as bedding for cows in the barn

The overarching goal of this internal policy paper is to analyse the historical patterns of the development of the welfare state. It aims to evaluate how changes in the mode of production have reformulated the existing forms of social protection systems and created a need for new ones. We also examine the socioeconomic impacts of these changes in terms of income distribution and inequality. Based on our historical survey, we sketch the implications of employment, equality, and social welfare in the current digital transition.

Our central argument is that development has not been and will not be deterministic. Different options are available, and countries react differently depending on their political constellations and the historical legacies of their previous policy solutions.

1. Introduction

In all societies, there must be some form of redistribution. Without redistribution, no society can be viable. Depending on the society, the redistribution occurs from hunting men to women and children, from rich to poor, and from transferring monetary resources over the individual's life cycle. In the former cases, we speak about vertical redistribution; we take from those who have and give to the have-nots. We speak about horizontal redistribution when we distribute from one individual's life phase to another. In horizontal redistribution, resources are transferred from the working-age phase to old age or to seek protection against various social risks such as sickness, unemployment, or incapacity to work.

Emerging social legislation, first in the form of poverty laws, provided some relief for the destitute. In addition, various forms of self-help organisations, such as guilds and other mutual arrangements, protect in the case of sickness, old age, and death. In many cases, these arrangements go back to the Middle Ages. Gradually, the state began subsidising and supervising mutual and voluntary schemes. However, as a rule, the benefit levels were meagre, and the coverage rates of the early programs were limited. The nuclei of these mutual organisations were skilled, unionised workers, while the unskilled, largely unorganised labourers were mainly excluded from benefit societies. Applicants with a good diagnosis (young, male, and healthy) with their low-risk characteristics were preferred to older workers and women with their high-risk propensity. The greater the need for protection, the more unlikely it was that help was available. The more peripheral the group of workers, the weaker the guaranteed level of social security. They had to rely on poor assistance. In other words, whereas the poorer sectors of society had no means for horizontal redistribution, they had to rely on a vertical distribution that was controlling and punitive.

Our review of the historical development of the welfare state posits that despite the challenges caused by industrialisation being similar in most European societies, the answers to these challenges were different in different countries and groups of countries. The problems were the same, but institutional solutions were different. Regarding the institutional consequences of the structural transformations of society, they are not deterministic, but there is leeway for different solutions.

Although each mode of production has its models of social protection, within this big picture, there are different forms of distributive arrangements in different parts of Europe, not to mention other continents. The same applies to the challenges caused by digitalisation and changes in the traditional industrial mode of production. Challenges may be similar in all countries, but the reactions and policies chosen differ depending on existing institutional settings and political constellations. Thus, by comparatively analysing historical patterns of changes in social protection systems, we can evaluate possible implications for equality and social welfare in the current digital transition and provide lessons for future policymaking.

With a slight exaggeration, it is possible to recognise three lines of explanation in the welfare state research tradition. We can speak about three generations of welfare-state research. The main characteristic of the "first generation" was that the welfare state was seen as a functional solution to major structural changes in society. Whether it was about industrialisation (Wilensky & Lebeaux 1958; Kerr et al. 1960; Wilensky 1975; see also Wilensky 2002), economic growth, or the

proliferation of capitalism (for example, Gough 1979), the development of social policy was interpreted as an automatic response to these profound structural transformations.

The problem with these structure-functional explanations is that they cannot explain the differences between developed countries. Why did some poor, less industrialised, and less urbanised countries guarantee better social security than remarkably wealthier and more industrialised nations? When looking for answers to such issues concerning differences between countries, eyes then turned to political power relations (Korpi 1985). This "second generation" approach concentrating on political power has been frequently used in comparative welfare research over the last two to three decades (for example, Alestalo & Kuhnle 1987; Korpi 1978 and 1989; Esping-Andersen & Korpi 1987; Esping-Andersen 1990; Huber & Stephens 2001; see also van Kersbergen & Manow 2009).

While social policy differences between countries on the same socio-economic development level became a problem for structure-functionalistic explanations, the interpretation of social policy differences in rather politically similar countries became a problem for the political approach. In the "third generation" of explanatory models, the prerequisites for welfare state development were set by the state's institutional structures and previously adopted social policy solutions (Orloff & Skocpol 1984; Skocpol 1992). The idea of institutional explanations was already sketched by Karl Marx [1818-1883]. In his The Eighteenth Brumaire of Louis Bonaparte, he wrote, "Men make their own history, but they do not make it just as they please; they do not make it under circumstances chosen by themselves, but under circumstances directly encountered, given and transmitted from the past." As Marx emphasised a century earlier, historical institutionalists focus on the importance of previous decisions and existing institutional arrangements that condition subsequent decisions. Institutions are sticky and have inertia. Therefore, most decisions on social policy reforms are path-dependent (Mahoney & Thelen, 2010; Häuserman et al. 2012; Varjonen et al. 2020; Varjonen 2021).

The morale of the cursory review of the plethora of explanations given to the development of welfare programs was to show that neither was the historical development nor would the future solutions be solely dictated by changes in the mode of production. There have been, and there will be, different paths to react to these changes. Industrialism made the old agrarian social security form obsolete, and new arrangements were created. Similarly, the digital era will challenge some of the welfare programmes created during the industrial period. However, this is not a law-like phenomenon. The reactions depend on the existing systems' political power structures and institutional legacies.

Structure of the presentation

In this working paper, we present a short review of social policy development over the past 100 years. In our historical analysis, we face problems similar to those encountered when constructing typical ideal welfare state regimes. We cannot satisfy the recommendation of the famous German historian Leopold von Ranke [1795 – 1886] and tell the true and total history wie es eigentlich gewesen. Instead, we must try to disentangle certain historical phases that are supposed to be central and representative of the welfare state formation in a country or groups of countries. Thus, our historical storytelling is ideal-typic in that we first sketch some broader developmental patterns, similarities, or family resemblances for a group of countries – or welfare state regimes, if you like –

and then try to give a more detailed historical assessment for specific countries regarded as representative of a certain developmental pattern. We concentrated on the development of the main social insurance programmes — work accidents, sickness, pension, and unemployment insurance programmes. Our comparative data are somewhat eclectic, and the sample of countries depends on the availability of statistics.

The structure of the presentation is as follows: First, we discuss the central features of agrarian social policy. Thereafter, we provide a comparative analysis of the timings of the central industrial social insurance forms: work accidents, sickness, pension, and unemployment insurance programmes. Section 4 digs a bit deeper into the content of these main programs. Section 5 presents the historical development of social spending and the financial distribution between the insured, the employer, and the state. In addition to safeguard social peace and prevent mass unrest from arising (as discussed in Section 4), one of the welfare state's main goals is to guarantee vertical and horizontal redistributions. The penultimate section examines outcomes in terms of income inequality. This section aims to understand how different policies have promoted equality in different phases of economic transformation.

2. Agrarian social policies: Putting the poor to work

Before proper legislation on social protection came around, private and church-based donations and alms were the first fora to help the poor. When the public sector gradually began to intervene, the state made the laws but left the responsibility for organising and financing to local municipalities or parishes. A well-known example is the Elizabethan Poor Law of 1601. Similarly, in most other countries, parishes (in particular, in the Nordic countries), churches (in the Catholic countries), or religious denominations intertwined with the public sector (as in the Netherlands) were the main organisations involved in poverty relief (Lindert 2004: 39-47).

In some countries, notably so in the Nordic countries, poor auctions were organised to “sell” the paupers to those wealthier persons who required the least amount of money for the maintenance of the person to be auctioned. The Nordic auctions resembled the English roundsman system to some extent; in the latter case, the parish subsidised local farmers and other households to employ poor workers. The roundsmanship could also be based on auctions. In the Netherlands and Belgium, agricultural work colonies and workshops for women (also typical in France) were common forms of agrarian social policies (Lindert 2004: 51-58).

One dividing line that was decisive for the later development of the welfare state was the relationship between the church and the state. In the Central and Southern European countries, the church and the state remained separate units, whereas in the United Kingdom, the Nordic countries, and the Netherlands, the church and state authorities were intertwined and local parishes were responsible for poverty relief. Gradually, this early divide led to different welfare state constellations, as shown in subsequent chapters (for a fuller discussion on different welfare state models and the role of religion, see, e.g. Beland et al. 2021; van Kersbergen & Manow 2009).

The main debate in the agrarian social policy discourse revolved around indoor versus outdoor relief. Whereas the former pertains to all non-cash benefits (be they based on auctions, roundmanship, or various forms of forced labour for the able-bodied and poorhouses for the rest),

the latter pertains to monetary help (be they based on private charity, alms-giving, or funds provided by municipalities or parishes). The emphasis was on indoor relief, and direct money-giving was regarded as morally destructive.

During the transition from agricultural to industrial production, the local character of agrarian social policy became a problem. The system that had its roots in charity, activities of parishes, or that other local characteristics of social policy did not fit in the geographically larger and more flexible framework of the industrial mode of production. Stiff pre-industrial traditions run in conflict with the demands of flexibility and mobility of labour in industrial society (Esping-Andersen & Korpi 1987). However, there were many conflicts before these structural demands were transformed into social insurance programs and institutional setups of industrial social policies in many different forms.

3. Social insurance – the greatest invention of humankind

The industrial mode of production was based on paid labour. Therefore, social risks in industrial production were related to the loss of income due to industrial accidents, sickness, unemployment, old age, or other reasons that caused incapacity to work. Social insurance was the answer to these problems. Despite the similar structural needs of industrial societies to organise social security against various risks of life, existing social policy institutions in advanced nations display a surprisingly high degree of heterogeneity, both in terms of timing (see Table 1) and institutional setups of the schemes (see Section 3).

Table 1 summarises the years in which social insurance plans came into force in several European countries. The years without parentheses signal the beginning of mandatory insurance, and those in parentheses pertain to state-subsidised voluntary (and, in the case of pensions, partly contributory) systems. Means are calculated based on first laws, be they voluntary or obligatory. From the table, we can see that, first, the order in which the insurance policies were enacted followed a certain pattern (for a fuller discussion, see, for example, Alber 1981). Second, countries have substantial differences in the timing of their first programmes.

In industrial machine-based production, the first risk that the worker met was work. Therefore, industrial accident legislation is most countries' oldest form of social insurance. In addition, implementation time was similar across countries. Work accident insurance was carried out around the turn of the 20th century (1871 in Germany (Prussia) and 1903 in Belgium). The time span between the two countries was 32 years.

Table 1. The timing of the first social insurance programmes in some European countries[3] and unweighted means and standard deviation (CV[4]).

[3] The countries are ranked according to the timing of the legislation. The forerunners first and the laggards last (The rank order is based on Schmidt 1988).

[4] Coefficient Variation (CV = standard deviation/mean *100). The CV is a standardised measure of dispersion of variable over research units. The smaller the CV value, the more homogenous the countries are in timing the first laws.

	Work accident	Sickness	Pension	Unemploy-ment
Germany	(1871) 1884	1883	1889	1927
Austria	1887	1888	1927	1920
Italy	1898	(1886) 1928	(1898) 1919	1919
Norway	1894	1909	1936	(1906) 1938
Netherlands	1901	1929	1913	(1916) 1949
Great-Britain	(1898) 1946	1911	(1908) 1925	1911
France	(1898) 1946	(1898) 1930	(1895) 1910	(1905) 1967
Ireland	(1897) 1966	1911	(1908) 1960	1911
Denmark	(1898) 1916	(1892) 1933	(1891) 1922	(1907)
Sweden	(1901) 1916	(1891) 1953	1913	(1934)
Belgium	(1903) 1971	(1894) 1944	(1900) 1924	(1920) 1944
Finland	1895	1963	1937	(1917)
Switzerland	(1881) 1911	(1911)	1946	(1924) 1976
Mean	1894	1905	1912	1917
CV	0.5	1.2	1.0	0.4

Source: Alber 1981; Schmidt 1988: 188; Hellsten 2004: 126.

There was significantly more variance in the implementation of sickness insurance. In the pioneering country, Germany, sickness insurance was introduced in 1883, whereas Finland did not introduce legislation on sickness benefits before 1963. Thus, the time span between the leader and laggard was 80 years. Pension insurance systems were established in the early 20th century, and the time difference between the first and last countries to do so was 57 years. Unemployment insurance differs from previous insurance programs in that not all countries mandate it. Denmark, Finland, and Sweden still have voluntary unemployment funds that provide earnings-related benefits to fund members. The first law was introduced in 1905 in France, and Sweden was the last country to introduce the scheme (in 1934).

The coefficients of variation indicate that the countries in the sample were most similar in terms of unemployment and work accident insurance schemes, whereas there were more variations in the sickness and pension schemes.

Often, the augmentation of the first forms of social insurance is explained by emerging industrialisation. The industrial mode of production created new needs and new problems to which social insurance was an answer (Kerr & al. 1961; Wilensky 1975 and 2002). In these kinds of functionalistic explanations, social policies and welfare states are seen as inevitable and automatic responses to changes in the mode of production. While the overarching situation does signify this,

it still needs some nuance. The responses to these structural changes varied significantly between countries.

By no means was the legislative process of social insurance automatic. This was highly conflicting. First, there was a classic conflict between employers and the fledgling labour movement: the conflict between the representatives of capital (capitalists) and labour (workers). Second, linked to the first reservation, there were conflicts between political parties representing different societal interests and socioeconomic groups. Both affected the timing and form of the first social insurance law.

With regard to the conflicts between employers and their workers, while work accident legislation did not intrude into the employer-employee relationship, unemployment benefits increased the employees' reservation wage by providing a means of livelihood to the unemployed, making the latter programmes unpopular with employers. Sickness and pension insurance programmes can be seen as falling between unemployment and work accident schemes in their impact on employee-employer relations (Väisänen 1992).

There were severe conflicts of interest between the fledgling working class, governments, employers, and representatives of various institutions involved in running pre-existing schemes. These historical time- and place-specific contexts have greatly shaped policymaking. Since policies create politics, early institutions formed a frame of reference for the subsequent policymaking and later developments in social insurance (for example, Skocpol 1992; Steinmo & al. 1998; Pierson 2000; Mahoney 2000; Mahoney & Thelen 2010).

For example, the fear of extending the gulf between employers and employees was the most acute in monarchies with authoritarian regimes, as in Germany (Ritter 1986: 50-82) and Austria (Hofmeister 1982: 294-295), but the issue was also present in many other countries. In authoritarian regimes, social insurance was used to placate the aggressive workers' "aristocracy," whereas in the U.K. and the Nordic countries, the starting point was linked to the mitigation of the position of the (agrarian) poor to a greater extent (Alastalo & Kuhnle 1987; Esping-Andersen 1987; Kangas & Palme 2005). These two underpinning rationales lead to two different approaches to social policy: Bismarckian workers' insurance (Arbeiterversicherung) and Beveridgian/Nordic people's insurance.

4. Institutional setups

This section discusses the development of the four main social insurance forms. We are primarily interested in the institutional setup of these schemes as well as the expansion of their coverage. "Coverage" pertains to the share of the population covered under these schemes. Our review of the developmental patterns of individual programmes follows the sequential order of the first laws, as shown in Table 1. Data were derived from the The Social Policy Indicators (SPIN) database housed at the Swedish Institute for Social Research at Stockholm University (Nelson et al. 2020).

4.1. Work accidents

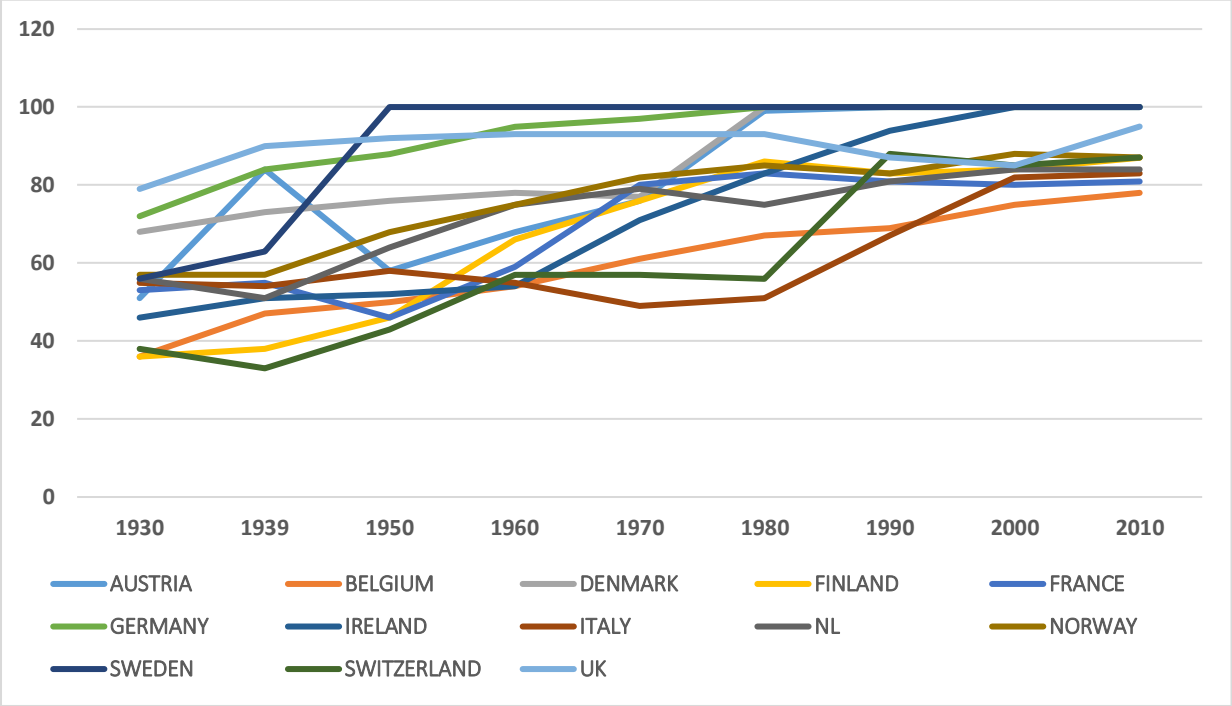
In its early forms, the work accident scheme was limited to certain dangerous occupations and hazardous areas. The name of a very early scheme is revealing, 'Working men's compensation'. Not surprisingly, the earliest insurance programmes to be organised in nearly all countries were related to accident insurance (see Table 1).

Unfortunately, our data do not go back further than 1930. However, the time series are sufficiently long to provide a picture of the general developmental pattern and country-specific variations. As Figure 1 shows, in several countries, the total labour force is covered under the scheme (coverage = 100%). However, in most countries, coverage is incomplete, mainly because the self-employed are not covered by the compulsory insurance. They have voluntary coverage, and they often do not insure themselves.

The concept of the risk insured has changed substantially. The very narrow concept of work injury, defined as a bodily injury caused by machines or occupational diseases directly linked to work, has been widened to cover a wider variety of disabilities and diseases whose aetiology does not need to be related to accidents and hazards in the workplace. In pace with the reduction in industrial production, the expansion of white-collar employment, and new forms of employment, there is a tendency towards claims due to work-related mental symptoms such as stress and burnout.

The evolution of the work accident scheme is an illuminative example of how insurance must be changed as a reaction to changes in the mode of production. The change in production makes old risks obsolete, and new risks may emerge. Social problems for which the programme originally provided protection changed in character. Therefore, the content of the program must be changed accordingly. Gradually, work accident insurance expanded to compensate for more subtle hazards, and the direct causal connection became blurred. These developments have narrowed down the conceptual differences between work accidents and sickness. In many countries (for example, in the Netherlands), these two benefit systems are merged, and compensation is paid through the same programme, irrespective of the cause of incapacity to work.

Figure 1. Development of coverage in work accident insurance in some European countries (insured / labour force, %) 1930-2010.



The birth of work accident insurance is also an example of an externality. In the early industrial era, an injured employee was sent from an industrial city back to the countryside from where they came. Thus, the worker became a burden to the local poverty relief system. The industry externalised this problem. Rural counties or parishes facing these externalities began to insist that cities share costs. The insistence spurred the creation of mandatory work accident insurance, which served to eliminate externalities and burdened the costs back onto their instigator.

4.2. Sickness insurance: Workers' insurance vs people's insurance

The development of sickness insurance demonstrates that in addition to providing security against social risks, social insurance has other ramifications as well, including dividing and unifying people.

In Germany, the Bismarckian anti-socialist laws of 1873 banned socialist organisations, but existing mutual insurance funds offered social democrats a legally approved channel to work for party purposes, and sickness funds constituted a legal substitute for illegal socialist organisations (Ritter 1986: 75). Therefore, it was from there that the labour movement recruited its members, and the mutual funds created cohesion and collective workers' identity and contributed to class consciousness.

To undermine support for social democrats and strengthen workers' loyalty to the state, governments in authoritarian regimes in Germany and Austria introduced compulsory social

insurance schemes (for a fuller discussion, see Alber 1981; Hofmaister 1982; Ritter 1986; Talos & Wörister 1994). By placing white- and blue-collar workers under different social policy schemes, the authorities separated these occupational categories from each other5. This functional separation of occupational categories formed the nucleus of the corporatist social policy strategy. The developmental pattern in this form of social policy was the gradual inclusion of new employment categories.

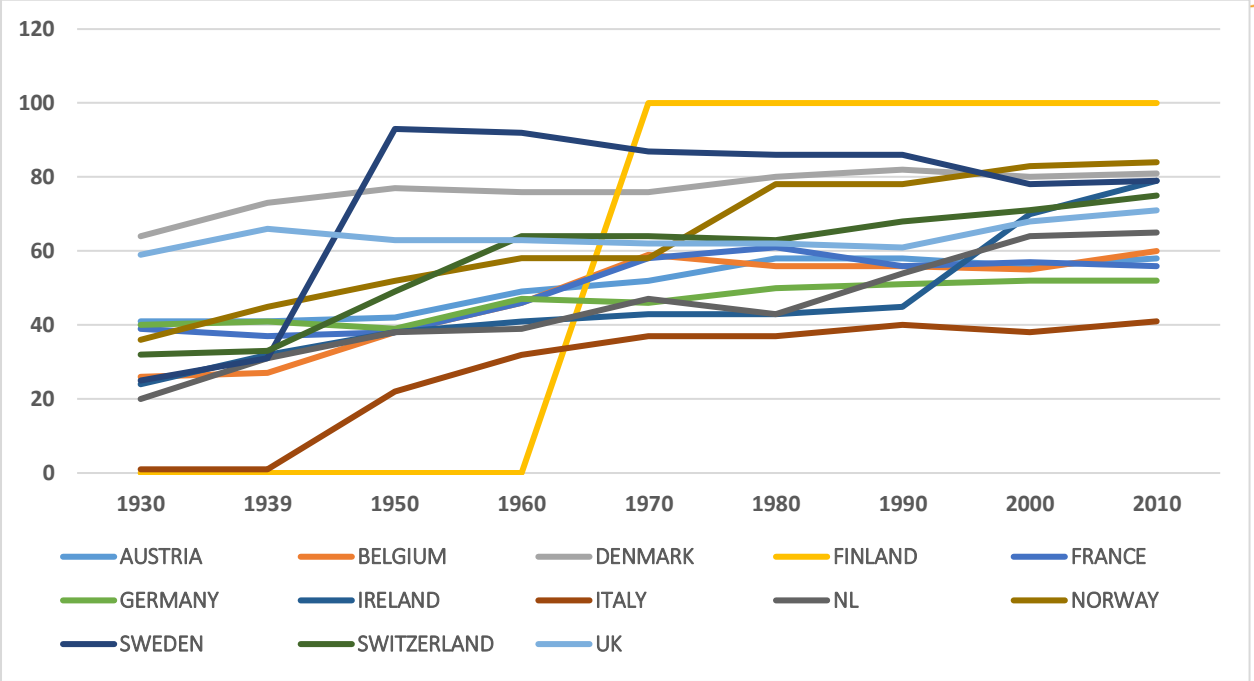
Compared to Austro-Germanic corporatism, the Belgian and Dutch variants were more liberal and less authoritarian. Furthermore, in the Low Countries, the religious denominational pillars or language cross-cut traditional class-based cleavages, and different groups of people belonging to the same denomination were unified in welfare programs. Therefore, sickness benefits tried more to unify various occupations than to divide them into separate occupationally determined schemes.

British development went in other directions, as in continental Europe. The British 1911 law relied on uniform contributions and flat-rate benefits, while the continental model had income graduation both in social security contributions and benefits paid out (Hennock 1981:94). The first British law relied on friendly societies as insurance carriers, but after the Second World War, the administration was centralised under a single Beveridgean scheme (Hennock 1981:99).

Differences in the institutional design of the British and German schemes mirror the larger ideological and political underpinnings behind social insurance. In Britain, the scheme was planned to replace old poverty laws and help the poor, while the German scheme was to help affluent sectors of the working class. In more general terms, in central European countries, the emphasis was on horizontal redistribution between active and inactive periods in an individual's life, whereas the British approach emphasised vertical redistribution between the rich and the poor. The latter approach has been especially strong in Antipodean countries, relying heavily on means-tested rather than contribution-based or flat-rate universal benefits.

[5] A good example of how social policy has many other functions as purely guaranteeing people's livelihood is the fact that the "white-collar worker" (Angestellter) came to refer to anyone who had insurance under special Angestellten-laws. (Ritter 1986:93). Promoting white-collar consciousness and status differences against workers. Thus, belongingness to certain social policy program came to be nucleus of social stratification.

Figure 2. Development of coverage in sickness insurance in some European countries (insured / population, %) 1930-2010.



The first Nordic social policy programs were amalgamations of peasant liberalism and nascent social democratic ideas, and later the emerging cross-class alliance between blue- and white-collar workers labelled socio-political development (e.g., Esping-Andersen 1985; Esping-Andersen & Korpi 1987; Baldwin 1990). In their heyday, voluntary sickness funds covered about half of the adult Danish and Swedish populations. To improve the scheme's coverage, both Scandinavian countries implemented compulsory insurance programmes. The stories of Norway and Finland are different. They began with compulsory insurance. In the Finnish case, the very first insurance immediately became universal. It was genuine people's insurance covering the total population, including unpaid family workers in agriculture, stay-at-home wives, students, etc. — people who, in most of the other countries, were left outside the protection.

4.3. Pensions: People's insurance vs work-relatedness or both?

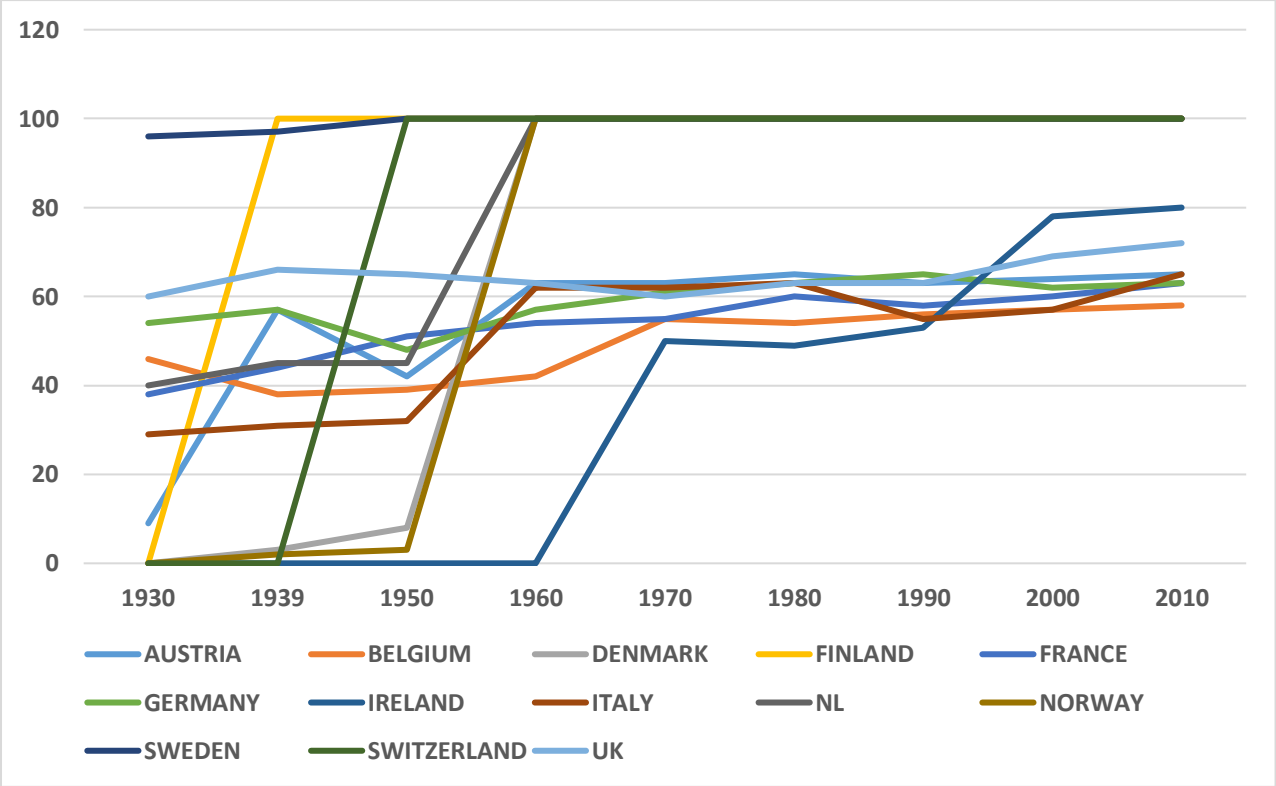
Regarding pension insurance, there are two crucial dimensions of coverage: entitlement and recipience rates (Palme 1990:42-48). While the former pertains to the proportion of residents aged 15–64 years who, in principle, are entitled to pensions, the latter pertains to those who are over the pension age and whom de facto receive pensions. Developmental trends in these two dimensions may differ.

As Table 1 shows, in half of the countries included in our study, the first form of pension insurance was voluntary, whereas the other half started with obligatory and fully legislated schemes. In five countries (Austria, Belgium, Germany, Italy, and the Netherlands), the initial schemes were

insurance-based, and five countries (Denmark, France, Ireland, Norway, and the U.K.) relied on means-tested programs.

There were pros and cons of both the models applied in the first programmes. With its paid premiums, the insurance model gave stronger claims rights to recipients than tax-based means-tested programmes. In addition, the insurance entitlement rate was higher than the means-tested programs targeting the poor. Furthermore, pension insurance premiums accumulated investment capital that could be used to promote nationally important projects (for example, building up infrastructure in Finland or housing construction in Sweden; see Kangas & Palme 2005; Kangas 2008). The problem in insurance-based pensions was that the maturation process was often slow (for example, 40 years); thus, although the initial entitlement rate could be 100%, the recipience rate could remain very low. Therefore, in some countries (Finland, Sweden, and Switzerland) that started with universal insurance, paid means-tested supplements on top of insurance contribution-based pensions.

Figure 3. Development of entitlement rate in pension insurance in some European countries (insured / population, %) 1930-2010.



As the figure shows, Sweden was the first European country to implement a citizenship-based old-age pension with full coverage, followed by Denmark, Finland, Norway, the Netherlands, and Switzerland. Countries that kept on the insurance path with employment-related pension provisions showed much lower entitlement rates. The same applies to the adherence rate. In both coverage rates, a significant amount of convergence occurred.

The Nordic countries provide an interesting example of an "encompassing" pension system. These countries combined citizenship-based pensions with earnings-related pensions paid on top of people's (national) pensions. In contrast to Bismarckian-style workers' insurance, the starting point was people's insurance (or national insurance), covering the entire population equally. Early programmes were designed to meet the needs of both rural and urban sections of the population (Kangas & Palme 2005). Gradually, when the prosperity of the working class increased and the middle class grew in political importance, flat-rate benefits became inadequate for these layers of a society striving for earnings-related pensions. To incorporate wealthier strata under the insurance, Sweden, Finland, and Norway complement their people's pensions with statutory earnings-related benefits. Denmark never managed to legislate on income-related pensions, but the need for income-loss compensation bifurcated into private individual and labour market pensions (Kangas, Lundberg & Ploug 2012). The same was observed in the Netherlands. These flat-rate universal national pension schemes, supplemented later by income-related benefits, came to form a basis for eliminating old-age poverty.

4.4. Unemployment insurance: Much more than just insurance against unemployment

In most countries, the first forms of unemployment protection schemes were state-subsidised voluntary funds. There were three camps in political debates on the proper institutional form of unemployment insurance. While liberals insisted on subsidies to voluntary unemployment funds, the conservatives often spoke in favour of obligatory, state-run schemes. The latter applies to power holders in central Europe, particularly where the elites wanted to incorporate the growing working class under the state's patronage. Representatives of the working class were not eager supporters of the state's activities. The labour movement preferred trade unions to the state as the proper organisation for the administration of unemployment insurance. (Carroll 1999). Statutory solutions and the state's governance and activities in the area of social questions were met with suspicion. For example, in 1893, the German socialist leader August Bebel warned his comrades that "every new extension of state power is narrowing down the sphere of union activity" (quoted in Ritter 1986: 80). Thus, the story of political debates and conflicts of interest is very much the same as in the case of sickness insurance (see Section 4.2).

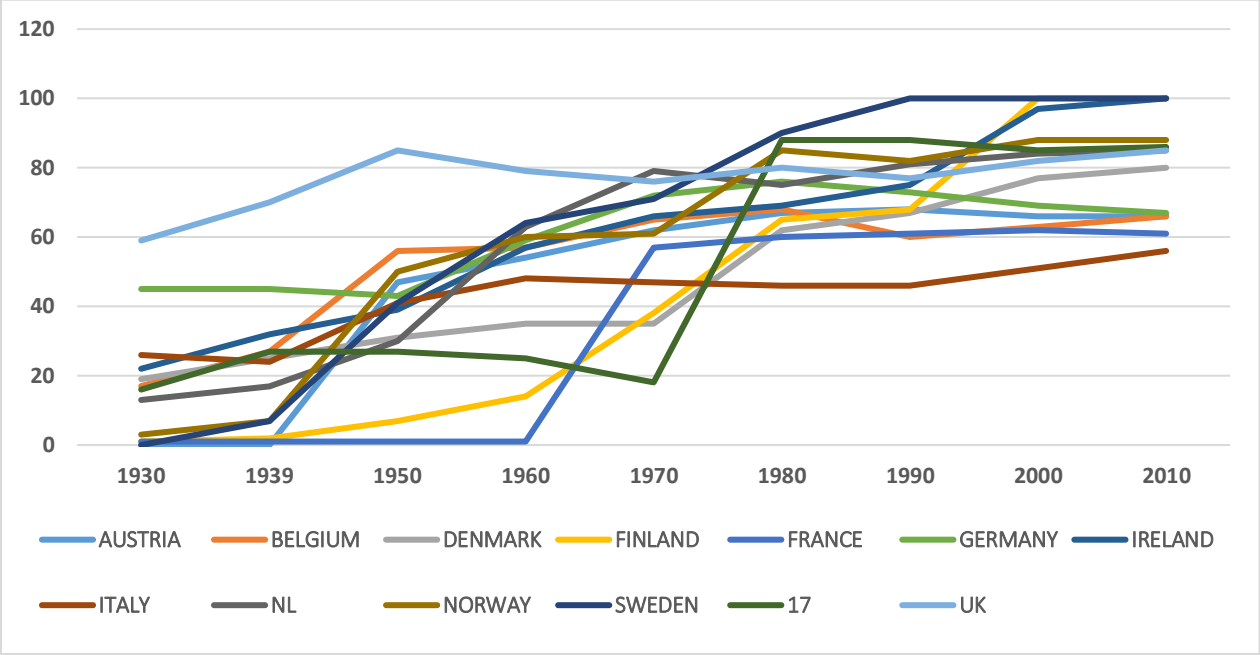
As a rule, the coverage rates of the fledgling insurance schemes were very low. In the early 1930s, the mean coverage of the 13 countries was as low as 17%. Before the Second World War, coverage was less than 5% in many countries. The coverage rates were somewhat higher in Germany and Austria, which implemented corporatist unemployment insurance schemes in the 1920s. In central Europe, unemployment insurance was typically occupationally segregated and administered by bi- or tripartite organisations (Carroll 1999: 126). Despite the compulsory nature and relatively high initial coverage rates, toward the end of our inspection period, central European countries tend to lag behind other countries. The same also applies to the U.K., which had the highest coverage rates in 1930.

There were tense relationships between funds, the fledgling working-class movement, and the state in Germany, Austria, and France. The politics of unemployment insurance in Belgium and the Netherlands were less conflictual. The Low Countries had stronger liberalist traditions and particular

structures of social cleavages that conditioned the creation of social policies in these small nations. In Belgium and even more so in the Netherlands, society has been divided into different sectors and pillars following denominational (Catholics versus Protestants) or political (Socialist versus Liberals) lines. In Belgium, linguistic questions have formed an additional line of demarcation. These blocks used to live side by side as separate subcultural communities, having their own social and political institutions (van Kersbergen 1995).

Only three countries (Denmark, Finland, and Sweden) have preserved their initial voluntary insurance models. While funds pay income-related daily allowances, basic unemployment benefits are available only for those who are not fund members. Often, the funds are run by trade unions, and union membership automatically guarantees membership in the unemployment fund. Therefore, the union density in these three countries was the highest in Europe.

Figure 4. Development of coverage in unemployment insurance in some European countries (insured / labour force, %) 1930-2010.



5. Social spending and financing

In the previous sections, we concentrated on developmental patterns in social policy institutions and the political and other societal background factors that conditioned these developments in different countries. The overarching message was that despite the development being linked to the shift to the industrial mode of production, industrialism was not a law-like deterministic process that dictated development. As we have seen, many outcomes depended on other factors. In some countries, the prevailing social policy option was workers' insurance, labelled by a gradual expansion of the coverage of the schemes, whereas other countries followed the people's insurance principle and expanded the coverage to the majority of the population, if not the total population (as pensions in the Nordic counties or sickness benefits in Finland, in particular).

It is one thing to provide benefits for the people who are covered under the insurance, another thing is what the costs are and who is responsible for financing them. Table 2 provides a summary of the developments in these dimensions over the last 160 years. Unfortunately, data on financing social security spending in the early years of social programmes are unavailable. The International Labour Organisation (ILO) provides data for 1950. Data for 2020 (the closest year available) were drawn from Eurostat (2022). In addition to spending levels and financial distribution, we present the unweighted mean and CV.

In the early years, the state and employers were the most important financiers of social security. They account for 82% of the total revenue. It has several country-specific characteristics. In the 1950s, employers were the most important financial source in Italy and France, whereas state revenue was prominent in Great Britain, Ireland, Denmark, and Sweden. The state in 2020 is still the biggest financier in Ireland and the Nordic countries.

Table 2. Social spending (% of GDP) in some European countries 1880 and 2020 and distribution of financing 1950-2020 (%) between the insured, employers and the state (including the local government).

	Gross social spending				Financing 1950			Financing 2020		
	1880	1920	1950	2020	Insured	Employer	State	Insured	Employer	State
Ger	0,5	m.d.	14	33	24	41	35	31	36	33
Aut	0.0	0.0	13	29	24	49	27	27	37	36
Ita	0.0	0.0	8	34	5	71	24	37	16	48
Nor	1.1	1.1	7	28	30	18	52	15	29	56
Nl	0.3	1.0	8	29	19	49	32	36	36	28
G-B	0.9	1.4	10	26	18	16	65	m.d.	m.d.	m.d.
Fra	0.5	0.6	12	34	15	68	16	17	39	44
Ire	0.0	0.0	9	16	6	23	71	12	28	60

	Gross social spending				Financing 1950			Financing 2020		
	1880	1920	1950	2020	Insured	Employer	State	Insured	Employer	State
Den	1.0	2.7	9	33	13	12	74	8	12	80
Swe	0.7	1.1	9	29	9	11	79	9	40	52
Bel	0.2	0.5	11	29	20	46	34	20	39	41
Fin	0.7	0.9	7	30	8	43	49	15	32	52
Swi	m.d.	m.d.	7	27	35	28	37	27	33	11
Mean	0.4	0.8	9.5	29.0	17.4	36.5	45.8	22.4	31.1	30.4
CV	80.6	93.4	24.2	16.0	53.4	55.6	45,4	48.1	28.7	38.8

Sources: data for 1880 and 1920 are derived from Lindert 2004: 12-13; data for 1950 from ILO 1964, and data for 2020 (or 2019) from Eurostat 2022.

As the CV indicates, countries have become more similar in spending levels. There is also a slightly converging trend in financial shares, albeit not as strong as in the case of social spending. Thus, the magnitude of responses to social risks caused by industrialisation, deindustrialisation, and the expansion of the service economy has converged. However, the basic institutional settings and financial structures have changed comparatively less. This supports our hypothesis of institutional inertia and the long shadow of the early institutional path chosen in the initial period of social policy.

Interestingly, countries, where the dividing line between the church and the state was blurred, began to develop more comprehensive social protection systems. This applies to the extension of coverage but not necessarily to the generosity of benefits. Examples include Nordic countries with their people's insurance, the Netherlands with its universal pension systems, and the United Kingdom with the Beveridge model (Kangas & Palme 2005). In continental and southern European Catholic countries, the developmental patterns were different. The state and church operated their domains, and the state began to implement workers' insurance (see Manow 2021). These developmental patterns have led to different institutional setups in the progress of national welfare states. Consequently, the outcomes differ in terms of poverty and income inequality.

6. Outcomes: the welfare state reduces income inequalities

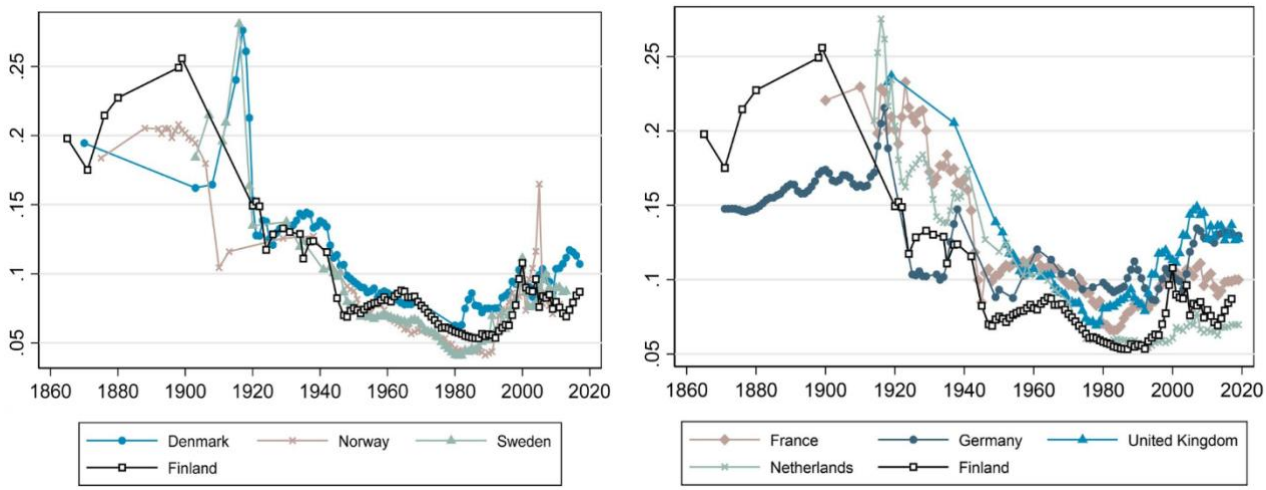
One of the major tasks of the welfare state is vertical redistribution, that is, to diminish the gap between the rich and poor (Goodin 1988). Unfortunately, we do not have comparable data for all countries or for the total time period. However, some historical information is available on value creation and distribution. For example, Thomas Piketty's (2014) massive Capital in the Twenty-First Century provides some estimates of the long-term (1910-2010) developmental patterns in inequality. Petri Roikonen's (2021) comparative data go even longer back in history (1860-2020; see Figure 5).

As can be seen, the agrarian record shows that before the First World War, the top percentile's share of total income was 20-25% in the agrarian north. The share was the highest in the agrarian

society in Finland. After the First World War, differences between Nordic countries virtually disappeared, and the curves followed similar patterns. After the Second World War, income disparities sharply diminished due to the establishment of the Nordic welfare state model (see Kautto & Kuitto 2021). Since the late 1980s, disparities have grown, when the top per cent accounted for about 5% of all income; 20 years later, its share was about 10%. The main explanation is the increase in capital gains and diminishing redistributive effects of taxes and income transfers (as depicted in Appendix Figure 1).

The patterns for the central European nations are very much the same as for the Nordic countries, although the share of the top percentile is significantly higher than in the Nordics, notably so in the United Kingdom. In 2020, the top percentile shares in the United Kingdom and Germany were approximately 15%, and the share for France was approximately the same as the Scandinavian levels. In the Netherlands, the increase in inequality has been the most modest. The results are more or less similar to those presented by Piketty (2014: 316-320).

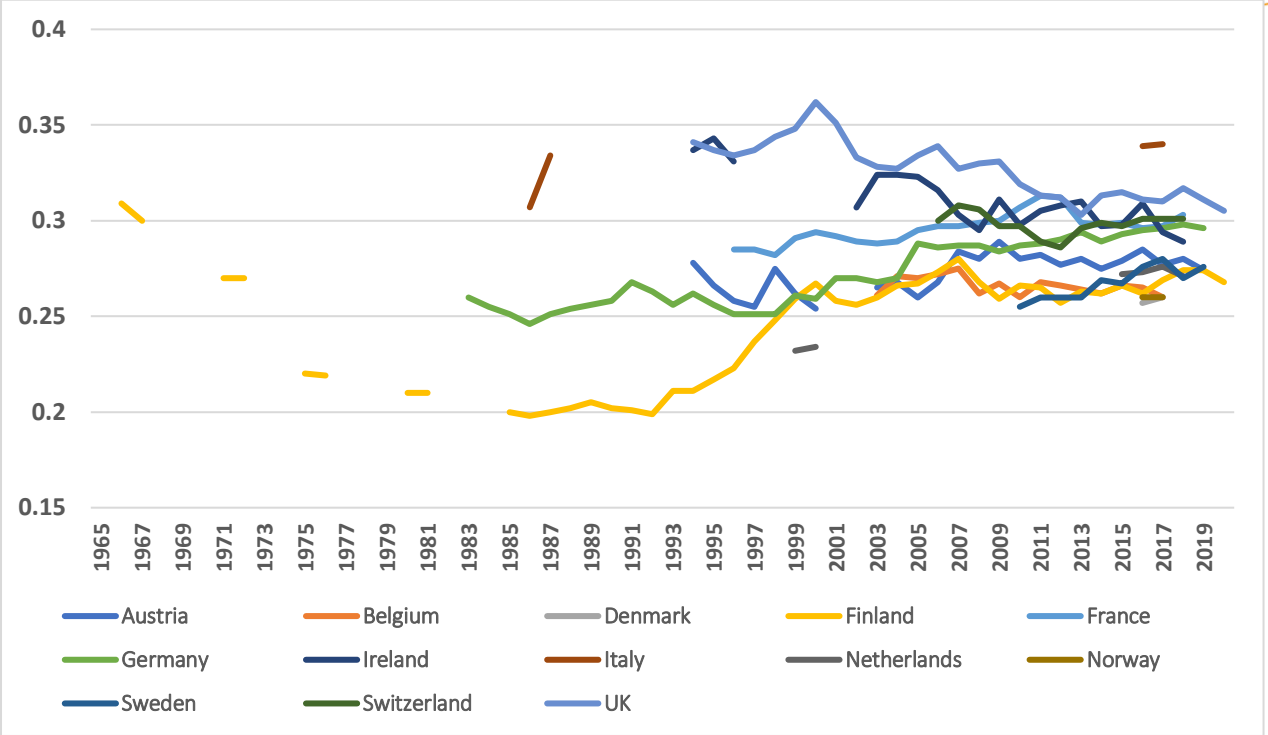
Figure 5. Top one per cent's share of income in the Nordic and Central European countries 1860-2020.



Source: Roikonen 2022.

An alternative way of looking for development in inequality is to calculate Gini coefficients that vary between zero (all income groups receive the same amount of money, that is, there are no income differences) and one (the highest-income group collects all the income). Figure 6 depicts the development inequality for all the countries included in our historical comparisons (authors' calculations from the Luxembourg Income Study data and Statistics Finland).

Figure 6. Development of income inequality (Gini coefficient) in some European countries from the mid-1960s to the late 2010s.



Sources: authors' own calculations from the Luxembourg Income Study data and Statistics Finland.

Two separate stories are depicted in the figure. The first is exemplified by the Finnish case The development of the welfare state (as described in Figures 1-4 and Table 2) significantly reduced income disparities until the late 1980s. After the economic crisis in the early 1990s, the high-tech "Nokia boom" rapidly widened income disparities. During the 2000s, the Gini coefficient stabilised. Regarding income distribution, the Finnish case demonstrates that social policy matters, depending on the characteristics of the welfare state. Income inequalities and poverty rates declined sharply from the mid-1960s to the early 1990s. The 1992 –2008 development, in turn, shows that the extremely rapid high-technology-driven economic growth disproportionally benefitted the wealthier strata of society. In addition, changes in taxation policies (taxation of capital income became lighter than that from employment) and cuts in social transfers have contributed to the increase in income disparities. (Tuomala 2019).

The second story is that of converging trends. As the curves show, the differences between the 13 countries have decreased. The correlation of variation tells the same story: in 1990, the CV was 14.2, whereas it decreased to 8.1 in 2018. As Appendix Figure 1 indicates, there are substantial differences in the redistribution capacity of the welfare state. For example, whereas the at-risk-of-poverty before social transfers in the Nordic countries is about the same level as in most other countries, the post-transfer poverty is comparatively low (Milotay et al. 2022). The CV in poverty before transfers is 15.9, whereas it is significantly higher after transfers (24.5). These differences indicate that the characteristics of the welfare state makes a difference – as it has always done.

7. Conclusions: The digital mode of production and its social policy implications

Our short review depicts changes in the characteristics of social policies when moving from the agrarian mode of production to industrialism. Social insurance was thought to aid in managing risk inherent to industrial production and wage labour. It also improved the functioning of the labour market and was considered to help the mobility of the labour force, in addition to being seen as a solution to poverty and the precariousness of the working class.

As we have shown, the structural transformation of the economic system changed the content of social policies, but there were many differences between nations in their welfare programmes. Undoubtedly, the digital mode of production will have ramifications for welfare states that were constructed to meet versatile industrial social risks.

The digital era refers to the time and society where the technical and conceptual connection of work, production, and living with respect to the community, time, place, and individual is changing. If this structure becomes increasingly shaky and uncertain, it will impact national welfare states, the essence of which is linked to the nation-state, place of residence, employment relationship, social status, and clearly definable social risks.

The digitalisation of society in general, and that of the mode of production in particular, will fundamentally change old practices and ways of doing things. Oftentimes, digitalisation is depicted as a threat that will erode paid labour. There are many doomsday prophecies at the end of paid work (Standing 1999; 2011, and 2016; Schmidt & Cohen 2013; Frey & Osborne 2017). Perhaps, these prophecies at the end of the work are too premature. However, the digital economy will change the mode of employment. The new mode of production and the types of qualifications and demands on skills may lead to social and labour market exclusion.

The loss of jobs or their replacement by machine power is not a new phenomenon in itself, but the dimensions brought about by digitalisation accelerate the replacement of work with capital — at least if Thomas Piketty (2014) is to be believed. From now on, work that can be replaced is also a kind of intellectual work that has not been automated before. The work itself will not disappear, but the forms of doing so will change. According to Piketty, income generation in digital society will shift to a more capital-oriented one, and, as a result, wealth will get concentrated in fewer hands (see also Standing 2016). The key question is whether the changes brought about by the new digital production are so profound that they also require changes in social policy activities.

Poor auctions did not fit the social policy of the industrial age. In addition, the social policy of the industrial age may be partially outdated and does not recognise the new social risks of the new production system. The industrial categories of social risks that social policy systems recognise may disappear completely or become so vague in nature that the industrial social policy cannot recognise them. Furthermore, industrial social insurance was mainly targeted to employees. In many countries, self-employed could opt out and voluntarily insure themselves. What they sometimes neglected. Therefore, the coverage rates are not 100% among the target population (see Figures 1-4). In the case that self-employment and atypical employment will increase, the traditional social insurance model does not sufficiently support the needs of new societies. If the social policy systems are not adapted to the changes, this process erodes the welfare state's general

acceptability and legitimacy. At the same time, the financial base of the welfare state becomes more fragile.

The capitalisation of the production process presents its own challenges. The industrial welfare state is built on insurance premiums paid by employers and employees as well as contributions from public authorities through taxation. The relative share of these forms of financing has varied in different eras and not between countries. Everywhere, especially in the Nordic countries, the financing of the welfare state still depends very much on the creation of value created by human labour, that is, the share of labour in the gross domestic product, the relative share of which will decrease in relation to capital. Then the question is what will happen with social security contributions based on wages and salaries.

The industrial welfare state was ultimately a national construct, and the national state formed a risk pool. Furthermore, financing was based on a chain-letter principle, that is, on an imaginary contract between generations. The question is, what will happen when production is more global and mobile in capital and labour? Thus, the current development challenges the traditional services and benefits tied to the national state and local communities, such as the municipality or province, financed by taxes and mandatory payments, which together form a phenomenon that we have generally come to know as the welfare state.

It is specifically and especially about the welfare state and its future, not necessarily about a wider welfare society. Society encompasses the public, private, and third sectors, communities, families, and individuals. Thus, there may be shifts in responsibilities between different constitutive parts of society, and state-centrism may give way to more individual-based and civil society solutions; that is, there may be shifts towards horizontal redistribution between the individual's life phases. There are tendencies away from defined benefits towards the defined contribution system that is a savings. Whereas in the defined benefits system, the state guaranteed a certain benefit level and collected contributions needed for financing, in the defined contribution model, the benefit level depends on the capital accumulated and returns from stocks development. There is a danger that the system will turn into a casino-model where individuals themselves are responsible for their welfare and in the end bear all the risks by themselves. However, an individual is ultimately too small a risk pool. Therefore, collective and state-led solutions are required and there are alternative, more positive scenarios as well, and these scenarios depict the picture of a more inclusive society and a more inclusive labour market (see OECD 2019).

Insurance has "enticing consequences". This reduces the insecurity of financial agents and enables them to take more risks. Social insurance stabilises people's expectations, which, in its own right, increases trust in the future and aids financial growth (Goodin 1998; Albert 2004). The proponents of Universal Basic Income (UBI) depict UBI as a solution to uncertainties created by digitalisation. UBI provides basic economic security, enhances people's use of their capacities, and serves as a springboard for risk-taking and new initiatives.

As argued in the beginning, all societies need redistribution that in modern societies takes place through social policy institutions. In all societies, minimum income protection, either UBI or residence-based universal basic security (for example, in Finland), is a necessary condition for fulfilling the grand goals advocated by the protagonists of UBI. However, this is not a sufficient condition to achieve the goals of an inclusive society. In addition, we need the amplitude of other

measures, such as available and affordable childcare, as well as well-functioning health and long-term care, continuous education, and social and employment services to support people and societies in their paths towards inclusive digital societies. Participation income model tries to combine basic security and inclusion. Participation income is a universal welfare scheme (as UBI) but it is conditional on individuals' participation in various social and economic activities (Atkinson 1996; Hiilamo 2022). Since the participation income is targeted to those people who have many different problems and who are the most need of public services, participation income may be a better solution than universal basic income to unify income transfers and various services the people in danger of social exclusion need (Hiilamo 2002, 143).

As our historical survey shows, despite common trends and commonalities, there have been numerous different solutions for the same problems. For those who manage to collect wealth, individual solutions – whatever they are – are the most probable source of security. For those who stay in secure employment positions, social insurance is a viable solution, whereas those in the margins of the labour market need special attention and more tailored solutions. In sum, there are versatile options to tackle the arising problems. Future is not deterministic, and there will be different avenues for digital and inclusive societies.

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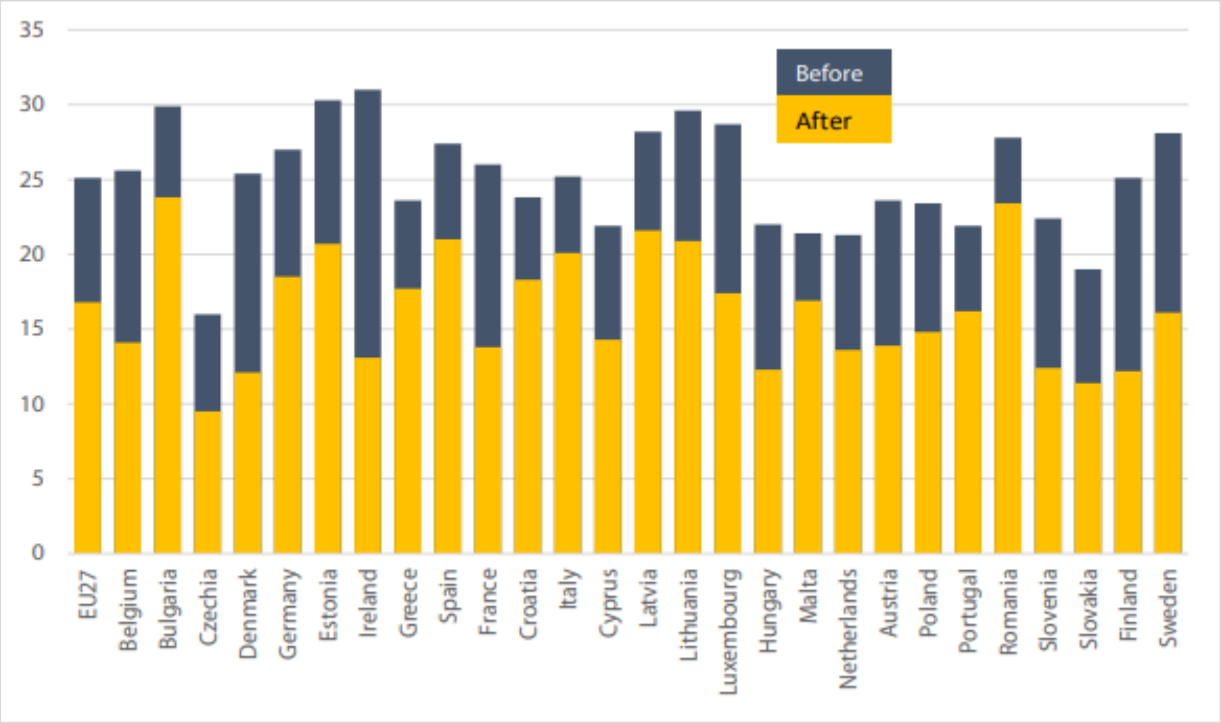
Appendix Figure 1. At risk of poverty rate before and after social transfers, 2020.



Source: Milotay et al. 2022