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Ralph Hippe and Roger Fouquet

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# The Human Capital Transition and the Role of Policy<sup>1</sup>

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## Abstract

A potentially important source of green growth in the future is the expansion of the weightless or dematerialised knowledge economy. Along with information and communication technology (ICT) and infrastructure, and the innovation system, human capital is a key pillar of this knowledge economy with its scope for increasing returns. With this in mind, the purpose of this paper is to investigate how industrialised economies managed to achieve the transition from low to high levels of human capital, and to identify lessons for green growth.

The first phase of the human capital transition was the result of the interaction of supply and demand, triggered by technological change and boosted by the demands for (immaterial) services. The second phase of the human capital transition (i.e. mass education) resulted from enforced legislation and major public investment. The state's aim to influence children's beliefs appears to have been a key driver in public investment. Nevertheless, the roles governments played differed according to the developmental status and inherent socioeconomic and political characteristics of their countries. These features of the human capital transition are directly relevant to future transitions associated with green growth, and highlight the importance of understanding governments' incentives and roles in transitions.

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Keywords: Human Capital, Education, Economic History, Economic Policy

JEL codes: N33, I25, I28, Q01

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## 1. Introduction

Green growth entails the redirection of the economy onto a more sustainable long run trajectory (World Bank 2011, Bowen and Fankhauser 2011). Given the environmental impact and degradation of natural capital stocks of current economies, conventional growth is unlikely to be sustainable in the long run. In particular, the intensification of climate change due to increased fossil fuel use over the next century – if allowed to happen – is likely to impose escalating and irreversible impacts and costs on the economy and society (Wagner and Weitzman 2015). Therefore, in the long run, green growth can be seen as an attempt to avoid a potential environmentally-triggered economic and social collapse (Diamond 2005).

One of the key structural transformations sought in the pursuit of green growth is a reduction in carbon dioxide emissions. The most obvious way to achieve this is through a transition away from high carbon-emitting energy sources towards low carbon energy sources (Grubb et al. 2008, Foxon et al. 2008, Stern and Rydge 2012). Another proposed solution is to maintain our dependence on fossil fuels, yet reduce emissions through carbon capture and storage (IEA 2008). An alternative (yet, potentially complementary) way would be through a radical reduction in the use of material and energy resources by increasing the share of the ‘weightless’ economy (Quah 2001, Hepburn and Bowen 2013).

Quah (2001, 2002) argues that an increasing share of modern economies will reside in dematerialised or weightless knowledge products as a result of the ICT revolution. All goods and services that can be expressed in digital form (i.e., encoded in bits), such as telecommunications, financial services, news and media entertainment, computer software and algorithms, electronic databases and libraries, and all other goods and services that can be delivered via the internet, are dematerialised products, which have the same properties as knowledge. That is, they are non-rival (i.e. use by one person does not hinder another person’s consumption), infinitely expandable and not geographically constrained. Once created, they are reproducible at (virtually) zero marginal cost. Furthermore, growth triggered by such dematerialised products is likely to impose substantially less pressure on natural capital assets (including resource stocks, such as energy, and ecosystem services, such as the atmosphere). Thus, because of their special characteristics, ideas need not be subject to diminishing returns, and GDP growth may be sustainable with the use of non-renewable resources tending to zero and the use of ecosystem services tending to a sustainable level.

With this alternative perspective for green growth in mind, it would be valuable to develop a deeper understanding of the foundations of the weightless or knowledge economy (Powell and Snellman 2004). The ‘knowledge economy’ rests on four key pillars, according to the World Bank (2008): first, a broad institutional and legal structure of property, business and trade; second, human capital formation (e.g., education and skills); third, information and communication technology (ICT) and related infrastructure; and, fourth, an innovation system (including an advanced process of research and development for producing knowledge, and a specific institutional and legal structure for intellectual property rights). Mokyr (2002) and Jacob (2014) argue that this ‘knowledge economy’ has been gradually developing over several hundred years. Thus, in an attempt to outline the long run development of this weightless and dematerialised knowledge economy, this paper on human capital formation is intended as the first of three papers on the economic history of the pillars of the knowledge economy (with the other two focussing on the development of the ICT sector and the innovation system). Thus, *the purpose of this paper is to investigate how industrialised economies managed to make the transition from low to high levels of human capital, and to identify lessons for green growth.*

Over the last two hundred years, along with the transition in energy sources (see, for instance, Fouquet 2008, Kander et al 2013), the transition in human capital is arguably the most important economic and social transformation to have occurred. After all, human capital accounts for two-thirds of overall wealth (i.e., including natural capital) in most industrialised economies (Hamilton and Liu 2014) – and, based on rough estimates, has over the last two hundred years (McLaughlin et al 2014). Reflecting its importance, the Council of the European Union states that “[e]ducation and training have a crucial role to play in meeting the many socio-economic, demographic, environmental and technological challenges facing Europe and its citizens today and in the years ahead” (Council of the European Union 2009, C 119/2). Given the fundamental role human capital plays in economic growth and development, and especially for the weightless ‘knowledge economy’, research related to green growth needs to include human capital in its analysis.

The paper aims particularly to better understand the following questions: what factors have driven the human capital transition since before the Industrial Revolution? Was there a market failure in the area of human capital such that governments had to step in to foster increased investment? What role did the state play in the provision of mass schooling? What drove the public’s willingness to sacrifice scarce resources for this public good? What role did other stakeholders play?

The human capital transition, over the last five hundred years, triggered by the development and diffusion of the Gutenberg Press, and, particularly, in the last two hundred years, with expansion of public schooling, offers numerous lessons for green growth. First, it tells us (part of the story of) how we got here – how one of the pillars of the ‘knowledge economy’ developed. Second, it offers an example of a major transition of a key factor of production (hence, crucial for understanding economic development and growth). Third, it provides a lesson about a major transition where market failures were prevalent and government stepped-in and provided education. Fourth, given the important focus on environmental issues in green growth, a brief history of education policy helps to place environmental policy within the broader context of the history of public good provision. In all cases, understanding past transitions will offer insights into how to promote future transformations.

This paper finds that the history of the human capital transition highlights how the state can have a major role to play in future transitions related to investment in education (but also in ICT infrastructure and even in new energy systems). Even though demand for a knowledge economy in all its dimensions might be increasing in the most industrialised countries, an effective transition is likely to require further state action. Where demand is especially lacking, such as in less developed countries, the state’s role in achieving a transition to a green and knowledge economy will be particularly acute. A crucial factor in determining whether the transition moves beyond a first phase may well be the extent to which government directly benefits from the transition.

The paper is organised as follows. First, it highlights economic development in the long run and the contribution of human capital. Second, it reviews some of the basic principles of human capital theory. Then, it considers the characteristics and the evolution of the apprenticeship system and the production of books. Subsequently, it emphasises the role of different origins of demand for education. Government policy and its effectiveness are more closely analysed in the following part. The last part considers different indicators that show the evolution of human capital during the last 200 years and the actions taken by governments in education. Finally, a conclusion sums up the lessons from the human capital transition.

## **2. Long-Run Economic Development and Human Capital**

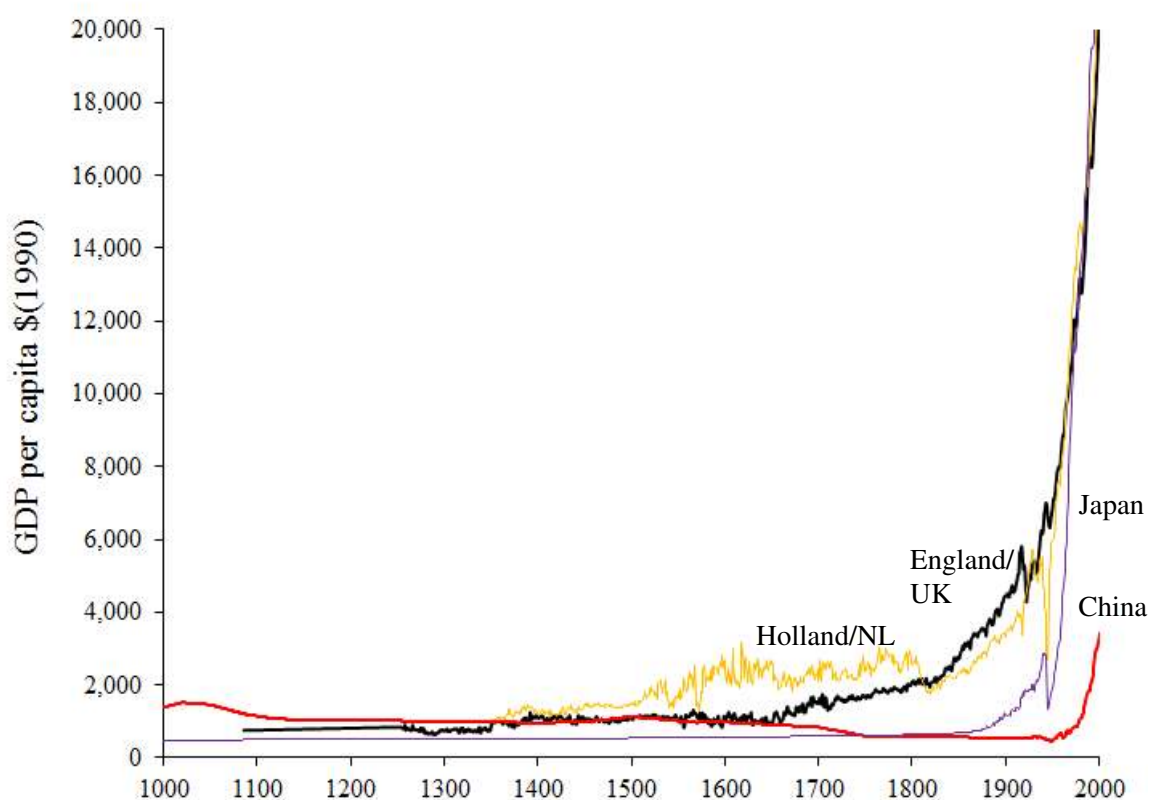
The idea that human capital may be considered as a determinant of economic development has a long history (Demeulemeester and Diebolt 2011). Smith and Marshall had already incorporated the notion of something akin to human capital in their thinking. However, the first exogenous growth models developed by Solow and Swan (Solow 1956, Swan 1956) only incorporated capital, labour and technological progress in the aggregate production function. Subsequently, the importance of human capital was put forward in particular by Becker, an important founder of human capital theory (e.g., Becker 1981). Furthermore, Nelson and Phelps (1966) emphasised that human capital is important for implementing and adopting new technologies. Schultz (1975) argued that workers are better able to cope with changes in the economic structure and handle new technologies if they have more human capital. An extension of the original Solow-Swan model, the human-capital augmented Solow model, was presented by Mankiw et al (1992). It explicitly included human capital as a factor in the production function.

Nevertheless, the prominence of human capital's role emerged following the development of endogenous growth models. Romer's (1986) work can be seen as the first important contribution in this field. These 'new growth models' aim to endogenise the different sources that lead to growth. In this way, the growth rate is not exogenously determined (as in the Solow-Swan models) but is established within the endogenous growth model itself. The overall category of endogenous growth models can be divided into two main approaches (Aghion and Howitt 1998). The first line of thought focuses on human capital accumulation as the main driver of growth (Lucas 1988). The second approach underlines the importance of technological change for the creation of economic growth (Romer 1990). Since the original contributions by Lucas (1988) and Romer (1990), the literature has steadily been advancing (see Ang and Madsen 2010). In fact, these initial models (and models by, e.g., Segerstrom et al 1990, Grossman and Helpman 1991, Aghion and Howitt 1992) are now considered as the first generation of endogenous growth theory models. A second generation of models takes semi-endogenous (e.g., Jones 2002) or Schumpeterian approaches (e.g., Aghion and Howitt 1998, Peretto 1998, Young 1998). The appropriateness of these new types of models is still being debated and empirically tested (e.g., Madsen 2010, Madsen et al 2010; Ang and Madsen 2010).

While endogenous growth models have been central to human capital's prominence in economic growth theory, they are limited - in the sense that they are not able to explain the process of economic growth since the beginning of human existence



(Galor 2005). A new ambitious theory has been developed aiming at understanding the growth patterns of human kind in the very long run. This Unified Growth Theory (UGT) has particularly been advanced by Galor (e.g., Galor and Weil 2000, Galor and Moav 2002). UGT classifies economic growth in the very long run in the following way. First, a long phase of hunting and gathering was typical for human development between 1 million BC and 8000 BC. After the Neolithic Revolution, the Malthusian growth regime began. It was characterised by a per capita income which always fluctuated around low levels of subsistence. Accordingly, Figure 1 shows that GDP per capita in several European countries and China were rather low and fluctuating between 1300 and the take-off during the Industrial Revolution. Thus, the Industrial Revolution allowed the European countries to escape the Malthusian growth regime. This Post-Malthusian growth regime lasted until the demographic transition in Europe around 1870. Economies and populations grew substantively during this epoch.



Source: Fouquet (2015), Bolt and van Zanden (2014).

**Figure 1. GDP per capita in Selected European and Asian countries, 1000-2000**

The final growth pattern is the modern growth regime which has characterised the world's advanced countries from the nineteenth century onwards. This regime shows an

acceleration of technological progress. Moreover, human capital is increasingly demanded. Thus, UGT postulates that human capital played a crucial role in the transition from the Post-Malthusian regime to modern growth. Human capital and technological progress brought about the demographic transition which has led to lower population growth. The overall result has been high and sustainable growth in per capita output in the most advanced countries. However, not all countries have reached the modern growth regime and some countries reached it earlier than others. Therefore, a Great Divergence has emerged between the most advanced countries and other countries.

These different theories show that human capital is an important driver for economic growth. Still, there has been some controversy about this issue over the last decades. In fact, Demeulemeester and Diebolt (2011) show that there have been several alternating waves of optimism and scepticism since the Second World War. The early contributions led to the consensus in the 1950s and 1960s that education makes an important contribution to economic growth. In contrast, the 1970s were characterised by scepticism in a time of economic downturn. The new important theoretical contributions of the 1990s reinvigorated once again the case for human capital. These optimistic ideas were supported by different empirical studies (e.g., Barro 1991, Mankiw et al 1992, Barro and Lee 1993) but also more critical voices appeared such as Benhabib and Spiegel (1994) and Pritchett (2001). However, measurement errors may account for some of these more pessimistic results (Krueger and Lindahl 2001). Thus, Sianesi and van Reenen conclude in their literature survey in 2003 that “as a whole we feel confident that there are important effects of education on growth” (Sianesi and van Reenen 2003, p. 197). Finally, more recent studies by, e.g., De La Fuente and Doménech (2006), Cohen and Soto (2007), Hanushek and Woessmann (2008), Ciccone and Papaioannou (2009) and Gennaioli et al (2013) have further emphasised the crucial impact of human capital on growth and development.

### **3. Principles of Human Capital Theory**

In the economics of education, the acquisition of human capital (through education or training) is assumed to give utility to an individual (see Brewer et al 2010). It is an investment decision which enables an individual to obtain higher monetary returns in the future. The investment in human capital increases the knowledge and skills of an individual and thus his productivity (e.g., Schultz 1961, Becker 1964, Schultz 1971, Lucas

1988). This investment comes at an expense due to direct costs (e.g., schooling fees), foregone earnings, psychic costs related to the studies and other related expenses. Still, the private returns of human capital acquisition can be numerous, e.g., higher earnings (Mincer 1958), a better job and a lower probability of being unemployed. Further positive effects include a higher social status and social prestige, better health, higher social capital, higher cultural capital and other benefits that are valued by an individual. The combined positive effects of human capital give incentives for individuals to invest in human capital to maximise their well-being during their life. Therefore, human capital theory suggests that a higher level of education is correlated with a higher level of earnings. This positive relationship has been found in many empirical studies, although the return to education can be influenced by many external factors. For example, one year of increased schooling gives a global average return of 10 % (Psacharopoulos and Patrinos 2004).

Overall, an individual is part of a larger market which is characterised by demand for educational goods and its supply, leading to an equilibrium process whose outcomes can be observed. Thus, the consumption and investment characteristics of education make it similar to other durable goods. Thus, education cannot be described by the use of static models. In consequence, a longer term view is inherent to the human capital concept. Therefore, the decision to invest in human capital has to be made in accordance to the expected discounted future returns and costs involved.

In addition, human capital may not only have important private returns but also significant social returns (see Lange and Topel 2006). These human capital externalities can be defined as “the sum of the private and external marginal benefits of a unit of human capital” (Lange and Topel 2006, p. 461). Human capital externalities have been analysed from different perspectives. In particular, growth theorists such as Uzawa (1965) and Lucas (1988) have put forward the positive effects of interactions among individuals, leading to higher social than private returns of human capital. Individuals that have a higher endowment of human capital may increase the productivity of others, so that human capital accumulation leads to an increase in total factor productivity. On the other hand, it is also possible that positive externalities arise which are not directly associated with productivity, such as lower criminality (Lochner and Moretti 2004), higher political

participation (Friedman 1962), externalities connected to consumption and higher economic growth (Sturm 1993, Hanushek and Kimko 2000; see Brewer et al 2010).<sup>2</sup>

These social returns to human capital have been generally perceived by governments. Therefore, governments have spent an increased amount of public expenditures on education in the long run. One fundamental question that arises in this context is the allocation of these scarce resources to maximise human capital output. The state may not allocate these resources in an efficient manner because, in standard economic theory, markets provide an efficient method for allocating scarce resources. Still, it is possible that markets fail in their attributed task, so that a market failure occurs. Different reasons may lead to such a failure (Brewer et al 2010). Firstly, it is possible that markets are not perfectly competitive. Thus, the market may become dominated by one or more agents who are able to set the prices. In the area of education, schooling markets are far from perfect. Secondly, information asymmetries may arise in a market. In particular, the quality of products or services may not always be perceivable by consumers due to a lack of information. In education, parents may not have sufficient information and may not perceive the true value of education. In addition, they may choose schools that may be socially suboptimal (e.g., preference for schools with a certain social or racial profile and not for the quality of a school). Although the market may satisfy the preferences of parents, the obtained solution may not be optimal for society as a whole. Thirdly, the existence of externalities suggests that consumption and production may have effects that are not included in prices. For example, the knowledge and learning of others can have a positive effect on an individual. Furthermore, the individual's decision to invest in education may have positive benefits but also costs for society. However, an individual does not take all of them into account when taking his investment decision. Even if the social benefits are higher than the costs, it is still possible that an individual may choose not to invest and consume a socially optimal amount of education. In this case, governments can intervene by making a certain minimum amount of education obligatory through compulsory schooling. Finally, public goods may not be sufficiently provided by markets because they are nonrival and nonexcludable. To some extent, the notion of public goods applies to education. For example, the consumption of services in the area of education does often

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<sup>2</sup> In contrast, another strand of the literature suggests that there might also be negative externalities because human capital would not increase productivities but only waste valuable resources due to signaling effects (e.g. Spence 1973). However, Lange and Topel (2006) do not find important negative impacts, the positive effects largely dominate.

not preclude others. A pupil obtains education together with other pupils by a teacher. Libraries give access to books to many individuals. Thus, education may not be sufficiently supplied in a perfectly competitive market, as is the case with other public goods.<sup>3</sup> For this reason, this has led to the “widespread belief that the market for educational services fails when left to its own devices” (Johnes 1993, p. 14).

Therefore, governments have intervened to avoid the consequences of market failures in this area. They have regulated the education sector, taken an important share of the financial burden and operated education facilities. This involvement of the state may have led to suboptimal educational outcomes in some areas.<sup>4</sup> However, the aim of the state may not always have been to maximise human capital levels. Schooling is never neutral but is a process of socialisation that produces beliefs alongside human capital. Therefore, authors of the so-called class-conflict model suggest that there is a struggle between different classes of society in the area of education. The dominating elites of a country are assumed to use formal schooling to impose their social, cultural and economic values and structures on other parts of society (Bowles and Gintis 1976, Carnoy and Levin 1985, Fuller and Rubinson 1992). Taking a more positive interpretation, one could also argue that “public schooling can promote social cohesion among disparate social groups and alleviate ethnic tensions by providing a core set of common norms that foster trust and promote interaction among individuals” (Gradstein et al 2005, p. 5).

More generally, governments would not need to produce schooling but could sponsor the private sector to provide schooling. The simple production of skills could be contracted out and private schools could be subsidised by the use of vouchers or mandates. Yet a government would not be able to control (cultural and ideological) beliefs and private institutions (e.g., particular religious and social groups) could produce beliefs at school that could challenge the government and the political system.<sup>5</sup> Furthermore,

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<sup>3</sup> In addition, the assumption of perfect competitive markets implies that capital markets should be perfectly functioning. In this case, parents should always be able to find a way of financing the education of their children. This, however, is not the case either (Johnes 1993).

<sup>4</sup> For example, the existence of public schools may have led to a monopoly of these schools in certain geographical areas. Taking the point of view of the market, schools may thus not have been under market pressure to ensure quality standards and low operating costs. Some recent reforms have been aimed at improving the status quo and in part reorganising the involvement of the state in this sector (Brewer et al 2010).

<sup>5</sup> For example, Milton Friedman also suggests that “a stable and democratic society is impossible without a minimum degree of literacy and knowledge on the part of most citizens and without widespread acceptance of some common set of values. Education can contribute to both” (Friedman 1962, p. 86, in Gradstein et al 2005, p. 5). He further argues that “the major problem in the United States in the nineteenth and early twentieth century was not to promote diversity but to create the core of common values essential to a stable society... Immigrants were flooding the United States... speaking different languages and observing diverse

egalitarian principles have given the state the moral responsibility to provide schooling to ensure that all children obtain a certain minimum level of education so that every child could have equal opportunities in later life. However, the external monitoring of schools is costly and difficult to implement effectively for the state. Therefore, it is argued that given the socialising and equalising aspects inherent to education a government needs to produce schooling in a direct way at arm's length (Pritchett 2003, Gradstein et al 2005).

In addition, it should be mentioned that there are different types of schools and forms of training. More generally, according to Johnes (1993) one can distinguish between general and specific human capital. General human capital can be defined as skills and knowledge that can be used in any work context and increase the productivity of an individual. General human capital can take the form of skills such as numeracy and literacy. On the other hand, specific human capital can only be used in a specific work context to increase an individuals' productivity. For example, some of the specific skills of craftsmen could not be used in other professions. Similarly, if an individual works for a monopsonist, it cannot transfer its skills obtained through training to another employer either.

More generally, investments in human capital can occur (in the terminology of Becker 1993) in the form of on-the-job training in firms (distinguishing general and specific training analogously to the presentation above), schooling, information and health.<sup>6</sup> Schools are considered to be specialised institutes that produce training, whereas firms additionally produce goods. Therefore, Becker argues that firms and schools are in many instances “substitute sources of particular skills. This substitution is evidenced by the shift over time, for instance, in law from apprenticeships in law firms to law schools and in engineering from on-the-job experience to engineering schools. [...] [T]here are complementary elements between learning and work and learning and time” (Becker 1993, p. 51). The level of complementarity depends partly on the quantity of formalised knowledge that is available. In some cases, schools can thus be treated as a special form of firms. Therefore, the effects of schooling (as mentioned above) are identical to those of general training.

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customs ... The public school had an important function in this task, not least by imposing English as a common language” (Friedman 1962, p. 96, in Gradstein et al 2005, p. 9).

<sup>6</sup> According to Sweetland (1996), the area of education can be further broken down: “[t]here is formalized education at primary, secondary, and higher levels (Cohn & Geske, 1990), informal education at home and at work (Schultz, 1981), on-the-job training and apprenticeships (Mincer, 1974), and specialized vocational education at secondary and higher levels (Corazzini, 1967)” (Sweetland 1996, p. 341).

In addition, there are still other possibilities than on-the-job training and schooling to accumulate human capital and increase one's productivity. These are particularly related to the investment in information. For example, more information about wages and employment possibilities may positively affect the future earnings of an employee. Thus, increased information and knowledge about the economic, social and political system might increase productivity and incomes.

Finally, investments in health may also allow to improve productivity. Physical and emotional health have significant effects on earnings. While throughout most of history (and still today in some countries) physical strength has been an important factor for expected earnings (at least for an important share of the population), knowledge and skills have replaced physical strength in more developed countries. Similarly, emotional health has important effects on productivity and output (see e.g., Layard 2005).

## **4. Traditional Education and Skills Transmission**

### **4.1. Apprenticeships**

The transmission of technical skills from generation to generation has been central to maintaining productivity levels over centuries, and the transmission of new skills (often in conjunction with new technologies) spatially has been key to raising productivity levels from one decade to the next. Apprenticeships had been the most important source of training and technical knowledge acquisition for many centuries (Epstein 2004). In England, for instance, “domestic, agricultural or industrial apprentices and live-in servants made up 15-20% of the adult male population in early modern England” (Humphries 2006, p. 79, referring to Stone 1666). “In the late sixteenth and seventeenth centuries roughly two-thirds of the English male labor force had at one time or another been apprenticed in one of the greater cities, primarily London” (Rappaport 1989 p.77). Even in the eighteenth century, apprentices in the non-agricultural sectors accounted for between 7.5% and 10% of the total labour force (Humphries 2006, Wallis 2008).

The apprenticeship was a contract (of between three and seven years depending on the craft and the country (Epstein 1998, Wallis 2008)) between a master and his ‘student’. Without a contract guaranteeing some return on the investment, few tradesmen would have been willing to share their skills with young men who were likely to leave once the training was complete and work for higher pay.

In addition, from the seventeenth century, masters required apprentices to pay an upfront premium. In eighteenth century England, premiums were typically between five and ten pounds (roughly £(2000)500 and £(2000)1,000) in the trades and about 50 pounds (£(2000)5,000) in the professional sector (Minns and Wallis 2013). In addition to the nature of the craft and prestige of the guild, premiums also varied according to family connections, experience, expected future income and other factors that gave signals about the probability of attrition and the level of productivity of the apprentice.

The premium amounted to close to one year of a craftsman's salary, and the apprentice generally depended on financial help from parents and the wider family. For instance, it would take a youth two years of work in the agricultural sector to earn five pounds. Although a premium had to be paid in many instances, the apprentice received accommodation, boarding and subsistence wages (around five pounds per year in the eighteenth century), and a training. This training also offered important informal connections to colleagues and potential clients, who might help recover the very expensive set-up costs of one's own shop, which was often 10 to 20 times the initial cost of a premium (Campbell 1747, in Minns and Wallis 2013).

#### **4.2. The Role of Guilds**

Apprenticeships had their roots in the craft guilds which began to exist from the eleventh century (Lauterbach 1994, Epstein 2004) – although the degree of control over apprenticeships by guilds varied, and was greater in many German regions than in England, whereas apprenticeships were mostly left to the private decisions of masters and apprentices in some parts of Spain and France (Wallis 2008). The guilds were associations of craftsmen with tight regulations, creating conditions similar to cartels. They had many functions, in particular they “supervised job performance, work conditions, and quality of instruction; enforced contracts through compulsory membership, statutory penalties, and blackballing; and protected apprentices against poor training in craft-specific skills within oligopsonistic labor markets” (Epstein 2004, p. 382). Most guilds sought to limit the poaching of trained apprentices amongst workshops, protect the apprentices from excessive abuse and, therefore, promote proper training (Epstein 1998, p. 691-2). By the sixteenth century, a national system of technical training was being introduced in England (Humphries 2006, p. 75). Thus, along with their other roles, guilds were influential in the production of knowledge in the form of human capital.



Guilds provided an information pool and network for a particular supply of skills across regions. Although these networks were limited and far from efficient, the distribution of information helped signal changes in the demand for the skills and, therefore, provide a supply, if necessary (Epstein 1998, p. 694). Searchers wandered the country assessing practices and demands. Journeymen, either as part of a guild or as independents, travelled the country to provide their skills. In other words, the guilds acted as a means of disseminating knowledge (in the form of human capital) throughout the economy.

In fact, many of the European rulers tried to attract these skilled workers to their cities since the Middle Ages and particularly, during the times of the Renaissance and following the Reformation, especially if they were coming from the enemy. This development found a peak when mercantilist states and guilds tried to inhibit the emigration of skilled workers from the 1650s onwards. However, these attempts were mostly unsuccessful due to the lack of administrative capacities and the incentives provided by other states (Harris 1998). Thus, Epstein believes that “technological leadership moved over time from southern to northwestern Europe [...] largely thanks to skilled migrants” (Epstein 2004, p. 385).

Apart from the opposition of governments and guilds, other factors contributed to the limitations of technical knowledge transfer: trade secrecy, information costs, transport costs and the non-existence of a sufficiently high skills base, which made it difficult to locally integrate the knowledge and inventions of migrants. However, where this knowledge base was sufficiently high, the accumulated knowledge of a country transferred by skilled migrants could be combined with the local knowledge, often giving a technological lead to this country. Information costs and transport costs were lowered due to urbanisation and state competition over time, making it easier for technologies to diffuse (Epstein 2004).

Guilds have frequently been associated with stifling innovation. At times, they were probably a powerful force in encouraging knowledge to be embodied in human rather than physical capital. Yet, they were also responsible for the invention and diffusion of others. Evidence suggests that, in the face of growing competition and expanding markets, the guilds’ barrier to technological innovation declined after the later Middle Ages (Epstein 1998 p. 694). Furthermore, craft guilds did “increase the supply of technology in three ways: by establishing a favourable environment for technical change; by promoting technical specialization through training and technical recombination through artisan

mobility; and by providing inventors with monopoly rents” (Epstein 1998, p. 701).<sup>7</sup> Thus, Epstein (1998, p. 704) concludes, somewhat controversially (as more evidence is probably needed to conclude fully), the two opposing forces of a monopolistic support system for invention and of the demand for ever-wider competitive markets in skilled labour provided a healthy source of technological innovation and diffusion.

Yet, the government increasingly saw the need to intervene in the transmission of these skills. A new structure was set up which defined the legal framework and regulated the apprenticeship training system. For instance, the guilds were formally abolished by decree in Prussia in 1869 – more generally, the state saw the guilds as a competing institution for power (Smits and Stromback 2001, Epstein 2004). Although the guilds may have formally been abolished, Smits and Stromback (2001) argue that they were only “transformed into the Chambers of Crafts and retained substantial control over the apprenticeship system” in Germany (Smits and Stromback 2001, p. 17). Therefore, the organisation and ways of training were not determined by the state but were left to the self-administering chambers. In Germany, it may have been a “managed transformation of the highly restrictive guild system to a regulatory regime that allowed industrialisation to proceed” (Smits and Stromback 2001, p. 17).

### **4.3. The Decline of Apprenticeships**

While the apprenticeship system and occupational skills played an important role before and during the Industrial Revolution (Mokyr 2009, Minns and Wallis 2013), the social changes it caused brought about a crisis in apprenticeship training during late eighteenth and the nineteenth century (Lauterbach 1998), arguing that, at least in Germany, the quality of apprenticeship training was being neglected. Meanwhile, the duration of apprenticeships in England fell to four years in the late eighteenth century (Wallis 2008).<sup>8</sup>

Structural shifts altered the demand for human capital during the Industrial Revolution (Weedon 2003, p. 62). Zeira (2009 p.63) argues that “industrialization changed the

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<sup>7</sup> An interesting question is whether there were also incentives for inventing technologies to sidestep the guilds? Epstein mentions that inventors had an incentive to keep their inventions secret from the guild. Yet, “although technical secrets were often kept within the craftsman's family, it is unlikely that significant breakthroughs could withstand a guild's scrutiny for long. On the other hand, an inventor had to weigh the guild's offer of a temporary quasi-monopoly rent against the possibility of obtaining a one-off royalty (net of migration costs) from a rival craft or government.” (1998 p.704).

<sup>8</sup> A comment from the early 1960s, after the decline in this form of training, summarises what happened: “apprenticeship has all but disappeared, partly because it is now inefficient and partly because schools now perform many of its functions. Its disappearance has been hastened no doubt by the difficulty of enforcing apprenticeship agreements. Legally they have come to smack of indentured service” (Schultz 1961, p. 10).

type of human capital required for production. While prior to the industrial revolution human capital was mainly specific to the profession, the industrial revolution created demand for more general human capital, which included the ability to read, to write, and to perform calculations. Hence, while the apprenticeship system could provide most of the required human capital prior to the industrial revolution, following it there was increasing demand for people who have a much broader and flexible human capital, which can be acquired only at schools”. Similarly, Collins and Halverson (2010, p. 23) add that “[a]fter the Industrial Revolution, schools stressed the learning of basic skills that children would need to function as intelligent citizens and workers and on the knowledge in the different disciplines”. Thus, the apprenticeship partly lost its role because there was a changing demand for human capital.

Its decline was also partly due to changes in the supply of other forms of education. In principle, dissemination of this specialised technical knowledge could take different forms: through printed media, patents or migrants. Epstein (2004) argues that, especially early-on, texts were not a very successful method for the dissemination of specialised technical knowledge because the manuals were often not complete or did not include some of the essential information to actually put a new technique into practice. Yet, the costs of written education changed over time. In comparison with schooling, an apprenticeship was the much more expensive alternative. Minns and Wallis (2013) estimate that schooling costs were about 1 pound per year in the eighteenth century.<sup>9</sup> Eventually, in the eighteenth century, books on craft skills became the third most important category of books (the first being religion and the second being law), highlighting the increased importance of reading skills for tradesmen and craftsmen (Cook 2006).

## **5. Catalysing the Human Capital Transition**

### **5.1. The Gutenberg Revolution**

Critical to the transformation of education in Europe was its ability to reduce the price of books and the written word. Before the invention of the printing press, book production involved the production of handwritten manuscripts. In addition to other costs, this was a

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<sup>9</sup> They estimate this number in the following way: “Assuming that youths would earn a rising fraction of adult income with age (20% at age 14, 40% at age 15, 60% at age 16, 70% at age 17, 80% at age 18, 90% at age 19, and [100]% at age 20 — see Van Zanden, (2009b), p. 160), a provincial adult unskilled wage of 1s per day, that youths work 228 days per year (Voth 2001), and a discount rate of 7.5%, the present value of lost earnings during an apprenticeship, relative to a subsistence income of £5 per annum, was about 26 pounds” (Minns and Wallis 2013, p. 344).

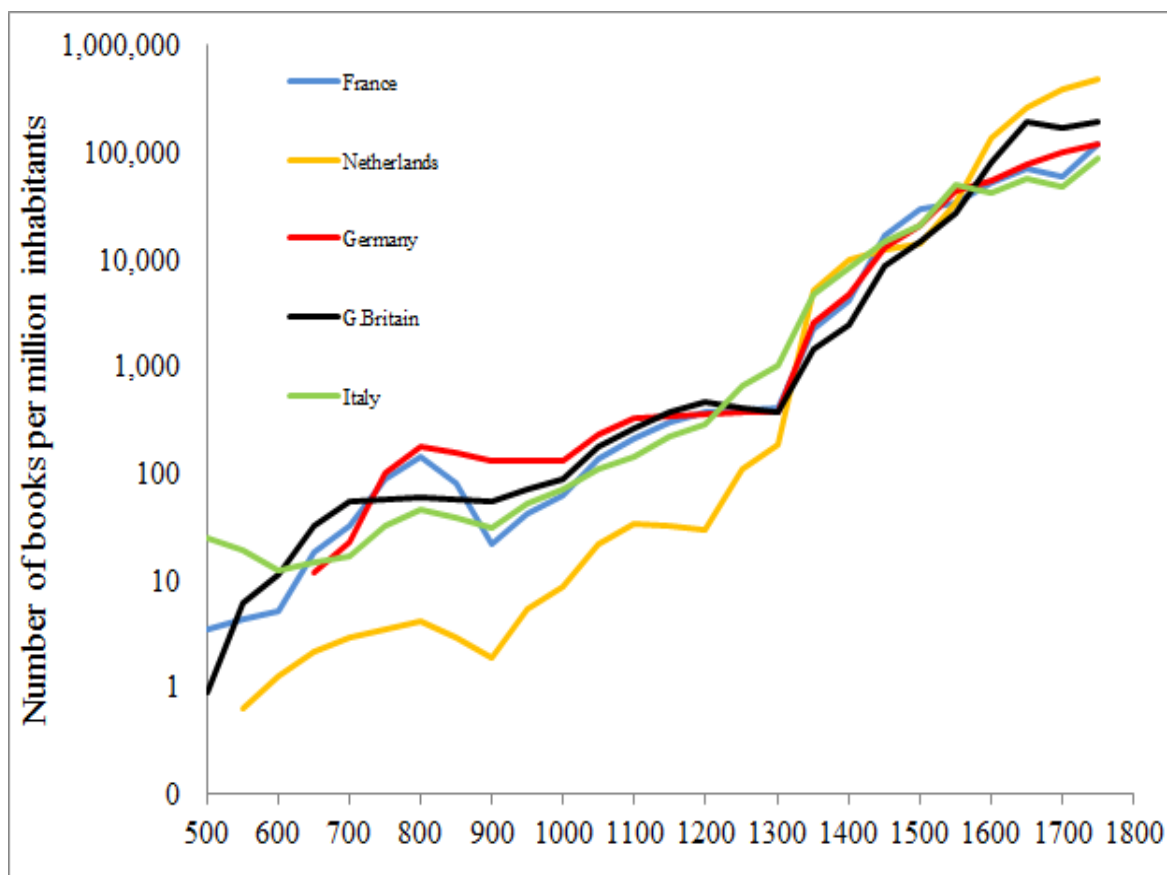
very time-consuming exercise, as Clark (2007) illustrates (see also Clark and Levin 2001): Copyists were able to copy 3,000 words (of plain-text) per day, implying that one copy of the Bible took 126 man-days (Clark 2007, p. 252). Because the copying of a text by hand needed more space than printing it, the area needed per word was also two times higher, increasing further the costs of the employed materials (Clark 2007). For this reason, books cost more than one year's salary for an average man and were, therefore, luxury goods (van Zanden 2009a).

Nevertheless, the supply and the demand of manuscripts were promoted by the growth of monastic institutions from the sixth century (see Figure 2). Additional demand came from the growth of cities throughout Europe between the twelfth and fifteenth centuries. Cities were characterised by an ever more elaborate division of labour, and they generated economic and military demands for individuals who were able to keep records, trained in administration and able to communicate properly. Bureaucracy expanded continuously and the oral tradition was slowly replaced by the written word. For this reason, more young people began to learn to read. In addition, universities were established for purposes of advanced training and in turn created themselves further demand (Venezky 1996). In addition, the price of book materials was also lowered by economics of scale and learning effects associated with the increased use of paper (van Zanden 2009a). As a result of rising demands and declining costs, manuscript production increased until the eve of the invention of the printing press (see Figure 2). It is estimated that more than 10,000 copyists worked in manuscript production in Paris and Orléans alone shortly before Gutenberg's printing press (Chassant 1846).

The invention of the printing press by Johannes Gutenberg in Mainz between 1446 and 1450 was, then, partly stimulated by this ongoing and increasing demand for written documents. In fact, Gutenberg was not the only one who tried to improve the existing manuscript production system. Different methods had been explored, including xylography and tabular printing. However, Gutenberg's printing press proved to be superior in quality and lower in cost for the production of books (Guellec 2004). Therefore, the printing press was not invented by accident but after many years of diligent pursuit carried out by Gutenberg.

The fact that the printing press was invented in Mainz is itself not so much accidental as the city was part of the Rhine valley which was quite industrialised for its time and specialised particularly in metallurgy. In consequence, the broad timing of the printing press was the outcome of the several mentioned demand factors. These factors

were again conditioned by the availability of paper in Europe in general and in Germany in particular. Furthermore, the growing market made the development of the printing press increasingly competitive relative to manuscript production (Guellec 2004).



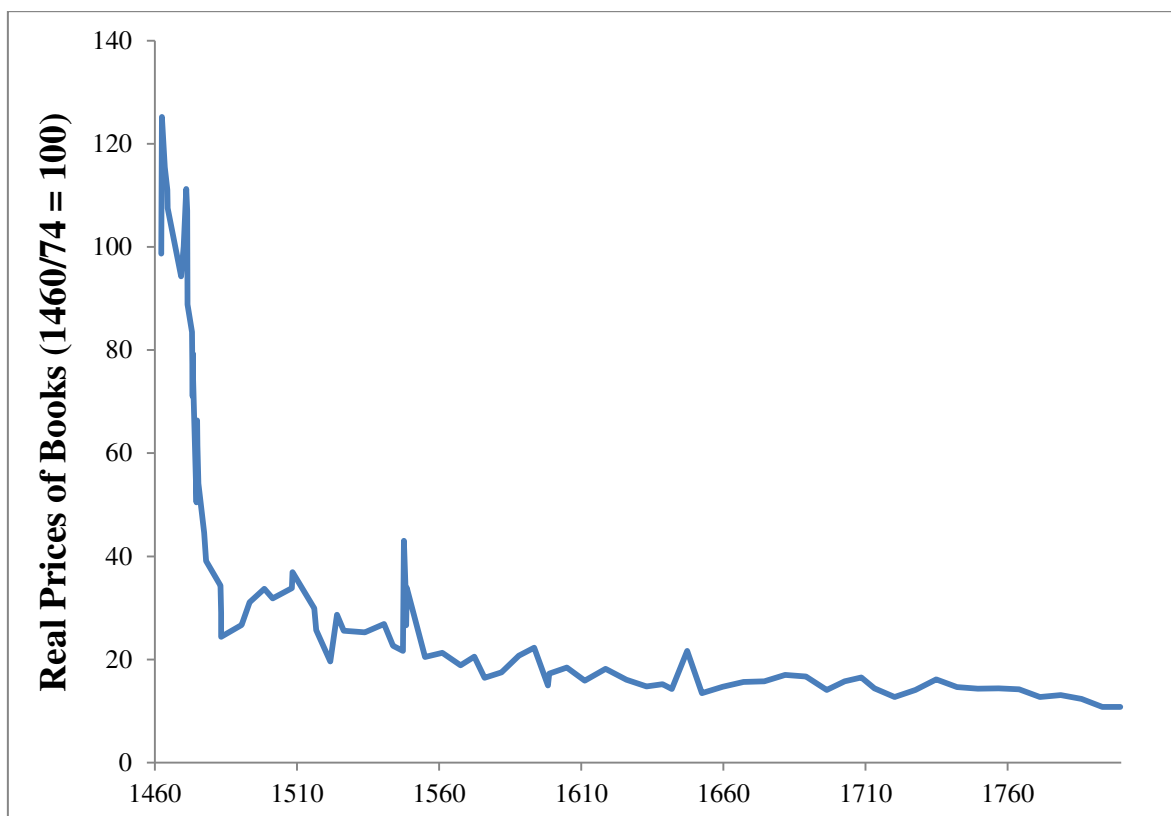
Source: Derived from Buringh and van Zanden (2009).

**Figure 2. Book production in Western Europe (per million inhabitants), 500-1750**

The printing press fundamentally changed the world of book production and knowledge diffusion. It enabled a much faster and less costly production of books. Cuijpers (1998) indicates that printed books were about 50-80% cheaper than their handwritten homologues in the 1460s. Furthermore, the printing press was a technology which was skill and capital intensive. Therefore, this high-tech innovation corresponded perfectly to the needs of the European economy which was characterised by high labour costs (in contrast to e.g. the Chinese economy) (van Zanden 2009a). Thus, the new technology spread quickly throughout Europe.

The spread of the printing press allowed a spectacular increase of book production, knowledge diffusion and human capital accumulation. In the earliest centuries presented here (500-700), overall book production in Europe was restricted to only 12,000

manuscripts written every century, whereas in the eighteenth century the number increased to more than 1,000,000,000 books (Buringh and van Zanden 2009). The decisive massive increase in book production clearly occurred during the period after the printing press was invented. The data show that more books (and manuscripts) were produced in Europe in the second half of the fifteenth century than in the entire 1000 years before the invention of the printing press. This radical change in the production of knowledge is also highlighted by the fundamental decrease in the price of books. The fall in book prices had the effect that a literate person was able to consume more books which in turn increased the incentive (and reduced the cost) to learn to read. Furthermore, the increased output of books itself created economies of scale, lowering book production costs even further and leading to higher price reductions. For example, van Zanden estimates the real price of books (i.e. deflating the book price by a cost of living index) for the Netherlands between 1460 and 1800 (see Figure 3).



Source: Van Zanden (2009a).

**Figure 3. Estimates of real prices of books in the Netherlands (1460/74 = 100), 1460-1800**

The dramatic fall in the real price of books is more than evident. Van Zanden (2009a, referring to Cuijpers 1998) illustrates this change by using the Gutenberg Bible as a point of reference. An original copy of the Gutenberg Bible was sold at a rate of about an annual wage gained by a labourer. A bible of comparable quality could be obtained for a price of less than 12 days of a carpenter's wage before the end of the eighteenth century (and lower quality bibles were also available at prices equivalent to a daily wage).<sup>10</sup> Thus, van Zanden concludes that “within the span of one generation – from 1455 to 1485 – book prices may have declined (in real terms) by 85 to 90%, a revolution in the price of communication comparable to current developments in ICT technology” (van Zanden 2009a, p. 182).<sup>11</sup>

## **5.2. Early Private Demand for Books and Literacy**

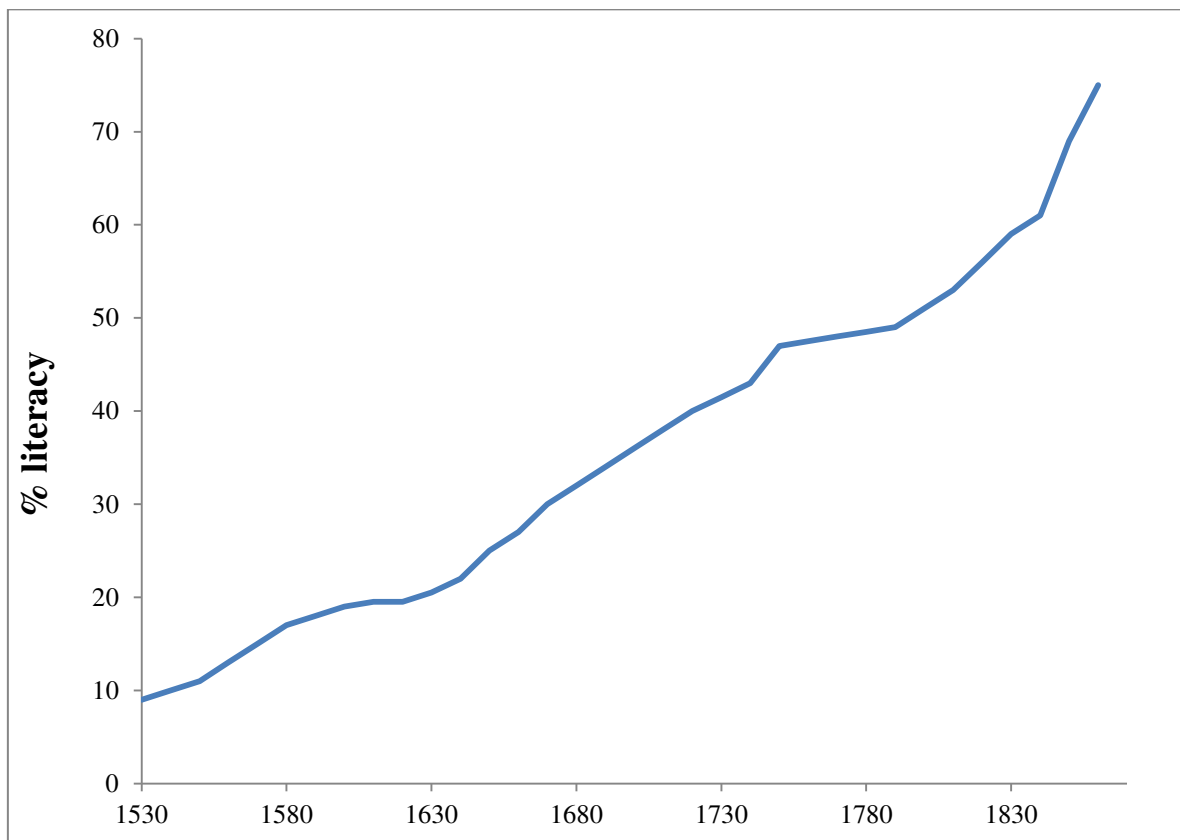
Clearly, the dramatic decline in book prices following the diffusion of the Gutenberg Press was crucial to increasing the spread of written word. At the beginning of the sixteenth century, literacy rates in most European countries were below 10%, possibly below 1% in German states (Engelsing 1973, Becker and Woessmann 2008). Then, over the next three centuries, particularly in North-Western Europe, such as the German states, Holland, Sweden and England, greater access to books enabled literacy rates to increase (see Figure 4 for England). However, literacy rates would not have reached 50% in the second-half of the eighteenth century without a strong demand to read (Mitch 1992b).

In fact, demand for literacy, numeracy and a general education stemmed from many different private and social or public sources (e.g., Cipolla 1969, Fuller and Rubinson 1992, Mitch 1992a, Galor 2011). Commercial demand (i.e., coming from the trade sector), spiritual demand (from the Churches), military demand (to create a more efficient army), industrial demand (e.g., to increase labour productivity), parental demand (e.g., to improve the prospects of the future career of their children), status demand (to distinguish oneself as part of an elite), and ‘belief-formation’ demand (to increase social control and advance nation building) were all private or social drivers to invest in education.

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<sup>10</sup> This fall in prices had also a major impact on the spread of the ideas of Protestantism. For example, Luther's translation of the New Testament in 1522 was affordable even to labourers (Stöber 2004).

<sup>11</sup> Similarly, Clark (2004, p. 8) calculates that “the estimated price of a standard page of text in the middle ages was 50 times the price in 1700-59”.



Source: Cressy (1980).

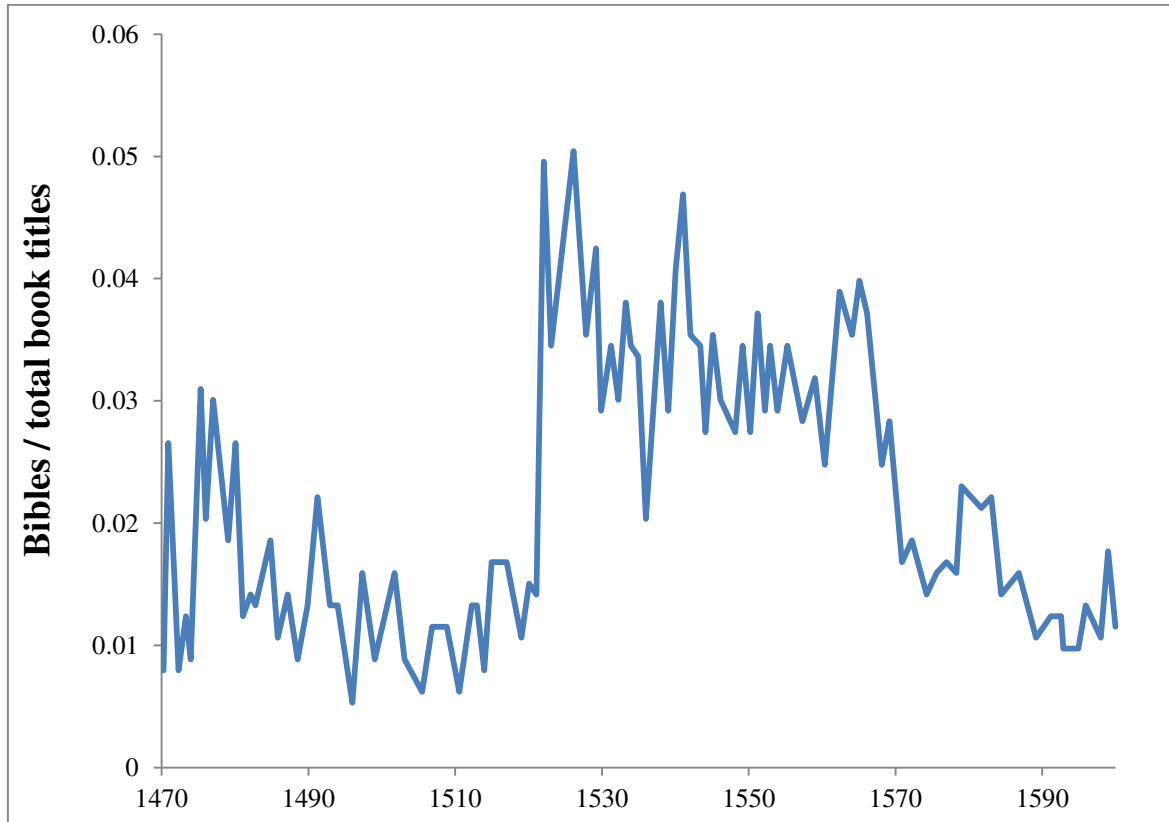
**Figure 4. Literacy in England, 1530-1870**

Mitch (1992b) has emphasised that early advances in literacy levels were brought about by private demand, rather than any direct actions by the state. “[T]he success of printing should probably be connected with more general changes in society. The end of the Middle Ages was marked by the rise of the bourgeoisie. Now that it controlled new economic and commercial sectors, the middle class intended to participate in political decision that concerned them as well, and it signalled its social success by paying more attention to culture, which it adapted to its own interests.” (Gilmont 1999, p. 215). Indeed, the percentage of households owning books increases from one in ten in 1560, one in four in 1580, one in three in 1590, and nearly one in two by 1620 (Morgan 1997, p. 14). Similarly, the average size of personal libraries grew (Gilmont 1999, p. 214). Increases in book collections offer an insight into the different income elasticities amongst different professions and social status. “Between 1500 and 1525 the average physician’s collection increased from 26 to 62 books; the average jurist’s from 25 to 55; the average merchant’s from four to ten and the average artisan’s from one to four” (Morgan 1997, p. 13-14).



Basic education in the form of literacy or numeracy had become increasingly important in economic affairs throughout history. Cook (2006, p. 71) suggests that “one of the earliest exceptions to the exclusion of literacy to all but social elites was its appearance among the trades”, in particular due to the need of record keeping. For example, reading and writing ability became a prerequisite to become an apprenticeship with English goldsmiths in 1478 (Anderson 1965, Venezky 1996). Increasing urbanization led to an economic environment that demanded more book keepers, administrators and clerks and more sophisticated forms of bureaucracy. More generally, “[l]iteracy continued [...] to be driven by practical utility, appearing first and to the highest degree in those trades most closely associated with the market economy (Thomas 1986), and in areas where new technologies were forcing change, such as navigation and warfare” (Venezky 1996, p. 59).

Meanwhile, demand for spiritual guidance, and the associated religious competition, were crucial ingredients for the explosion of printed works, particularly from the early sixteenth century. As already mentioned, the increasing number of monasteries throughout Europe during the Middle Ages reflected the growth in the supply of and demand for spiritual guidance.



Source: Dittmar (2013).

**Figure 5. Share of bibles in total book output in Europe, 1470-1600**

With the cheaper costs of printing, Luther could dare to propose that everybody should be able to read the bible. Given that fewer than one German in one hundred was able to read at that time, his ambition must have seemed just a utopian vision (Engelsing 1973, Becker and Woessmann 2008). However, it is important to remember that for the first seventy years after the invention of the printing press, around 1450, the Bible had been printed in Latin. Most people did not read, but it made it harder to learn to read, when the Bible was in Latin. Although translations had existed before (into old French, Spanish, Catalan and German in the thirteenth century and the Wycliffe Bible into English in 1383), these were usually banned, so, very hard to access and extremely expensive (Biller 1996). The first printed non-Latin Bible was into Greek by Erasmus in 1516. However, it was Luther's translation into German of Erasmus' Greek Bible in 1521 that made the Bible accessible and at a low cost, electrifying the book market (see Figure 5). In 1526, a Dutch Bible was printed; another German Bible out of Zurich in 1530; in Italian in 1532; in French in 1535 (Gilmont 1999, p. 214-5). As a consequence, one of the most powerful drivers of European demand for books from the 1520s onwards was the translation of the Bible into European languages.

### **5.3. Early Spiritual Demands for Mass Education**

With the aim of ensuring that all should read the Bible, Luther argued for the establishment of compulsory schools and claimed that local rulers were responsible for their establishment. This would have effectively implied a shift of instruction from religious to secular authorities. In consequence, a range of ordinances that promoted schooling were passed in Protestant territories and their implementation was controlled (Becker and Woessmann 2009). For example, a first land-mark church order was passed in Braunschweig in 1528, supporting the creation of new schools and defining the school curricula. It was soon followed by others (e.g., Saxony in 1557, Württemberg in 1559, Lüneburg 1564) (Green 1979). Yet, Luther's preaching did not lead to universal mass schooling (Stone 1969, Ramirez and Vetransca 1992).

Luther also urged parents to value the education of their children and to send them to school. For example, Luther writes that "I see that the common people are dismissive to maintaining the schools and that they withdraw their children from instruction altogether and turn solely to the care for food and bellies, and besides they either will not or cannot consider what a horrible and un-Christian thing they are doing and what great and

murderous harm they are doing everywhere in so serving the devil” (Luther 1909, p. 526, as cited in Becker and Woessmann 2009, p. 541). Thus, Luther’s insistence over moral obligations might have altered parents’ and rulers’ beliefs about the benefits of educating children (Becker and Woessmann 2009).

At first, the Catholic Church attempted to ban Bible translations. Similarly, the state sought to censor publications. Henry VIII’s experience highlights the difficulties of introducing policies to control information production and dissemination. In the early sixteenth century, most publications read in England were printed on the continent. Following Henry VIII’s break with the Catholic Church, Luther’s sympathisers were frustrated by Henry’s lack of theological reforms, and “bombarded England with highly aggressive pamphlets printed in Antwerp” (Gilmont 1999, p. 216). Unable to censor these publications, Henry VIII encouraged printers to be set-up in England, which they did over the next two decades, and, thus, he was better able to police their activities (Gilmont 1999, p. 217).

Although the Catholic Church’s Counter-Reformation<sup>12</sup> tried to undo many of Luther’s teachings, it eventually embraced the ideal of improving literacy levels and the concept of schooling (Ramirez and Vetransca 1992). Religious competition<sup>13</sup>, and the threat of losing an even greater share of the ‘market for spiritual and moral guidance’, may have been an important factor. “In the face of Protestant competition, religious and secular authorities in Catholic areas also increased their efforts to provide popular schooling; it is notable that the parts of Europe where schooling lagged most seriously were those, like Spain and Italy, where the Counter-Reformation triumphed completely and eliminated religious competition” (Glenn 2012, p. 140).

Overall, the churches played a major role in the supply of schooling for the next three hundred years. Their importance only declined with the rise of the national state. In the nineteenth century, religious authorities feared that state-provided education would be secular and educational content not in line with their own views (see also Boli 1992). This was the case of the Catholic Church in France. In France enrolment was relatively

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<sup>12</sup> See Ekelund et al (2002) for an economic interpretation of the Protestant reformation and Ekelund et al (2004) for an exploration of the economics of the Counter-Reformation.

<sup>13</sup> The question whether religious competition leads to more or less religious participation by individuals is still disputed. On the one hand, it is argued that the existence of various religions leads to a decrease in the plausibility of a given religion and thus less religious participation (Chaves and Gorski 2001). On the other hand, authors such as Adam Smith suggest that a non-state-sponsored religious group has to provide special care for its believers, raising the quality of and participation rate in religious activities (Iannaccone, Finke and Stark 1997). For more information see Höhener and Schaltegger (2012).

widespread before the central state developed to a modern organised entity (Archer 1979) because the Catholic Church was interested in controlling the socialisation of children. Later competition with the state further increased French schooling (Fuller and Rubinson 1992). Thus, enrolment rates of children were about a third in the 1830s and reached 80% by the 1880s (see Galor 2011).

In other locations, particularly in Protestant regions, the state worked together with the Church. In particular, the early worldwide leader in reading, Sweden, passed a Church law in the seventeenth century with the intention of spreading literacy due to religious motivations. Thus, Venezky argues that “reading ability was pressed on the population by church and state” [...] “through regular parish examinations, fines for parents who failed to teach their children and denial of Communion and marriage rights to those adults who could not read and recite the catechism”, leading to almost universal reading ability in the population until 1750 (Venezky 1996, p. 48). Similarly, the state cooperated with the Lutheran Church in Prussia (Soysal and Strang 1989).<sup>14</sup>

In general, where the state was weak, it had to rely more on the infrastructure of the Church, giving the Church more power and influence (Vincent 2000). The United States is another example where enrolment rates were high in the presence of a relatively weak central state. Meyer (1989) proposes that this fact can be explained by a particular faith in schooling and literacy (due to Protestantism) and its positive effects on nation building. These ideas originated in Britain and were spread to America. Once again, spiritual demand had been an important driver of education.

## **6. Demand for Education**

### **6.1. The Pros and Cons of Mass Education**

Although some early reformers had promoted mass education, formal schooling was not widespread before 1800. Instead, most education was provided in more informal settings. The diversity of opportunities to become literate is highlighted by Cipolla (1969), making reference to Rashin’s study (1958). Still in 1883/4, the study shows that in a province of Moscow, Russian Empire, the distribution of 7,123 factory workers with the capacity of reading according to the source of their education is: 38% became literate in their village,

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<sup>14</sup> More generally, the authors see the values in formal education close to those of Protestantism, as highlighted by Weber (1958): “formal education’s emphasis on individual socialization and achievement parallels the Protestant emphasis on the individual’s unmediated relation to God and individual salvation” (Soysal and Strang 1989, p. 279).

town or district schools, 36% outside school, 10% in factory schools, 9% with clergy, and 7% became literate during military service (Rashin 1958, p. 588).

Mitch (1992b, referring to Briggs 1978, Mitch 1982) claims that fees for private schools at the elementary level were at levels that working-class families could afford in many European countries between the sixteenth and nineteenth century. He further argues that private instruction could then have achieved universal literacy without the state.

Yet, different classes tended to have different demands for education. Whereas the middle class sought secondary or tertiary education for their children to move up the social ladder, workers might not seek education beyond the primary level because they failed to see the benefits of education. In this way, educational differences among the classes and perhaps also regions of countries were exacerbated. In this way, access to higher status jobs was often limited to particular groups of society, hindering mobility between social classes.

This point illustrates that the ruling elites in many countries were wary of the threat that more education posed to their political, economic and social position. These elites feared that education would make the workers despise their lot in life, a life that had been assigned to them 'by nature'. Therefore, education was perceived by some to lead them to seek more rights and make them more prone to resist domination (Graff 1991, Lindert 2004).

Despite these upper-class fears, there had been a growing demand for mass education for military and industrial reasons. Indeed, supporters of military conscription had particular interest in mass schooling. In fact, there had been an important demand for gunners in the sixteenth century (Cipolla 1969). Because gunners had to be literate to perform their profession, a number of European governments created specialised schools for their education where they learned to read, write and calculate as well as some basics in ballistics. Sweden had promoted mass schooling for instilling national loyalty, teaching discipline and lessening social tensions among the population, and their leaders found that literate soldiers were also considered much more effective in warfare (Malmström 1813). Similarly, Napoleon was aware of this fact and promoted the education of his recruits. Later on, his enemies used this insight to create an educated army (Vincent 2000). For instance, defeated Prussia successfully reformed its education system. This may have been one of the reasons Prussia (and the other German states) won the Franco-German War in 1870. "[I]n 1870 there were more than 20 per cent illiterates among the recruits of the French army while there were only about 3 per cent among those of the Prussian army

[...]. As the French remarked at the time: *Sedan est la victoire du maître d'école allemande*" (Cipolla 1969, p. 23-24, see also Fourrier 1965). Cipolla states that "[s]ocieties which produced an increasing number of literate soldiers had a decisive advantage over those that failed to do so" (Cipolla 1969, p. 23). Accordingly, Vincent notes that "[a]s Europe prepared for war, most of the potential combatants had ensured that their recruits would be able to read the instructions on their weapons and write back to their families" (Vincent 2000, p. 10). In other words, military objectives played a role in the provision of education by the state in the nineteenth century.

## **6.2. Books in the Industrial Revolution**

The basic technology did not significantly change after Gutenberg until the nineteenth century (Chappell 1970). Afterwards, the Industrial Revolution had a dramatic impact on the supply of printed materials. Steam power began to be used in the pressing process as early as 1810. At the same time, the first successful attempts were made with machine-produced (pulp-fibre) paper and machines for mass production entered the market in the 1840s. Further advances in paper production and in printing machines (in particular the linotype) immensely cut time and capital costs in printing in the second part of the century (Cook 2006). These changes had their effects on the number of published titles.

Weedon analyses England over the period of 1836 and 1916 in more detail. He concludes that the time between 1846 and 1916 "saw a fourfold increase in production and a halving of book prices" (Weedon 2003, p. 57, see also Figure 4).

What were the determinants of these important changes in book and print production in the nineteenth century? Weedon suggests that technological transformations were essential in the process. She emphasises that paper, an essential part of the production costs of a book, could now be produced by the use of machines. The cost of paper fell significantly by about two-thirds between 1866 and 1896, making book production much cheaper.

Even more spectacular increases were recorded for the newspaper industry. Cipolla (1969) highlights that "in the United Kingdom in 1831, the average monthly issue of the newspaper press amounted to about 3,240,000 copies (equivalent to about 137 copies per 1,000 inhabitants). By 1882 it had gone up to 135 million (about 3,700 copies per

1,000 inhabitants) (Cipolla 1969, p. 107)<sup>15</sup>. To have a sense of the overall evolution of newspaper circulation in the UK, Murch (1870) states that it was about 38,648,000 copies in 1831 and increased to 546,059,000 copies in 1864 (i.e. an increase of 1,313%). Not only more newspapers were printed but also the cost of newspaper production decreased. For example, price reductions in newsprint were of an order of 10 during the period from the 1860s to the 1890s (Cook 2006). In other words, steam power was revolutionising all forms of print media.

### **6.3. Industrial Demands for Education**

The industrial demand for literacy was slower to develop. In the first phase of the Industrial Revolution, industrial demand for skilled labour was rather limited (Galor 2011). Some factory workers needed to be literate and numerate, but most processes were still handled by illiterate workers (Landes 1969, in Galor 2011). Furthermore, the developing factory system increased the opportunity costs of education for young children because they could be employed in factories (Cipolla 1980, Venezky 1996), leading to stagnating educational levels. The evidence to date finds little importance for the role of formal education in the Industrial Revolution in Britain (Mitch 1999).

However, Becker et al (2011) identify an important role for education in Prussia's industrialisation catch-up during the second-half of the twentieth century. Furthermore, industrial modernisation led to the need for skilled labour and created demand in the second phase of the Industrial Revolution (Galor and Weil 2000, Galor 2011). Certainly, by the second half of the nineteenth century, industrialists identified a growing need for workers to be educated in order to effectively use the machines.

Human capital became more important in the process of production because it was complementary to (physical) capital and technological progress. Labour productivity was also higher for skilled individuals (Galor et al 2009, Galor 2011). In addition, educated individuals were considered to be more easily adaptable to technological change and open to new arriving ideas (Cipolla 1969). Technological progress was advancing quickly during this period and thus the corresponding demand for human capital took off. Therefore, Zeira argues that “[b]oth the mechanization of production and the increase in the scale of production changed dramatically the whole character of producing and

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<sup>15</sup> Numbers from France emphasise the stark increase in newspaper production: “[i]n 1840 the monthly issue of all the Paris journals totalled less than 3 million copies. By 1882 it was up to 44 million copies (Cipolla 1969, p. 107)”.

marketing. It now required new skills, of reading, writing, and arithmetic. The need to handle and operate machines and to take care of them required some knowledge in science and engineering and at least some literacy skills, to read manuals, to correspond with producers on problems in machines, etc.” (Zeira 2009, p. 602).

**Table 1. Usefulness of literacy in English male population, 1841-1891**

Category of occupational usefulness of literacy	1841	1851	1871	1891
Literacy required	4.9	5.6	7.9	11.1
Literacy likely to be useful	22.5	22.8	25.3	26.1
Literacy possibly useful	25.7	24.2	24.5	25.9
Literacy unlikely to be useful	46.9	47.0	42.3	37.0

*Source:* Mitch (1992a).

*Note:* ‘Usefulness’ refers to the degree that literacy was useful in a work context.

Mitch (1992a) estimates that a literate worker gained about 13% more than an illiterate one around 1870. The increasing opportunities for members of the lower classes to enter into competition for higher ranked jobs and more frequent opportunities to use literacy skills in everyday life no doubt stimulated private efforts to become educated. More generally, the structural changes in the sectors of the working population had its own repercussions on the requirement of literacy with a long-run move out of agriculture, where literacy was less needed (Table 1). Finally, the demographic transition further increased the need to invest in each child due to the lower number of children.

According to Galor et al (2009), capitalists had an interest in promoting public education because they needed skilled workers in their factories during the second part of the Industrial Revolution. In contrast, large landowners preferred to block educational expansion because industrialisation threatened their social status. In addition, workers would be more prone to migrate to better paying urban centres and would be less willing to accept existing working conditions in the fields. Finally, land owners were often those that had to pay the taxes for improving the educational system and they did not want to take this financial burden.

Thus, against the interests of land owners, capitalists were active in lobbying for public education and tried to influence government actions towards intervention in the education field. In particular, technical education was seen to be an important way of providing skilled workers. The example of England may illustrate this. It was the industrial leader but late in the provision of public education. According to Galor (2011), the



government changed its prior laissez-faire politics when it became clear that other countries (such as Germany or France) were becoming more inventive and innovative in industry. According to a jury member of the Paris exhibition of 1867, the exhibition showed that there was insufficient progress in the English industrial sector. The reason for this “upon which there was most unanimity conviction is that France, Prussia, Austria, Belgium and Switzerland possess good systems of industrial education and that England possesses none” (Green 1990, p. 296, in Galor 2011, p. 476). Later on, the vice president of the committee of the Council of Education believed that “[u]pon the speedy provision of elementary education depends our industrial prosperity ... if we leave our work-folk any longer unskilled ... they will become overmatched in the competition of the world” (Hurt 1971, p. 223-224, in Galor 2011, p. 477). Thus, Galor (2011) argues that the English government finally gave-in to the demand of capitalists and expanded public education.

Together with the process of industrialisation, the public became increasingly aware that more modern skills and knowledge related to modern production processes had to be acquired. Therefore, in their analysis of the United States between 1890 and 1970, Rubinson and Ralph (1984) find a significant impact of technological change on the expansion of schooling (i.e., enrolment rates). However, they acknowledge the fact that schooling and literacy were already important in the US before the Industrial Revolution. They were part of a process of status competition among different parts of the population (according to ethnic origins, occupational status, religious affiliation, etc.). Moreover, the importance of technological change weakened over time because the schooling system was expanded more by political considerations.

#### **6.4. The Incentives for the Nation-State to Provide Mass Schooling**

Alongside military and industrial reasons, illiteracy also started to be seen as a disgrace for a nation (Cipolla 1969), putting pressure on governments that did not want to fall behind the ‘civilised’ leaders. Therefore, international reputation and competition can be seen as a factor that influenced government policy in this context. In addition, there was a growing belief in the role of mass education in forming the beliefs of the population and in directing and possibly controlling their behaviour.

Ramirez and Ventresca (1992, p. 49) consider the later phases of the construction of mass schooling to be a project of the nation-state, emphasising its overall transnational character. They argue that mass schooling evolved and standardised around similar ideological and organisational forms. It allowed the nation-state to connect with

individuals. The rise of the nation-state was, therefore, intrinsically related to mass schooling. Public life became increasingly reordered around the nation-state and former transnational populations were transformed into citizens of nation-states. Education as such became its own institution, with its own goals, interests and stakeholders. “Almost all European governments took steps which homogenized their populations: the adoption of a state religion, expulsion of minorities, institution of a national language, eventually the organization of mass public instruction” (Tilly and Tilly 1973, p. 44, cited in Alesina and Spolaore 2005, p. 184). Later on, former colonies proceeded in a similar fashion to achieve the goal of nation building in the second part of the twentieth century.

In line with this idea, Alesina and Reich (2013) argue that the magnitude of homogenisation aimed at by a government depended on its particular regime. In particular, they distinguish between democratic regimes, “safe” non-democratic regimes and “unsafe” non-democratic regimes. For example, in France the Ancien Régime was powerful but not interested in pursuing homogenisation. The French Revolution toppled the regime but other elites soon came to power. Still, the threat of more democracy necessitated increased efforts of nation building and homogenisation. One important way to homogenise the population was linguistic homogenisation by enforcing that French was the only language used at school. The cases of Italy and England similarly illustrate that mass schooling was perceived to be a requirement for nation building. Similarly, in many African states after decolonisation an important share of enrolments was only realised after the (re)organisation of a more or less effective national state. Increasing enrolments had different advantages. It had a signalling effect, emphasising that the nation-building process was underway. Moreover, it was aimed at showing that the ideals of progress were embraced by the elites, giving further legitimacy and credibility to their ruling. The erection of schools had, thus, also an important symbolic effect in several dimensions (Ramirez and Ventresca 1992).

## **7. Government Intervention in Education**

How can the European countries be classified according to the importance of government involvement in education? Mitch (1992b) distinguishes between two categories of European countries. First, the countries that were the leaders in industrialisation (e.g., England, France, Germany) showed a gradual increase of literacy over several centuries

prior to the eve of mass schooling (see Figure 4 for England).<sup>16</sup> This gradual process may have involved local demand which was met by local supply. Second, the late-industrialising nations (such as Russia, Italy, Spain) had much lower literacy levels but then these countries increased them much more rapidly. In fact, the governments were aiming at closing the gap with the leading European countries. Thus, the role of the central state was much more important in these countries and local elites had a less decisive influence in advancing educational levels.

Using a different approach, Soysal and Strang (1989) divide the European countries into three groups according to the conflict and competition within societies on the subject of education. The first category, the ‘statist construction of education’, includes Prussia and Scandinavian countries (Denmark, Norway, Sweden). In these cases, the state was able to build upon the knowhow and physical infrastructure of the national churches. In fact, instruction was mostly provided by churches before the nineteenth century (Vincent 2000). Thus, the alliance between the state and the church was crucial.

Second, the ‘societal construction of education’ took place in countries such as France, The Netherlands, Switzerland, Great Britain and the United States. In these countries, there were many conflicting interests articulated by important stakeholder groups. These were of a religious order (e.g., Great Britain and the Netherlands) or of local character (e.g., the United States). Therefore, a centralised, nationwide educational system was only constructed relatively late although schooling had already been expanding quite significantly before the involvement of the state.

Finally, the ‘rhetorical construction of education’ in countries such as Portugal, Italy, Greece and Spain meant that compulsory education were passed relatively early but actual action did not take place for many decades. The dates of the introduction of compulsory education and enrolments ratios in 1870 illustrate this discrepancy (Table 2). For example, although Greece introduced compulsory schooling quite early in 1834, its insufficient implementation led to primary enrolment ratios of only 20% in 1870. In this and other countries, there was no competition over education. In addition, the state was too weak and had too little power to enforce its own legislation in its territory.

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<sup>16</sup> The same can be said of the evolution in numeracy (A’Hearn et al 2009).

**Table 2. Introduction of compulsory education and primary enrolments ratios in 1870**

Country	Introduction of compulsory education	Primary enrolment ratios in 1870
Prussia	1763	67
Denmark	1814	58
Greece	1834	20
Spain	1838	42
Sweden	1842	71
Portugal	1844	13
Norway	1848	61
Austria	1864	40
Switzerland	1874	74
Italy	1877	29
United Kingdom	1880	49
France	1882	75
Ireland	1892	38
Netherlands	1900	59
Luxembourg	1912	-
Belgium	1914	62
United States	-	72

*Source:* Soysal and Strang (1989).

Another question concerns the effectiveness of state policy in education. When was state action effective? Mitch (1992b) points out that a state's education policy might not have been very effective if demand was low. Even if a sufficient supply of education was guaranteed by the state, lacking interest or even resistance from parents meant that classrooms stayed half-empty. Furthermore, state policy was rather ineffective when there had already been a high level of literacy and a large supply of private schools. In this case, Mitch (1992b) argues that public policy initiatives were redundant and in many cases already existing private schools were only turned into public ones. In contrast, a state's policy may have been quite effective when a clear shortage of supply did not meet popular demand. In addition, state policy could overcome local resistance where local elites blocked the provision of educational facilities against the will of the local population. Moreover, public policy could be effective when an initial level of instruction was present but this level had to be advanced still further. Here, the state's policy (in particular in England, France and Germany) was directed towards the construction of new schools, the standardisation and improvement of teaching, the reduction or elimination of schooling fees and the establishment of compulsory schooling laws. National literacy campaigns (e.g., in Scandinavia in the seventeenth century) may have also been an important tool to increase the effectiveness of education policy.

In consequence, Mitch emphasises that an effective educational policy needed the concordance between the demand for instruction and the influence of policy measures. Both are dependent on the popular attitude towards literacy and the power relations within society.<sup>17</sup> Thus, education policy needed to count on popular and local elite support to be effective. Where one or both of those factors were lacking, national public policy was often without great effect. Therefore, local institutions and local elites played an important role. Accordingly, Lindert (2004) notes that many of the early high performers in mass education had decentralised education systems. For example, he argues that the Prussian education system was essentially based on bottom-up structures.<sup>18</sup> Other examples for decentralised education systems include the US and Canada. In all of these countries, local governments were able to levy their own local taxes that financed the school system. Thus, local actors were able to choose whether they wanted to be committed to schooling or not and were freed of interests that may have been existing at the national level. Local leaders were thus influenced by local debates and local demand. Thus, local funding also meant that regional differences in education could become even more striking. In consequence, whereas, in the first phase, decentralisation enabled educational levels to increase in the most favourable regions, in the second phase, it tended to fail to increase educational standards in the laggard regions. In the latter phase, the government was needed to avoid such a market failure<sup>19</sup> and to centrally enforce higher educational spending.<sup>20</sup>

In what specific ways can the state act in order to avoid market failures in the educational sector? First, the state can provide sufficient supply. In theory, the private sector could also be fully responsible for the supply side: according to Lindert (2014),

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<sup>17</sup> He distinguishes three cases: egalitarian, elite and autocratic forms of power distribution. In the egalitarian case, the preferences of the majority were implemented by the elites. Thus, there was a high risk that policy measures were simply redundant or not meeting private demand. In these societies, the acquisition of education meant the prospect of moving up the ladder of society, leading to popular demand. When the powers in society were more concentrated but upward mobility was still possible (e.g., in France and Germany), the effectiveness of public educational policy was probably higher. Finally, in the case of more autocratic forms of government, when power was extremely concentrated (such as in Spain and Portugal) and the masses lived at low standards of living, public action was ineffective. On the one hand, demand was low and actions by the state were perceived as intruding into family's life. On the other hand, local elites blocked educational changes that may have been intended at the national level (Mitch 1992b).

<sup>18</sup> Overall, the Prussian kings were not fervent promoters of the spread of mass education. They "did as much, and said as much, to *block* schooling and free thought as to spread it" (Lindert 2004, p. 118).

<sup>19</sup> Here, it is assumed that all regions benefit socially from higher education levels.

<sup>20</sup> Some studies have suggested the existence of a human capital Kuznets curve, adapting the idea of Kuznets (1955) to education. In other words, increases in human capital inequality in earlier phases are followed by subsequent reductions in human capital inequality in later phases of economic development. For empirical contributions, see e.g., De Gregorio and Lee (2002), Castello and Domenech (2002), Lim and Tang (2008) and Morrisson and Murtin (2013); for theoretical models see e.g., Galor and Tsiddon (1996), Glomm and Ravikamur (1998) and Matsuo and Tomoda (2012).

investments in primary education have brought high private and social returns for at least the last 600 years. However, he points out that the private sector has never solved the ‘capital constraint’ problem, i.e. that universal education investments are to be paid back by the increased future earnings of children. For this reason, the state has to step in to avoid underinvestment in education. Yet this supply of schools, teachers and materials generates important costs for the government. This is one reason why the state was not able to finance public education throughout most of history. In fact, it did not have the necessary fiscal capacity due to inefficient state bureaucracies, etc. On the other hand, the willingness to invest in education and thus to increase taxes was dependent on the interests of the ruling classes. As long as these ruling classes, in particular land owners, were opposed to educational reforms, progress was limited or inexistent in this area (see also Hippe and Baten 2014). Therefore, Lindert (2014) argues that the provision of voting rights to larger parts of the population made a crucial change to the composition and attitude of governments towards educational investment. Thus, government spending on education has risen dramatically during the last two centuries. Higher spending does not necessarily translate into higher enrolments but is often well correlated (see Fuller 1983, Walters and O’Connell 1988).

Second, the state can create demand for education. Thus, investing in the quality and credibility of schools may have an important impact on demand and enrolments. The quality of schools depends on several factors, among other things on the quality of teachers. The supply of those teachers, again, depends on, e.g., their salaries and the social status of the teaching profession (Cipolla 1969).<sup>21</sup> Assuring the quality of teachers can thus be an important policy objective. In addition, the state can politically construct the organisation of work. For example, it has the power to create minimum educational standards for the entry into jobs in the public and private sectors. If parents or their children want to enter this well-paid job market, they have to invest in education. In consequence, the state can create a public demand in a politically-directed way. Likewise,

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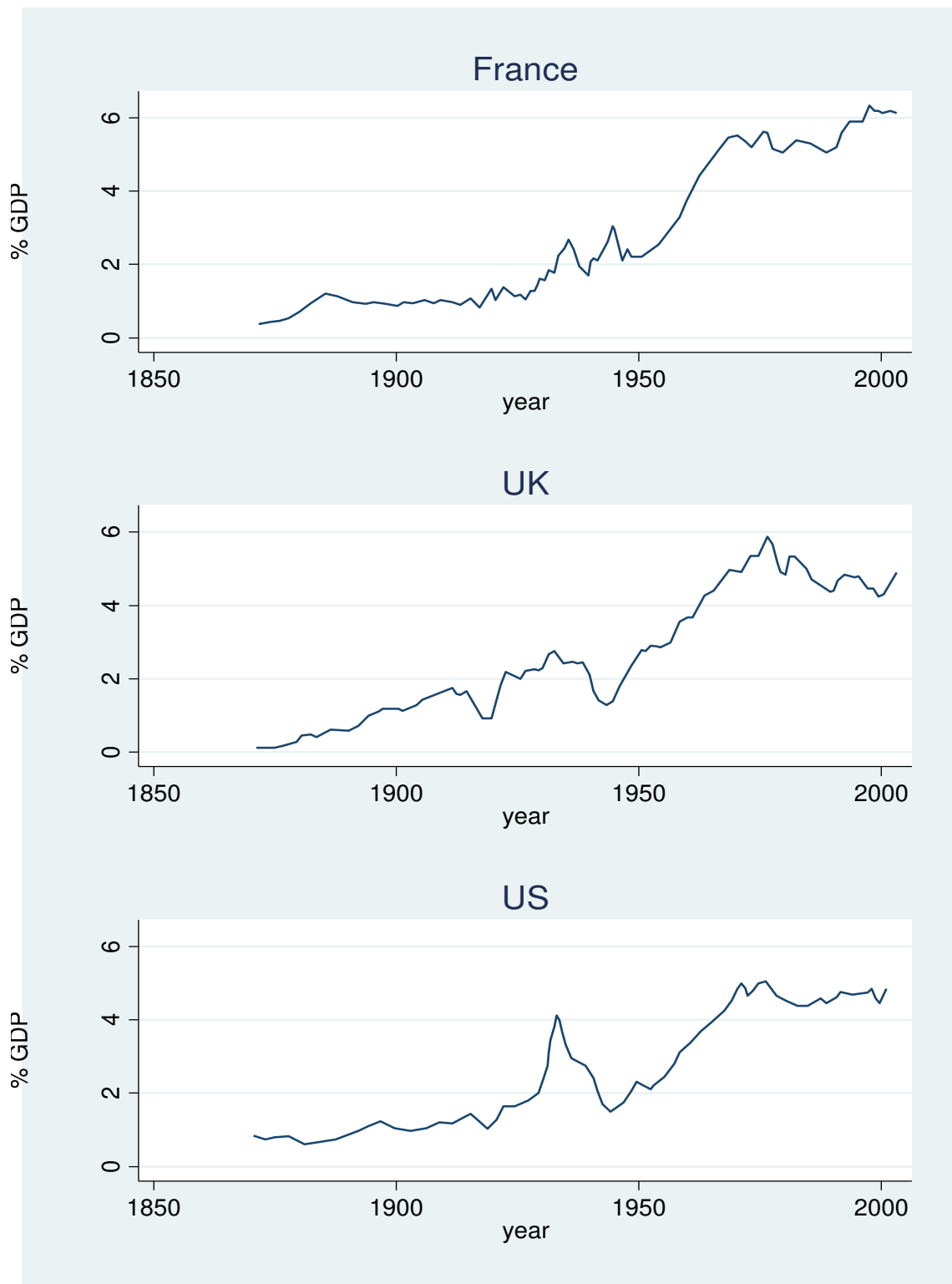
<sup>21</sup> The level of salaries was quite diverse across Europe. However, apart from some exceptions they seem to have been low. Thus, Cipolla (1969) suggests that the average salary of a teacher was comparable to that of a craftsman before the 19<sup>th</sup> century. In addition, the social status of teachers still varied importantly from one European country to the other in the 19<sup>th</sup> century. For example, teachers enjoyed high public respect in Germany (and Prussia in particular) (Cipolla 1969). Social prestige and income may thus be causes of high quality. Maybe a long-standing tradition of the teaching profession was also an important factor. In contrast, schoolmasters and mistresses did not have a good reputation and not much prestige in England and southern Italy in the 19<sup>th</sup> century.

the state can decrease the opportunity costs for sending children to school (e.g., by limiting child labour and giving schools a normative legitimisation).

Finally, the ideological and symbolic compound associated with education (e.g., economic and social opportunity, but also Western ideals such as nation building, individual development and progress) can be used by the state to advance mass schooling through corresponding signalling activities (such as literacy campaigns) (Fuller and Rubinson 1992).

However, it appears that the state's involvement to improve educational quality and quantity might have been too late in some countries. For example, Mitch (1986) indicates that this may have been the case in nineteenth century England. In consequence, was the UK spending too little on education (and too late)? To have a better grasp of the amount of public spending in comparison with economic output, public investment in education can be directly measured as a share of GDP. Carpentier (2007) shows the relative position of the UK with other countries that were catching up. In particular, he considers the differences between the UK, France and the US (Figure 6). The very low values of the UK until the end of the nineteenth century appear to be also quite low in comparison to these other industrialising countries. This illustrates the claim that the major deficiency of the UK in the second part of the Industrial Revolution was its lack of skilled workers due to a lack of education. The United States was by far the leading country among these three nations in 1870, spending almost 1% of its GDP on education. France follows with a large gap at about 0.5%, while the UK lags very much behind. The UK became aware of this later on and the government increased its expenditures much more pronouncedly. France also increased its relative expenditure on education, becoming for a decade the leader of these three countries. Subsequently, the UK had the highest shares until World War I. However, the real take off in educational spending shares occurred only between the 1950s and the 1970s. Since then, educational spending has mostly been between 4 and 6 % of GDP in all three countries.

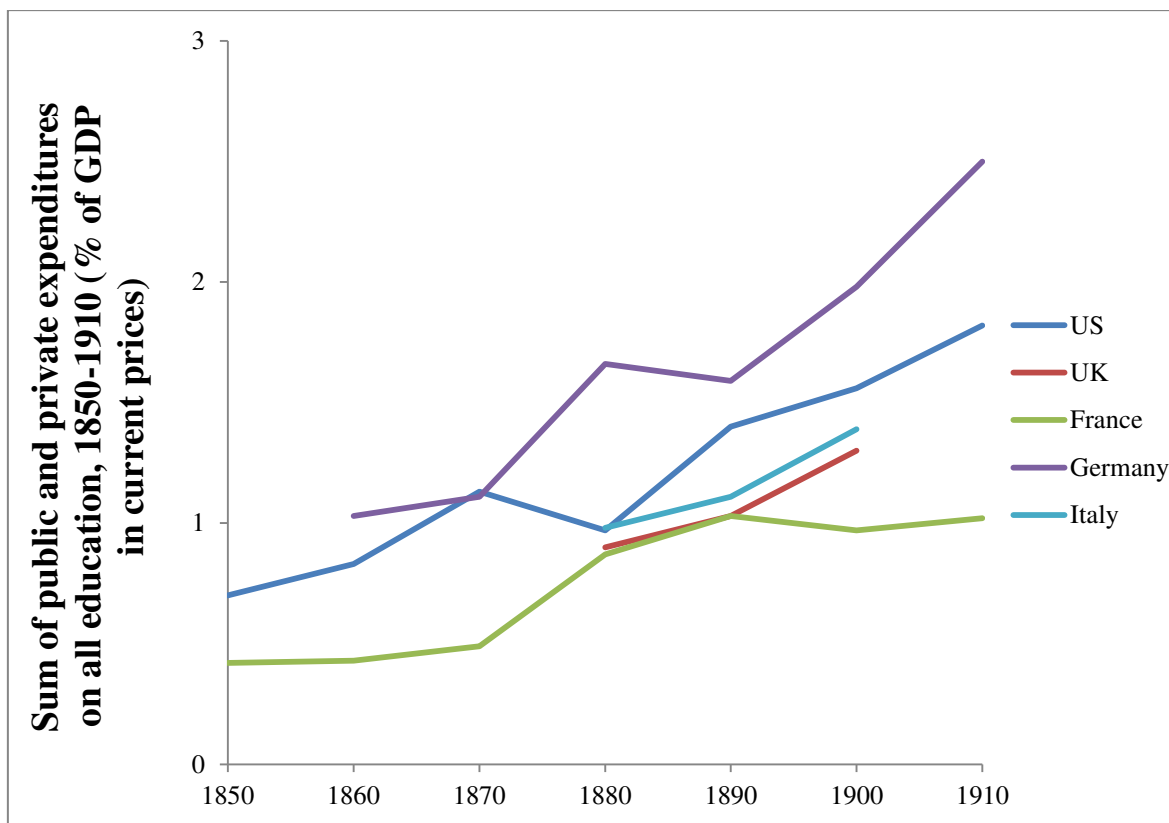
These data illustrate the evolution of public expenditure on education. However, they do not include private investment in education. The overall investment in education might have been much higher than the public investment alone. Lindert (2004) provides some estimates on total (i.e., public and private) expenditure on all levels of education in a number of countries between 1850 and 1910 (see Figure 7).



Source: Carpentier (2007).

**Figure 6. Public expenditure on education as a share of GDP in the UK, France and the US, 1870-2003**



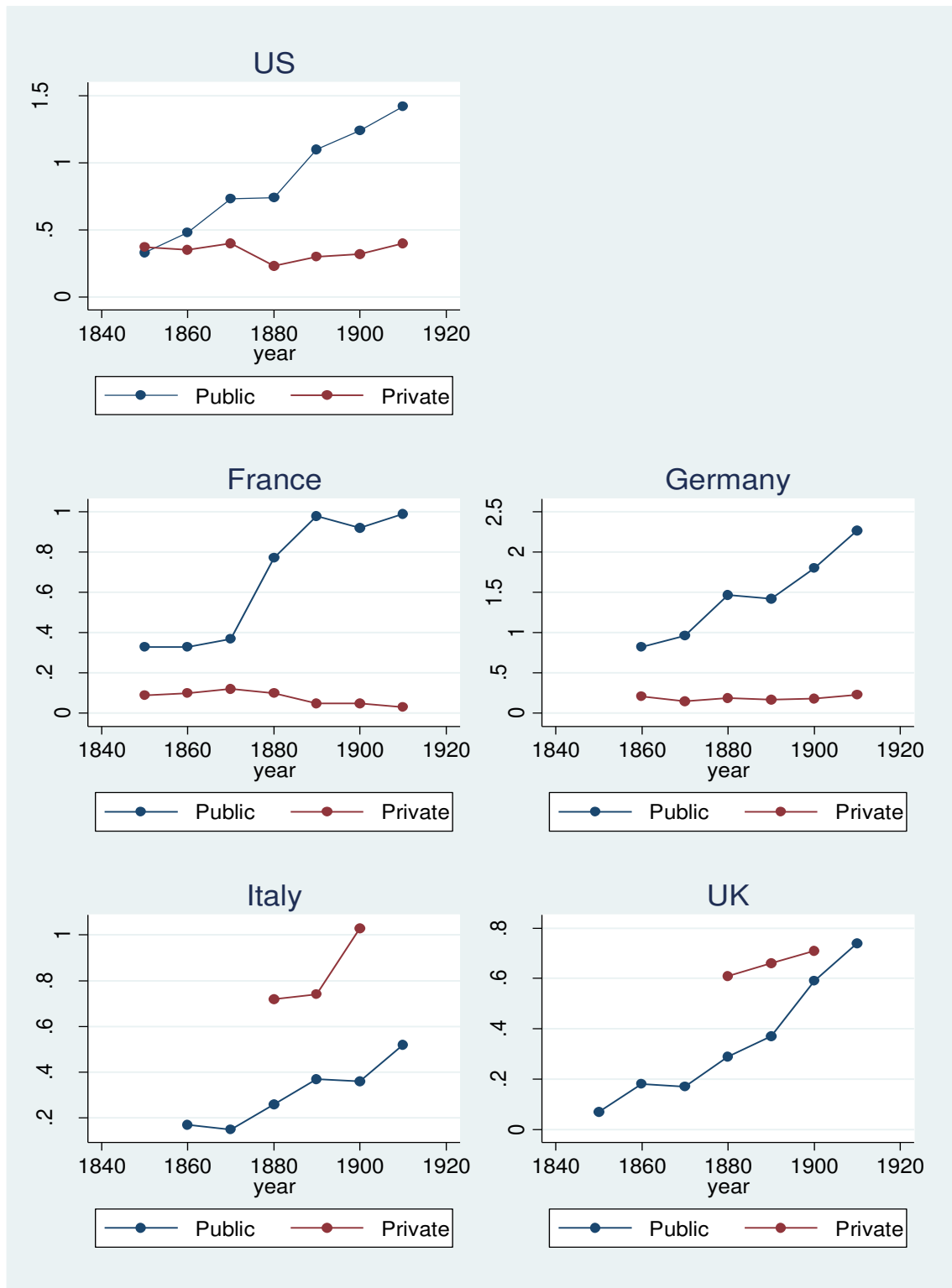


Source: Derived from Lindert (2004).

**Figure 7. Total of public and private expenditure as a share of GDP, 1850-1910**

The data suggest that overall investment in education was highest in Germany throughout the second part of the nineteenth century, followed by the United States. France appears to have had much lower levels, and the gap to the leading countries widened at the end of the nineteenth and the beginning of the twentieth century. Data on Italy and the UK are even more tentative but could suggest a more intermediary position.

The next logical step is to ask about the composition of this investment. Was private investment in education higher or lower than public expenditure? Thus, did public investment replace private investment over time? The next figure illustrates the relative importance of public and private investment (as a share of GDP) in these countries (see Lindert 2004 for details).



Source: Derived from Lindert (2004).

Note: Vertical axis refers to expenditures on all levels of education as a % share of GDP in current prices. The value for private expenditure for the UK in 1890 has been interpolated.

**Figure 8. Public and private expenditure as a share of GDP, 1850-1910**

Three different patterns emerge. First, private and public expenditures were more or less at the same level in the US in the 1850s. However, public expenditures as a share of GDP rise (almost) continuously whereas private expenditures stagnate. The initially slightly higher levels for private expenditures might possibly suggest that public expenditures partly replace private ones. Second, public expenditures are much higher than private ones in both France and Germany throughout the period. The gap also widened given the increased efforts of the government to provide schooling. Finally, private expenditures appear to have been higher in Italy and the United Kingdom at the end of the nineteenth century. Therefore, the tentative evidence would suggest that government spending became the major form of investment in education only in the twentieth century, much later than in other countries.

## **8. The Worldwide Human Capital Transition and the State**

### **8.1 Trends in worldwide human capital levels during the last two centuries**

It appears important at this stage to have first a general overview of the long-run human capital transition in the world before moving on to the role of the state. We may begin with numeracy levels (Crayen and Baten 2010). Numeracy is measured here by the age heaping method which measures the share of people that are able to count.<sup>22</sup> The industrial countries have the highest numeracy levels of all countries at the beginning of the nineteenth century. These countries are relatively closely followed by East Asia, which has similar high numeracy levels as the industrial countries in the 1880s. Not far behind of East Asia are the Eastern European/Central Asian countries which achieve the maximum numeracy values by the 1900s. Thus, these three regions reach the upper limit of numeracy levels at the end of the nineteenth century. All other world regions were not able to achieve such a level until the middle of the twentieth century. The most advanced area of these follower regions is Latin America/the Caribbean, which has been inspired by the educational policies of the industrialised countries. The following world regions are

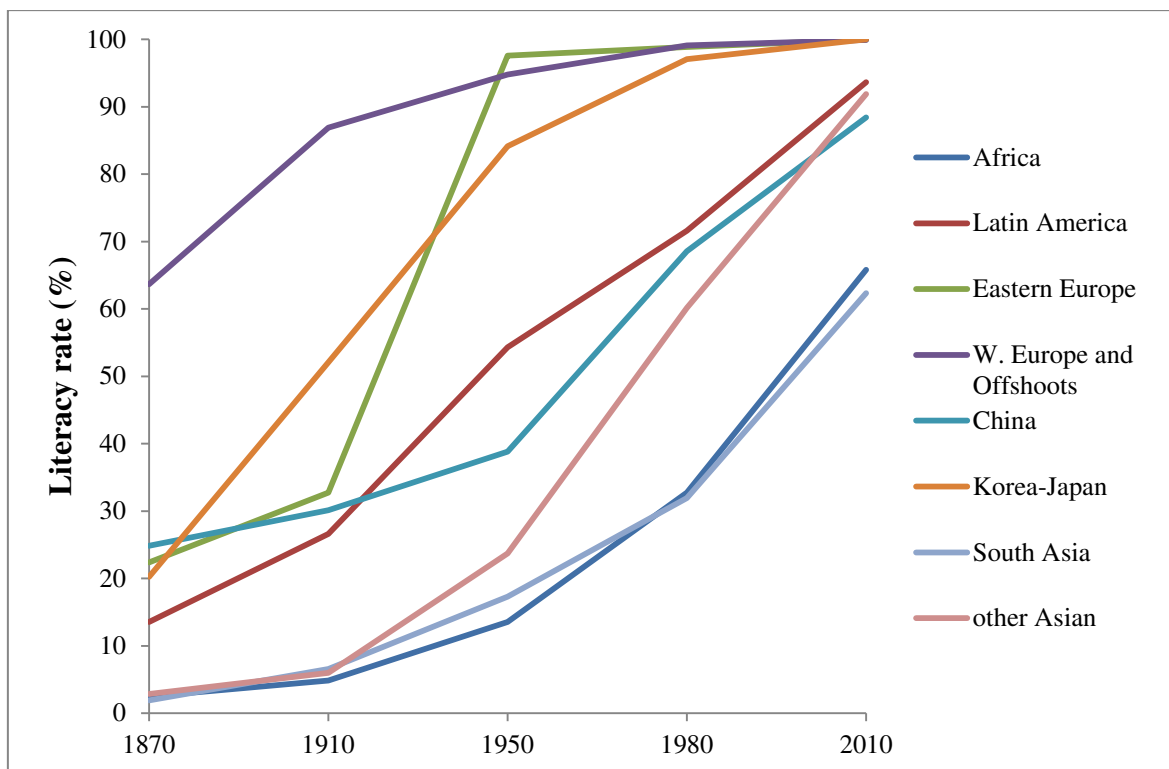
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<sup>22</sup> It uses a particular heaping phenomenon in the age distribution of censuses and other comparable data to calculate numeracy levels. More specifically, individuals over-reported ages on 0 and 5 to census takers, leading to significant spikes in the age distribution. The reason for this was that they were not able to count and to know their exact age, so that they rounded it. This is a well-known phenomenon that can be found in historical sources and in a range of developing countries today. For further information, see e.g., A'Hearn et al (2009), Hippe and Baten (2012) and Hippe (2012).

Southeast Asia, Sub-Saharan Africa and the Middle East/North Africa. The lowest numeracy characterised South Asian countries throughout the period.

Numeracy is just one indicator of human capital levels. Literacy is surely the most common variable for long-run education. The overall trends since 1870 (Figure 9) are quite similar in many respects to the ones identified in numeracy. In particular, literacy levels are once again led by the West. The gap between the West and all other countries appears to be much more important than in numeracy. One important reason for this is that literacy levels are much lower than basic numeracy at the beginning of the period. This circumstance is related to the underlying concept of measurement: the numeracy indicator proxies very simple counting skills which are even more basic than literacy skills. In any case, the West is again followed by East Asian countries (i.e. Korea-Japan and China) and Eastern Europe. Eastern European countries show a particular sharp increase in literacy between 1910 and 1950. In contrast to Korea-Japan, China does not substantially increase its literacy levels until the second half of the twentieth century and thus falls back. Latin America takes an overall similar evolution as China. Although its literacy levels speed up between 1910 and 1950, progress is more slowly achieved afterwards. In China, the reverse is the case. Societies characterised by almost complete illiteracy in the 1870s come from South Asia, 'other Asian' countries and Africa. Whereas the 'other Asian' countries are able to close the gap to the leading regions until 2010, South Asia and Africa show important but not sufficient progress. However, it seems that they may be able to join all other regions in the decades to come.

Taking another standard indicator, the years of primary education, the conclusions are quite similar (see Morisson and Murtin 2013). Clearly, this variable is even more related to the state as the previous indicators because most of schooling has been provided by the state during the considered time span. The increases are not as impressive as in literacy in many cases but this lies partly in the nature of the indicator. Still, the trends that were discernible in the literacy data can also be found here. Primary years of schooling amounted to about 3 years in the West in 1870, whereas it ranged from 0 to 1 years in all other regions. In 2010, three different regimes exist: about 6 years of primary education in the West, Korea-Japan and Eastern Europe, about 5 years in Latin America, China and other Asian countries and, finally, about 3.5 years in South Asia and Africa. Except for the leading group, all other regions appear to be converging to this group in the longer run.



Source: Morriison and Murtin (2013).

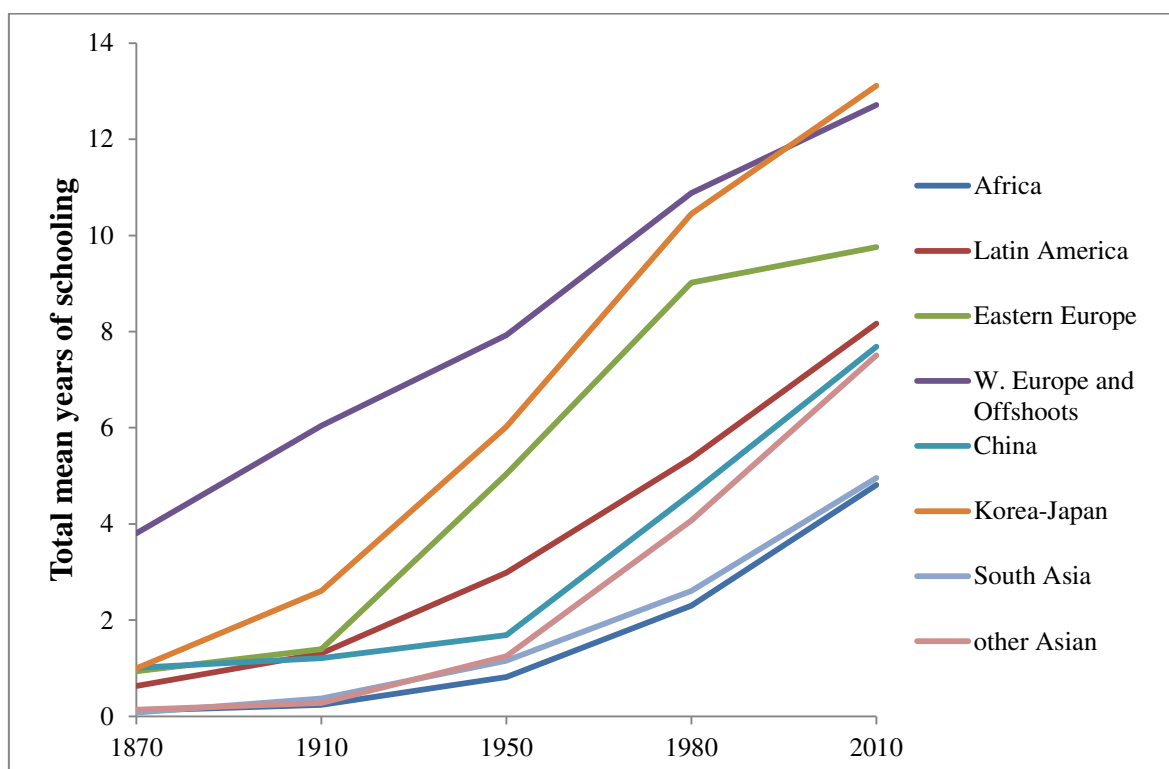
**Figure 9. Evolution of literacy in world regions, 1870-2010**

Primary education is a measure of basic human capital. Thus, it is similar to literacy and numeracy. If we want to enlarge the concept of human capital to include also more advanced skills, we should also take into account the role of secondary education. Therefore, the total years of schooling indicator gives a fuller comprehension of basic and more advanced human capital levels (Figure 10). However, it is clear that an important part of this variable is constituted by the levels of primary education as shown in the previous figure. Most of the trends in the average total years of schooling are, therefore, quite in line with the results for primary education. The most evident change in the pattern is the evolution of Eastern Europe. In primary education, Eastern Europe was already at similar levels as the West and Korea-Japan by 1980. In primary and secondary education, there still remained an important gap of about 1.5 to 2 years. In addition, this gap was not closed but even widened until 2010. This change was probably motivated by the fall of Communism and the subsequent transition period in these countries.

One can also look at these data in another way. The notion of the technological frontier has been very important in the growth literature (e.g., Vandebussche et al 2006). The same idea can be applied to human capital. If we consider the leader of human capital (i.e. the West) as marking the frontier of human capital, we can calculate the simple

distance of other regions to this frontier (using total years of schooling). Taking this perspective, it becomes clear that notably between 1870 and 1910 the gap remained rather stagnant and very wide between the West and “the Rest”. Only Korea and Japan exhibit important progress. Afterwards all countries show to quite different extents convergence to the human capital frontier but (apart from Korea-Japan) all countries are still quite far away.

Thus, all the indicators employed in this analysis illustrate a move from relatively low human capital levels to much higher levels during the last two hundred years. In schooling, this transition has taken place in all regions between 1870 and 2010. The West had already relatively high schooling levels in the second part of the nineteenth century (so that one needs to go back to the early nineteenth century to see the entire trend) but these levels are still very low compared to contemporary current levels. The human capital transition is a phenomenon of the last two hundred years, and the state has been playing an important role in this transition.



Source: Morriison and Murtin (2013).

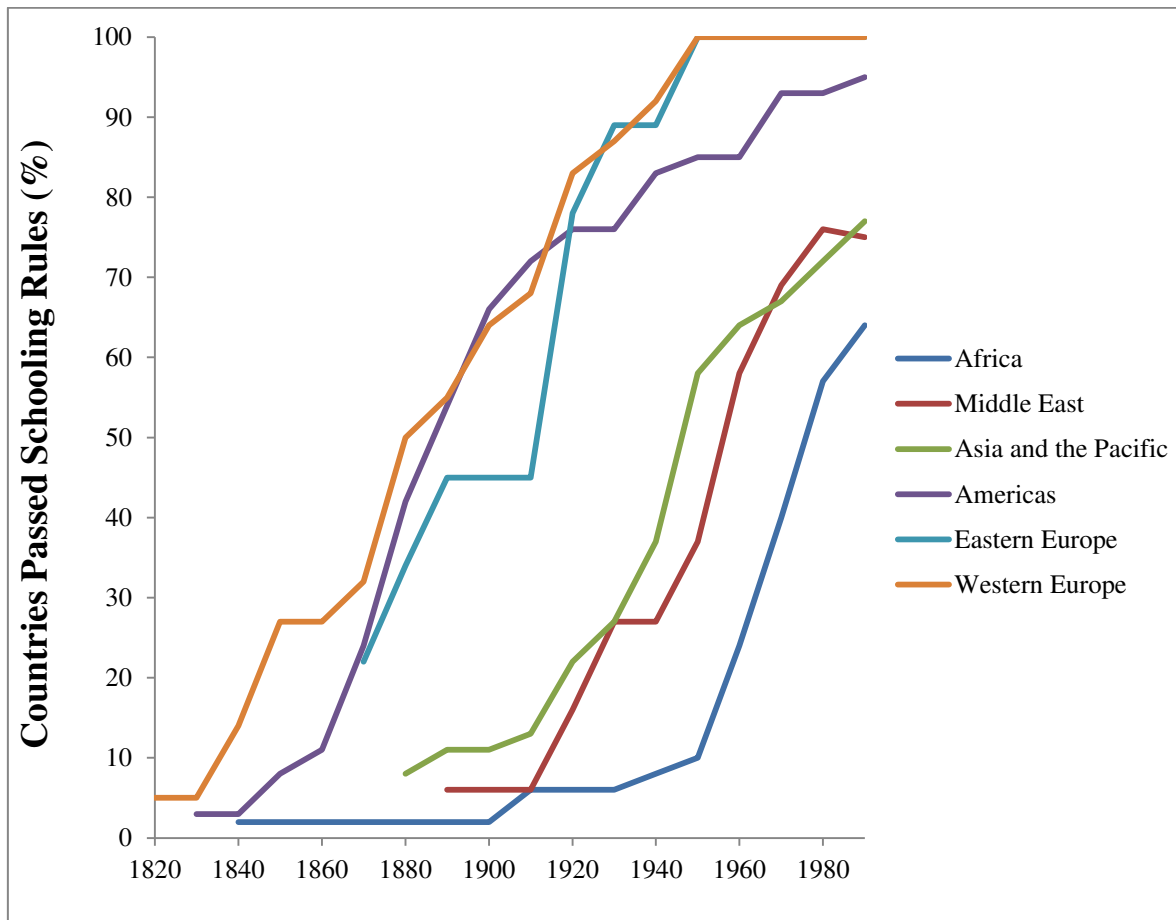
**Figure 10. Evolution of total years of schooling in world regions, 1870-2010**

## 8.2 Human capital and the state

The involvement of the state in the transition from low mass levels of education to high levels becomes evident when considering different indicators. Passing compulsory schooling rules is one clear sign that a state intends – at least symbolically – to improve its educational levels. Figure 11 shows the evolution of the cumulative share of countries in a world region that have passed compulsory schooling rules. Western Europe appears to be the leader in state laws on education, achieving a rate of around 50% by 1880. It is followed by the Americas and Eastern Europe, both culturally linked to the leaders. Asia and the Pacific were the next to follow slowly. The Middle East began its major involvement in state education even later from the 1910s onwards. Both regions show a parallel spectacular growth between the 1930s and the 1950s with a lead of one decade for the Asia and the Pacific region. Progress was less striking from then onwards. In Africa, the turning point came with the 1950s and the period of decolonisation. Afterwards, similar levels as in the former two regions were almost reached. Accordingly, Ramirez and Boli-Bennett (1982) argue that there is an acceleration phenomenon, i.e. there is a correlation between the date of independence of a country and the time to pass compulsory schooling: the younger a country is, the faster it passes compulsory schooling laws (Adick 2003). Overall, the transition from almost non-existing official legal involvement in compulsory schooling to almost universal compulsory schooling in many parts of the world is very clear.

We can also consider another indicator related to state involvement. It is the cumulative share of countries within a world region that have created a central education authority (Ramirez and Vestransca 1992). In some respects this indicator shows similar trends. Western Europe leads in this area until the 1870s, the Americas (and probably Eastern Europe) lag behind. The Middle East and Asia and the Pacific follow and finally Africa dramatically increases its share of countries with central education authorities after decolonisation. Thus, all major world regions had almost universally central education authorities by the 1990s – except Western Europe. Indeed, this is in striking contrast to Western Europe where compulsory schooling laws and centralised state control has been contested for the last 200 years. Still in the 1990s, it was not implemented in a sizable share of countries. In contrast, the idea of a central education authority has been deemed to be necessary in the continents that followed Western Europe. Less resistance and more conviction of the necessity of central state policy has characterised experiences in these

continents. It highlights once again the connection between the (in part newly created) nation-states and mass schooling in these countries.



Source: Ramirez and Ventrasca (1992).

**Figure 11. Proportion of countries having passed a compulsory schooling rule, by region and decade, 1820-1990**

## 9. Conclusion

By radically reducing the use of natural capital (such as energy resources and the absorption capacity of the atmosphere) per unit of GDP produced, the expansion of the dematerialised and weightless ‘knowledge economy’ offers a potential way to generate green growth, and place the global economy on a more sustainable trajectory. With this in mind, this paper aims to better understand the market and institutional forces that led to the human capital transition in present-day industrialised nations – that is, the development of a key pillar of the ‘knowledge economy’.

To this end, it was necessary to seek to answer the following questions: What factors have driven the demand for and supply of human capital over the last thousand



years in Europe? Has there been a market failure in the formation of human capital? What role has the state and other institutions played in the provision of schooling? Why were government and the public willing to invest heavily in this public good? To better understand the forces that led to the human capital transition, this paper brought together a wealth of evidence on the history of education, and broader human capital formation, across Europe.

*One of the central features of the history of the European human capital transition has been the decline in the price of written education in the fifteenth century following the development of the Gutenberg Press and in the nineteenth century with its mechanisation. This incentivised the development of written education, and implied that traditional work skills were complemented by a broader education in literacy and numeracy, and the ensuing improvements.*

However, this narrative also seeks to emphasise, as Mitch (1992b) did, *the fundamental role demand played in driving the early human capital transition*. Early demands in transitions are often driven by ‘luxury’ services, where some consumers have a relatively high willingness to pay, creating niche markets (Fouquet 2010). In the case of education, this was associated with the demand for spiritual guidance. The initial demand to read the bible (either in Latin or, for most Europeans, in their mother tongue) was stimulated by Luther and other champions of the Reformation. In other words, capitalizing on a technological revolution, one persuasive voice (accompanied by a growing number of followers) can initiate a transformation in beliefs that stimulates an initial (immaterial) demand for one of the key sources of modern economic growth.

In time, the demand for written education stemmed from many additional sources, associated with commercial, military, industrial, parental, status, and ‘belief-formation’ factors. So, the first phase of growth in human capital levels (particularly in literacy) in the leading countries can be explained by the interplay of supply and demand. This provided a basic level of education to upper and middle classes. Mirroring this experience, the declining costs of using ICT are enabling developing countries to accelerate investment in human capital and seek to catch-up with the industrialised nations. However, if human capital transitions in developing economies unfold in a similar way to the transitions in Europe, then certain segments of the population will be left behind. That is, while probably upper and middle classes in developing economies become highly educated, a poorer segment will struggle to raise their levels of human capital. *Thus, without major efforts from government, educational and ultimately income inequality is likely to increase.*

Indeed, the second phase of the human capital transition (i.e., the spread of mass literacy and the construction of mass schooling from the nineteenth century) were particularly driven by the state. In certain cases, *shocks (e.g., wars, the loss of international competitiveness) played a key role in altering beliefs about the value of education and stimulating public investment in human capital.* For instance, Prussia's move to embrace education more forcefully was triggered by defeat in the Napoleonic wars. Similarly, industrialists in the United Kingdom at the end of the nineteenth century started to realise that their ability to keep-up with foreign competitors, particularly Germany and the USA, depended on having a well-educated workforce from which to hire.

*However, in general, the role of the state was more important in those countries that had to catch-up with the leaders.* Particularly in lagging economies in Europe, there was a market failure – in the sense that, although the social and economic benefits of higher human capital levels would have been significant, education was not provided by the private sector. The construction of state fiscal capacities (including the building up of efficient bureaucracies) and falling resistance from social elites against public educational investments were often important prerequisites for state intervention. Once the state got involved in the education sector and created a mass public schooling system, this market failure was at least partly resolved over time. Naturally, recognition of the importance of the human capital investment needed to be followed-up with effective implementation strategies and public financial support (often around 2-5% of GDP).

One reason why implementation and financial support for mass education often followed swiftly behind recognition was because, alongside religious institutions and other non-governmental organisations, the state placed a value on 'belief-formation' and the control of the provision of education. The desire for nation building implied that instilling values and cultural attributes (e.g., language), which would encourage future generations to identify with the state, was an important driver of public investment in education (see, also, Pritchett 2003). In other words, this secondary benefit of education (to government) may well have been pivotal to the second phase of the human capital transition.

When considering potential future transitions, it is important to consider the benefits that government may gain from the transition. For instance, the transition to a low carbon economy is currently hampered by institutional stagnation, despite governments having recognised the problem climate change poses (Barbier 2013). *Identifying the existence of a principal-agent problem and finding direct benefits for government might be a powerful means to incentivise government officials to develop effective implementation*

*strategies and find public financial support.* Thus, perhaps the rhetoric of green growth needs to be reformulated in terms of the benefits to government from achieving green growth.

With this objective in mind, it is important to remember that major transitions are typically long-term processes. The human capital transition (here, defined as an increase from 10% to 90% literacy rate) in Europe took roughly 400 years, from Luther's printed translation of the Bible into a European vernacular language until the First World War. In Japan and Korea, it took a little over one hundred years (from about 1850 to 1960). In South Asia and Africa, this is likely to take around one hundred years. *Thus, even in countries implementing basic education programmes today, there is a limit to how fast a transition can be achieved.* This is partly because new generations need to be educated and this takes decades.

Yet, even in the case of education, vested interests may inhibit a successful transition. *Therefore, these vested interests have to be identified and considered in any policy.* Indeed, the central state interacts with a range of stakeholders in educational policy. In particular, there are religious authorities (in Europe the Churches), elites (land owners and capitalists), parents, ideological movements (including liberals and conservatives) and the local authorities. Any of these can alter the rate and nature of the transition. On the other hand, if government has direct benefits from a transition (in addition to broader social or environmental benefits), then these vested interests are likely to be more swiftly overcome.

Having outlined the human capital transition and the role of government policy, it is valuable to consider potential avenues of future research related to this project. First, it would be useful to identify the relationship between human and natural capital. In some contexts, they can be seen as substitutes for one another. Certainly, investment in skills that enable workers to install low carbon technologies and infrastructure, whether labelled 'green jobs' or not (Bowen 2012), are likely to be substitutes for natural capital. On the other hand, it is probable that the growth in human capital levels in Europe from the end of the nineteenth century enabled the use of more complex and productive machinery that drove down the prices of goods, which in turn increased aggregate consumption of energy and other natural resources.

However, this human capital transition aided and was part of broader systemic changes, which included the adoption of new energy sources and technologies, such as electricity (Freeman and Louça 2001, Fouquet 2010). Indeed, a second avenue of research would be to link this shift from a low level 'equilibrium' to a high level 'equilibrium' in

human capital with other transitions that have taken place over the last three to five hundred years - related to knowledge (Mokyr 2002), communication (Fouquet and Hippe 2015) and energy sources and technologies (Fouquet 2010). For instance, have the trajectories and the defining characteristics of modern economies been shaped by the ability to produce large quantities of heating, power, transportation, and knowledge cheaply? Thus, a central purpose of this potential analysis would be to identify how these transitions contributed to systemic changes and what were the synergies and the implications (Freeman and Louça 2001).

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