Das Human Kapital:
A Theory of the Demise of the Class Structure

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Abstract

This paper hypothesizes that the demise of the 19th century's European class structure reflects a deliberate transformation of society orchestrated by the capitalists. Contrary to conventional wisdom, it argues that the demise of this class structure was an outcome of a cooperative, rather than divisive process. The research suggests that the transition from this class structure may be viewed as the outcome of an optimal reaction by the capitalists to the increasing importance of human capital in sustaining their profit rates. The paper argues that the process of capital accumulation gradually intensified the importance of skilled labor in the production process and generated an incentive for investment in human capital. Due to the complementarity between physical and human capital in production, the capitalists were among the prime beneficiaries of the accumulation of human capital by the masses. They therefore had the incentive to support public education that would sustain their profit rates and would improve their economic well-being, although it would ultimately undermine their dynasty's position in the social ladder. The research suggests that Karl Marx's highly influential prediction about the inevitable class struggle due to declining profit rates stemmed from an under appreciation of the role that human capital would play in the production process. The basic premise of this research, regarding the positive attitude of capitalists towards education reforms, is supported empirically by a newly constructed data set of the voting patterns on England's education reform proposed in the Balfour Act of 1902.

Keywords: Industrial Revolution, Human Capital, Growth, Class Structure, Education Reforms

JEL Classification Numbers: B10, O10, O40

"The history of society is the history of struggles between social classes"

Karl Marx

1 Introduction

During the 19th century, Europe witnessed the onset of the decline of the existing class structure, manifested by significant educational and political reforms. This research hypothesizes that, in contrast to the prevailing wisdom, the demise of the capitalists-workers class structure reflected a deliberate transformation of society orchestrated by the capitalists in reaction to the increasing importance of the human capital of workers in sustaining their profit rates. The proposed theory suggests that the accumulation of physical capital in the early stages of industrialization enhanced the importance of human capital in the production process and generated an incentive for the capitalists to support the provision of public education for the masses, planting the seeds for the demise of the existing class structure.

Existing theories about the demise of the capitalists-workers class structure focus on the role of the class struggle in this significant change. According to Marxist theory, capital accumulation and the associated decline in profit rates would intensify the degree of exploitation of workers and would bring about a class struggle between workers and capitalists that would eventually terminate the existing class society. The recent political economy literature accepts the basic Marxist premise regarding increased tension between workers and capitalists as the prime catalyst for changes in the social order. It suggests, however, that the transition in Western Europe during the 19th century is an outcome of deliberate concessions of the elite designed to avert political instability, expropriation, and possibly a revolution.[1]

The proposed theory, in contrast, suggests that the demise of the class structure was a by-product of a productive cooperation between capitalists and workers, rather than an outcome of a divisive class struggle. The theory argues that in the early stages of industrialization, when physical capital was the prime engine of economic growth, societies were marked by a stable class structure characterized by a dichotomous ownership on factors of production. Due to capital-skill

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[1] The effect of social conflict on political and educational reforms has been examined by Bowles and Gintis (1975), Grossman (1994), Grossman and Kim (1999), Acemoglu and Robinson (2000), Bourguignon and Verdier (2000), and Bertocchi and Spagat (2003), among others. They argue that reforms and redistribution from the elite to the masses diminish the tendency for socio-political instability and predation, and may therefore stimulate investment and economic growth. In particular, several studies examine the potential benefits for the elite from educational reforms. Bourguignon and Verdier (2000) suggest that if political participation is determined by the education (socioeconomic status) of citizens, the elite may not find it beneficial to subsidize universal public education despite the existence of positive externalities from human capital. Grossman and Kim (1999) argue that education decreases predation, and Bowles and Gintis (1975) suggest that educational reforms are designed to *sustain* the existing social order, by displacing social problems into the school system.

complementarity, the accumulation of physical capital by the capitalists increased the importance of human capital in sustaining the rate of return to physical capital and brought about a non-altruistic change in the attitude of capitalists towards the provision of public education for the masses.[2] The capitalists found it beneficial to support universal publicly financed education, which caused the main characteristics of the capitalists-workers class structure to gradually fade.[3] The research therefore suggests that Karl Marx's highly influential prediction about the inevitable class struggle due to declining profit rates stemmed from an under appreciation of the role that human capital would play in the production process.

The willingness of the capitalists to support universal public education rather than selective industrial education captures two of the underlying forces in the complementarity between human capital and physical capital. First, it appears that in the second phase of the Industrial Revolution the increase in basic literacy that was associated with universal primary education raised labor productivity. Second, investment in universal primary education generated a wider talent pool for advanced industrial and managerial occupations, benefiting the production process at the higher end. The utilitarian support of capitalists for universal education enhanced the participation of the working class in the process of human and physical capital accumulation, leading to a widening of the middle class and to the eventual demise of the capitalists-workers class structure.[4]

The support for public education is unanimous among workers and capitalists, despite the fact that the capitalists may carry the prime financial burden of public schooling. That is, due to the coexistence of credit market imperfections and capital-skill complementarity, the redistribution associated with public education is Pareto improving.[5] The distribution of the cost of education between workers and capitalists may differ across countries due to differences in their socio-political structure as well as their stage of development. Nevertheless, regardless of the distribution of political power in society, in light of the importance of nourishment and health for human capital

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[2]Since firms have limited incentive to invest in the general human capital of their workers, in the presence of credit market imperfections, the level of education would be suboptimal unless it would be financed publicly.

[3]The increase in inequality in mature stages of development due to skilled or ability-biased technological change that is induced by human capital accumulation (e.g., Katz and Murphy (1992), Galor and Tsiddon (1997), Acemoglu (1998), Caselli (1999), and Galor and Moav (2000)) does not reflect a reversal in the demise of the class. It is not related to class association as reflected partly by increased intergenerational mobility (e.g., Galor and Tsiddon (1997), Maoz and Moav (1999), Hassler and Rodriguez-Mora (2000)).

[4]Indeed, the second phase of the Industrial Revolution was associated with a widening middle class of white-collar workers, skilled artisans, and independent entrepreneurs (Cameron (1989, p. 213)). Moreover, the development of the middle class was encouraged by industrialists who demanded not only a more educated labor force but an intermediate class of people who could serve in managerial and marketing positions (Anderson (1975, p. 193)).

[5]This result is related to Benabou (2000), who demonstrates that when capital and insurance markets are imperfect, policies which redistribute wealth from richer to poorer individuals can have a positive net effect on aggregate output and growth. Unlike the current study in which the support for growth-enhancing redistribution via public education is unanimous, in Benabou (2000) redistributions are only supported by a wide consensus in a fairly homogeneous society but face strong opposition in an unequal one. See Benabou (2002) as well.

formation and labor supply, capitalists are unlikely to impose the prime financial burden on the working class as long as wages do not significantly exceed the subsistence level of consumption.

This research develops a growth theory that captures the emergence of human capital accumulation as a prime engine of economic growth in the transition of the currently advanced economies from the Industrial Revolution to modern growth. It demonstrates that the utilitarian support of capitalists for the provision of universal public education was instrumental to the rapid formation of human capital and was therefore a catalyst, and possibly even a necessary condition, for the demise of the class society.

The theory is based on three central elements. First, the economy is characterized by capital-skill complementarity.[6] Capitalists therefore benefit from the aggregate accumulation of human capital in society. Second, human capital is inherently embodied in individuals and its accumulation is subjected to decreasing marginal returns at the individual level. The aggregate stock of human capital, therefore, would be larger if its accumulation would be widely spread among individuals in society. Capitalists therefore benefit from a universal provision of education. Third, in the absence of public education, investment in human capital is suboptimal due to borrowing constraints. Public education therefore enhances investment in human capital by the masses, and may therefore benefit the capitalists as well as the workers.[7]

Historical evidence presented in Section 2 suggests that, consistent with the proposed theory, the process of industrialization enhanced the importance of human capital in production and induced the capitalists to lobby for the provision of universal public education. Furthermore, as suggested by the theory, the acquisition of human capital by the working class in the second phase of the Industrial Revolution and the associated increase in wages, in particular relative to the return to capital, brought about a decline in inequality and fading class distinction.

The basic premise of this research, regarding the positive attitude of capitalists towards education reforms, is supported by the voting patterns on the Balfour Act of 1902 – the proposed education reform in England that marked the consolidation of a national education system and the creation of a publicly supported secondary school system. In light of the proposed theory, one would expect that variations in the support of the Ministers of Parliament (MPs) for the Balfour Act would reflect the variations in the skill intensity in the counties they represent. Higher support for the Balfour Act would be expected from MPs who represent industrial skill-intensive counties.

We constructed a data set gathered from a variety of historical sources. The data combines

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[6]See Goldin and Katz (1998) for evidence regarding capital-skill complementarity.

[7]See Galor and Zeira (1993), Benabou (1996), and Durlauf (1996) for the effect of credit market imperfections on investment in human capital and economic growth in an unequal society.

home district and party affiliation of each MP with his voting record on the Balfour Act, the percentage of employment in various agricultural and industrial sectors in the MP's county, and per-capita income, degree of urbanization, and religious affiliation in each county. The empirical analysis supports the main hypothesis. It establishes that there exists a significant positive effect of skill-intensiveness of the industrial sector in a county on the propensity of the MPs to vote in favor of the education reform proposed by the Balfour Act of 1902.

2 Historical Evidence

Historical evidence suggests that, consistent with the proposed theory, the demise of the capitalists-workers class structure reflected a deliberate transformation of society orchestrated by the capitalists in reaction to the increasing importance of the human capital of workers in sustaining their profit rates. In particular, Section 2.1 presents evidence that the process of industrialization enhanced the importance of human capital in production and induced the capitalists to lobby for the provision of universal public education. Section 2.2 provides evidence demonstrating that the acquisition of human capital by the working class in the second phase of the Industrial Revolution and the associated increase in wages, in particular relative to the return to capital, brought about a decline in inequality and fading class distinctions. Finally, Section 2.3 presents evidence that dispel an alternative hypothesis that political reforms during the 19th century shifted the balance of power towards the working class and enabled workers to implement education reforms against the will of the capitalists.

2.1 Industrial Development and Education Reforms

Evidence suggests that the experience of the Western World throughout the various phases of the Industrial Revolution is consistent with the hypothesis of this research about the link between industrial development and educational reforms. The process of industrialization was characterized by a gradual increase in the relative importance of human capital for the production process. Indeed, as stated by Abramowitz (1993 p. 224), "In the nineteenth century, technological progress was heavily biased in a physical capital-using direction...the bias shifted in an intangible (human and knowledge) capital-using direction and produced the substantial contribution of education and other intangible capital accumulation to this century productivity growth." Furthermore, as argued by Goldin (2001), "The modern concept of the wealth of nations emerged by the early twentieth century. It was that capital embodied in the people — human capital — mattered."

In the first phase of the Industrial Revolution, human capital had a limited role in the pro-

duction process. Education was motivated by a variety of reasons, such as religion, enlightenment, social control, moral conformity, socio-political stability, social and national cohesion, and military efficiency. The extensiveness of public education was therefore not necessarily correlated with industrial development and it differed across countries due to political, cultural, social, historical and institutional factors.

In the second phase of the Industrial Revolution, education reforms were designed primarily to satisfy the increasing skill requirements in the process of industrialization, reflecting the interest of capitalists in human capital formation and thus in the provision of public education. The evidence suggests that in Western Europe, the economic interests of capitalists were indeed a significant driving force behind the implementation of educational reforms.

2.1.1 England

In the first phase of the Industrial Revolution (1760-1830), consistent with the proposed hypothesis, capital accumulation increased significantly without a corresponding increase in the supply of skilled labor. The investment ratio increased from 6% in 1760 to 11.7% in the year 1831 (Crafts (1985, p. 73)). In contrast, literacy rates remained largely unchanged and the state devoted virtually no resources to raising the level of literacy of the masses. During the first stages of the Industrial Revolution, literacy was largely a cultural skill or a hierarchical symbol and had limited demand in the production process.[8] For instance, in 1841 only 4.9% of male workers and only 2.2% of female workers were in occupations in which literacy was strictly required (Mitch (1992, pp. 14-15)). During this period, an illiterate labor force could operate the existing technology, and economic growth was not impeded by educational retardation.[9] Workers developed skills primarily through on-the-job training, and child labor was highly valuable.

The development of a national public system of education in England lagged behind the continental countries by nearly half a century and the literacy rate hardly increased in the period 1750-1830 (Sanderson (1995, pp. 2-10)).[10] As argued by Green (1990, pp. 293-294), "Britain's early industrialization had occurred without direct state intervention and developed successfully, at least in its early stages, within a laissez-faire framework. Firstly, state intervention was thought un-

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[8]See Mokyr (1993, 2001).

[9]Some have argued that the low skill requirements even declined over this period. For instance, Sanderson (1995, p. 89) suggests that "One thus finds the interesting situation of an emerging economy creating a whole range of new occupations which require even less literacy and education than the old ones."

[10]For instance, in his parliamentary speech in defense of his 1837 education bill, the Whig politician, Henry Brougham, reflected upon this gap: "It cannot be doubted that some legislative effort must at length be made to remove from this country the opprobrium of having done less for education of the people than any of the more civilized nations on earth" (Green (1990, pp.10-11)).

necessary for developing technical skills, where the initial requirements were slight and adequately met by traditional means. Secondly, the very success of Britain's early industrial expansion encouraged a complacency about the importance of scientific skills and theoretical knowledge which became a liability in a later period when empirical knowledge, inventiveness and thumb methods were no longer adequate." Furthermore, as argued by Landes (1969, p. 340) "although certain workers - supervisory and office personnel in particular - must be able to read and do the elementary arithmetical operations in order to perform their duties, large share of the work of industry can be performed by illiterates as indeed it was especially in the early days of the industrial revolution." The source of Britain's industrial leadership in the 19th century was a favorable endowment of resources, whereas Britain's deficiency in the latter part of the century was a scarcity of human capital which was essential in the second phase of the Industrial Revolution (Crafts and Thomas (1986)).

England initiated a sequence of reforms in its education system since the 1830s and literacy rates gradually increased. The process was initially motivated by a variety of reasons such as religion, enlightenment, social control, moral conformity, socio-political stability, and military efficiency, as was the case in other European countries (e.g., Germany, France, Holland, Switzerland) that had supported public education much earlier.[11] However, in light of the modest demand for skills and literacy by the capitalists, the level of governmental support was rather small.[12]

In the second phase of the Industrial Revolution, consistent with the proposed hypothesis, the demand for skilled labor in the growing industrial sector markedly increased and the proportion of children aged 5 to 14 in primary schools increased from 11% in 1855 to 25% in 1870 (Flora et al. (1983)). Job advertisements, for instance, suggest that literacy became an increasingly desired characteristic for employment as of the 1850s (Mitch (1993, p. 292)). In light of the industrial competition from other countries, capitalists started to recognize the importance of technical education for the provision of skilled workers. As noted by Sanderson (1995, pp. 10-13), "reading ...enabled the efficient functioning of an urban industrial society laced with letter writing, drawing up wills, apprenticeship indentures, passing bills of exchange, and notice and advertisement reading." Moreover, manufacturers argued that: "universal education is required in order to select, from the mass of the workers, those who respond well to schooling and would make a good foreman on the shop floor" (Simon (1987, p. 104)).

As it became apparent that skills were necessary for the creation of an industrial society,

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[11]The proximity of the education acts in the UK to major wars suggests that the provision of public education was partly a compensation for the services of soldiers.

[12]Even in 1869 the government funded only one-third of school expenditure (Green, 1990, pp. 6-7).

replacing previous ideas that the acquisition of literacy would make the working classes receptive to radical and subversive ideas, consistent with the proposed theory, capitalists lobbied for the provision of public education for the masses.[13] The pure laissez-faire policy failed in developing a proper educational system and capitalists demanded government intervention in the provision of education. As James Kitson, a Leeds iron-master and advocate of technical education explained to the Select Committee on Scientific Instruction (1867-1868): "...the question is so extensive that individual manufacturers are not able to grapple with it, and if they went to immense trouble to establish schools they would be doing it in order that others may reap the benefit" (Green, 1990, p. 295).[14]

An additional turning point in the attitude of capitalists towards public education was the Paris Exhibition of 1867, where the limitations of English scientific and technical education became clearly evident. Unlike the 1851 exhibition in which England won most of the prizes, the English performance in Paris was rather poor; of the 90 classes of manufacturers, Britain dominated only in 10. Lyon Playfair, who was one of the jurors, reported that: "a singular accordance of opinion prevailed that our country has shown little inventiveness and made little progress in the peaceful arts of industry since 1862." This lack of progress "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)).[15]

In 1868, the government established the Parliamentary Select Committee on Scientific Education. This was the origin of nearly 20 years of various parliamentary investigations into the relationship between science, industry, and education, that, according to the proposed theory, were designed to address the capitalists' outcry about the necessity of universal public education. A sequence of reports by the committee in 1868, The Royal Commission on Scientific Instruction and the Advancement of Science during the period 1872-75, and by The Royal Commission on Technical Education in 1882, underlined the inadequate training for supervisors, managers and proprietors, as well as workers. They argued that most managers and proprietors do not understand the manufacturing process and thus, fail to promote efficiency, investigate innovative techniques or value the skills of their workers (Green (1990, pp. 297-298)). In particular, W. E. Forster, the Vice

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[13]As hypothesized in this paper, there was a growing consensus among workers and capitalists about the virtues of reform. The labor union movement was increasingly calling for a national system of non-sectarian education. The National Education League (founded in 1869 by radical Liberals and Dissenters) demanded a free, compulsory, non-sectarian national system of education (Green, 1990, p. 302).

[14]Indeed, the Factory Act of 1802 required owners of textile mills to provide elementary instruction for their apprentices, but the law was poorly enforced (Cameron (1989, p. 216-217)).

[15]Moreover, the Nussey brothers, who had written a report on woolen textiles at the Exhibition, returned to Leeds to start a movement for a Yorkshire College of Science.

President of the committee of the Council of Education told The House of Commons: "Upon 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, pp. 223-224)). The reports made various recommendations which highlighted the need to redefine elementary schools, to revise the curriculum throughout the entire school system, particularly with respect to industry and manufacture, and the improve teacher training.

In addition, in 1868, secondary schools were investigated by the Schools Inquiry Commission, which found a very unsatisfactory level for the vast majority of schools that employed untrained teachers and used antiquated methods. Their main proposal was to organize a state inspection of secondary schools and to provide efficient education geared towards the specific needs of its consumers. In particular, The Royal Commission on Technical Education of 1882 confirmed that England was being overtaken by the industrial superiority of Prussia, France and the United States and recommended the introduction of technical and scientific education into secondary schools.

As argued in the proposed theory, it appears that the government gradually yielded to the pressure by capitalists as well as labor unions, as reflected by its increased contributions to elementary as well as higher education. In the 1870 Education Act, the government assumed responsibility for ensuring universal elementary education, although it did not provide either free or compulsory education at the elementary level. The Act created a national provision without an integrated system, where voluntary schools existed beside state schools. In 1880, prior to the significant extension of the franchise of 1884 that made the working class the majority in most industrial counties, education was made compulsory throughout England. The 1889 Technical Instruction Act allowed the new local councils to set up technical instruction committees, and the 1890 Local Taxation Act provided public funds that could be spent on technical education (Green, 1990, p. 299).

School enrollment of 10-year-olds increased from 40% in 1870 to 100% in 1900, the literacy rate among men, which was stable at around 65% in the first phase of the Industrial Revolution, increased significantly during the second phase reaching nearly 100% at the end of the 19th century (Clark (2002)), and the proportion of children aged 5 to 14 in primary schools increased significantly in the second half of the 19th century, from 11% in 1855 to 74% in 1900 (Flora et al. (1983)). Finally, the 1902 Balfour Act marked the consolidation of a national education system and created state secondary schools (Ringer (1979) and Green (1990, p. 6)).[16] Furthermore, science and

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[16]The English secondary institutions were initially financially independent from the state and their recruitment was more socially exclusive than in other countries in Europe. Children from the upper middle class, professional, business and commercial backgrounds dominated secondary schools. However, they often included lower middle class

its application in technology gained prominence (Mokyr (1990, 2002)). New universities were established in Manchester, Birmingham, Leeds, Sheffield, Newcastle, Bristol, and London with a strong emphasis on professional training in the medical, legal, engineering and economic studies neglected at Oxford and Cambridge, and science schools were established and financed through the Department of Science (Sanderson (1995, p. 47)).

2.1.2 Continental Europe

The early development of public education occurred in the western countries of continental Europe (e.g., Prussia, France, Sweden, and the Netherlands) well before the Industrial Revolution. The process was motivated by a variety of reasons, such as religion, enlightenment, social control, moral conformity, socio-political stability, social and national cohesion, and military efficiency. However, as was the case in England, massive educational reforms occurred in the second half of the 19th century due to the rising demand for skills in the process of industrialization. As noted by Green (1990, pp. 293-294) "In continental Europe industrialization occurred under the tutelage of the state and began its accelerated development later when techniques were already becoming more scientific; technical and scientific education had been vigorously promoted from the center as an essential adjunct of economic growth and one that was recognized to be indispensable for countries which wished to close Britain's industrial lead."

In France, indeed, the initial development of the education system occurred well before the Industrial Revolution, but the process was intensified and transformed to satisfy industrial needs in the second phase of the Industrial Revolution. The early development of elementary and secondary education in the 17th and 18th centuries was dominated by the church and religious orders. Some state intervention in technical and vocational training was designed to reinforce development in commerce, manufacturing and military efficiency. After the French Revolution, the state established universal primary schools. Nevertheless, enrolment rates remained rather low. The state concentrated on the development of secondary and higher education with the objective of producing an effective elite to operate the military and governmental apparatus. Secondary education remained highly selective, offering general and technical instruction largely to the middle class (Green (1990, pp. 135-137 and 141-142)). Legislative proposals during the National Convention quoted by Cubberley (1920, pp. 514-517) are revealing about the underlying motives for education in this period: "...Children of all classes were to receive that first education, physical, moral and intellectual, the best adapted to develop in them republican manners, patriotism, and the love of

and artisan families. (Green, 1990, p.20).

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labor...They are to be taken into the fields and workshops where they may see agricultural and mechanical operations going on..."

The process of industrialization in France and the associated increase in the demand for skilled labor, as well as the breakdown of the traditional apprenticeship system, significantly affected the attitude towards education. State grants for primary schools were gradually increased in the 1830s and legislation made an attempt to provide primary education in all regions, extend the higher education, and provide teacher training and school inspections. The number of communities without schools fell by 50% from 1837 to 1850 and as the influence of industrialists on the structure of education intensified, education became more stratified according to occupational patterns (Anbderson (1975 p. 15, 31)). According to Green (1990, p.157): "[This] legislation...reflected the economic development of the period and thus the increasing need for skilled labor." The eagerness of capitalists for rapid education reforms was reflected by the organization of industrial societies that financed schools specializing in chemistry, design, mechanical weaving, spinning, and commerce (Anderson (1975, p 86, 204)).

As was the case in England, industrial competition led industrialists to lobby for the provision of public education. The Great Exhibition of 1851 and the London Exhibition of 1862 created the impression that the technological gap between France and other European nations was narrowing and that French manufacturers ought to invest in the education of their labor force to maintain their technological superiority. Subsequently, the reports on industrial education by commissions established in the years 1862 to 1865 reflected the plea of industrialists for the provision of industrial education on a large scale and for the implementation of scientific knowledge in the industry. "The goal of modern education...can no longer be to form men of letters, idle admirers of the past, but men of science, builders of the present, initiators of the future."[17] (Anderson (1975, p. 194)).

Education reforms in France were extensive in the second phase of the Industrial Revolution, and by 1881 a universal, free, compulsory and secular primary school system had been established and technical and scientific education further emphasized. Illiteracy rates among conscripts tested at the age of 20 declined gradually from 38% in 1851-55 to 17% in 1876-80 (Anderson (1975, p. 158)), and the proportion of children aged 5 to 14 in primary schools increased from 51.5% in 1850 to 86% in 1901 (Flora et al. (1983)). Hence, consistent with the proposed theory, the process of industrialization, and the increase in the demand for skilled labor in the production process, led industrialists to support the provision of universal education, contributing to the extensiveness of education as well as to its focus on industrial needs.

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[17]L'Enseignement professionnel, ii (1864), p. 332, quoted in Anderson (1975).

In Prussia, as well, the initial steps towards compulsory education took place at the beginning of the 18th century well before the Industrial Revolution. Education was viewed at this stage primarily as a method to unify the state. In the second part of the 18th century, education was made compulsory for all children aged 5 to 13. Nevertheless, these regulations were not strictly enforced due to the lack of funding associated with the difficulty of taxing landlords for this purpose, and due to the loss of income from child labor. At the beginning of the 19th century, motivated by the need for national cohesion, military efficiency, and trained bureaucrats, the education system was further reformed, establishing provincial and district school boards, making education a secular activity and compulsory for a three-year period, and reconstituting the Gymnasium as a state institution providing nine years of education for the elite (Cubberly (1920) and Green (1990)).

The process of industrialization in Prussia and the associated increase in the demand for skilled labor led to significant pressure for educational reforms and thereby to the implementation of universal elementary schooling. Taxes were imposed to finance the school system and teacher training and certification were established. Secondary schools started to serve industrial needs as well, and the Realschulen, which emphasized the teaching of mathematics and science, was gradually adopted, and vocational and trade schools were founded. Total enrolment in secondary school increased sixfold from 1870 to 1911 (Flora et al. (1983)). "School courses...had the function of converting the occupational requirements of public administration, commerce and industry into educational qualifications..." (Muller (1987, pp. 23-24)). Furthermore, the Industrial Revolution significantly affected the nature of education in German universities. German industrialists who perceived advanced technology as the competitive edge that could boost German industry, lobbied for reforms in the operation of universities, and offered to pay to reshape their activities so as to favor their interest in technological training and industrial applications of basic research (McClelland (1980, p. 300-301)).

The structure of education in the Netherlands also reflected the interest of capitalists in the skill formation of the masses. In particular, as early as the 1830s, industrial schools were established and funded by private organizations, representing industrialists and entrepreneurs. Ultimately, in the latter part of the 19th century, the state, urged by industrialists and entrepreneurs, started to support these schools (Wolthuis (1999, pp. 92-93, 119, 139-140, 168, 171-172)).

2.1.3 United States

The process of industrialization in the US also increased the importance of human capital in the production process. Evidence provided by Abramowitz and David (2000) and Goldin and Katz (2001) suggests that over the period 1890-1999, the contribution of human capital accumulation to the growth process of the United States nearly doubled.[18] As argued by Goldin (1999), the rise of the industrial, business and commerce sectors in the late 19th and early 20th centuries increased the demand for managers, clerical workers, and educated sales personnel who were trained in accounting, typing, shorthand, algebra, and commerce. Furthermore, in the late 1910s, technologically advanced industries demanded blue-collar craft workers who were trained in geometry, algebra, chemistry, mechanical drawing, etc. The structure of education was transformed in response to industrial development and the increasing importance of human capital in the production process, and American high schools adapted to the needs of the modern workplace of the early 20th century. Total enrolment in public secondary schools increased 70-fold from 1870 to 1950.[19]

Nevertheless, due to differences in the structure of education finance in the US in comparison to European countries, capitalists in the US had only limited incentives to lobby for the provision of education and support it financially. Unlike the central role that government funding played in the provision of public education in European countries, the evolution of the education system in the US was based on local initiatives and funding. The local nature of the education initiatives in the US induced community members, in urban as well as rural areas, to play a significant role in advancing their schooling system. American capitalists, however, faced limited incentives to support the provision of education within a county in an environment where labor was mobile across counties and the benefits from educational expenditure in one county may be reaped by employers in other counties. "The impetus to expand education to the secondary level was primarily a grassroots movement led by parents, employers, and even young people themselves" (Goldin (1999)).

2.2 Schooling, Factor Prices and Inequality

The main hypothesis of this research suggests that in the first phase of the Industrial Revolution, prior to the implementation of significant education reforms, physical capital accumulation was

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[18]It should be noted that literacy rates in the US were rather high prior to this increase in the demand for skilled labor. Literacy rates among the white population were already 89% in 1870, 92% in 1890, and 95% in 1910 (Engerman and Sokoloff (2000)). Education in earlier periods was motivated by social control, moral conformity, and social and national cohesion, as well as required skills for trade and commerce. In particular, Field (1976) and Bowles and Gintis (1975) argue that educational reforms are designed to *sustain* the existing social order, by displacing social problems into the school system.

[19]See Kurian (1994).

the prime engine of economic growth and the concentration of capital among the capitalist class widened wealth inequality. Once education reforms were implemented, however, the significant increase in the return to labor relative to capital, as well as the significant increase in the real return to labor and the associated accumulation of assets by the workers, brought about a decline in inequality and eventually the demise of the European 19th century class structure.[20]

The theory predicts that in the first phase of the Industrial Revolution, prior to the implementation of education reforms, capital accumulation brought about a gradual increase in wages along with an increase in the wage-rental ratio. Education reforms in the second phase of the Industrial Revolution are predicted to generate a sharp increase in real wages along with a sharp increase in the wage-rental ratio. Finally, wealth inequality is predicted to widen in the first phase of the Industrial Revolution and to reverse its course in the second phase, once significant education reforms have been implemented.

Indeed, evidence from the UK supports this hypothesis. As documented by Willimason (1985) and depicted in Figure 1(b) for the time period 1823-1915, wealth inequality in the UK reached a peak around 1870 and declined thereafter, in close association with the patterns of enrolment rates and factor prices, depicted in Figures 1(a), 1(c) and 1(d).[21] It appears that the decline in inequality is indeed associated with the significant changes that occurred around 1870 in the relative returns to the main factors of production possessed by capitalists and workers. As depicted in Figures 1(c) and 1(d), based on the data set of Clark (2002, 2003),[22] real wages as well as the wage-rental ratio increase dramatically as of 1870.[23] These changes in factor prices reflect the increase in enrolment rates – in particular the process of education reforms from 1830 to 1870 and its consolidation in the Education Act of 1870 – and its delayed effect on the skill level per worker.[24]

Similar patterns of the effect of education on factor prices and therefore on inequality are

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[20]A similar prediction would emerge if an increase in labor augmenting technological progress would take place and would thereby raise the relative return to labor, bring about a decline in inequality. However, as discussed in the case of the UK, this is inconsistent with the contribution of TFP growth for output growth over this period.

[21]It should be noted that the return to capital increased moderately over this period, despite the increase in the supply of capital, reflecting technological progress, population growth, and accumulation of human capital.

[22]Clark (2003) constructs three series for wages in England over this period. Farm wage, Helper Wage, and Craftsmen Wage. Figures 1(c) and 1(d) are based on Helper wage. Nearly identical time path will emerge if wages of Craftsmen will be used instead of wages of Helper. Farm wage appears less relevant given the focus of the paper.

[23]Stokey (2001)'s quantitative study attributes about half of the rise in real wage over the period 1780-1850 to the forces of international trade. Moreover, technological change in manufacturing was 3 times as important as technological change in the energy sector in contributing to output growth.

[24]Throughout the period 1873-1913 in which real wages increase significantly, the growth rate of output per capita is explained entirely by the contributions of physical and human capital accumulation. Thus, TFP growth is zero over this period, depicting a marked decline over a 0.6% annual TFP growth in the period 1856-1873. (Mattews et al. (1982)). An increase in labor-augmenting technological change is therefore not a viable explanation for relative and absolute increases in real wages and the decline in inequality in the UK over this period.

observed in France as well. As argued by Morrisson and Snyder (2000), wealth inequality in France increased during the first half of the 19th century, and as depicted in Figure 2(b), started to decline in the last decades of the 19th century in close association with the patterns of enrolment rates and factor prices, depicted in Figures 2(a), 2(c) and 2(d). The decline in inequality in France appears to be associated with the significant changes in the relative returns to the main factors of production possessed by capitalists and workers in the second part of the 19th century. As depicted in Figures 2(c) and 2(d), based on the data presented in Levy-Leboyer and Bourguignon (1990), real wages as well as the wage-rental ratio increase significantly as of 1860, reflecting the effect of the increase in enrolment rates on the skill level per worker.

The German experience is consistent with this pattern as well. Inequality in Germany peaked towards the end of the 19th century (Morrisson and Snyder (2000)) in association with a significant increase in the real wages and in the wage-rental ratio from the 1880s (Spree (1977) and Berghahn (1994)), which is in turn related to the provision of industrial education in the second half of the 19th century.

The link between the expansion of education and the reduction in inequality is present in the US as well. Wealth inequality in the US, which increased gradually from colonial times until the second half of the 19th century, reversed its course at the turn of the century and maintained its declining pattern during the first half of the 20th century (Lindert and Williamson (1976)). As argued by Goldin (2001), the emergence of the "new economy" in the early 20th century increased the demand for educated workers. The creation of publicly funded mass modern secondary schools from 1910 to 1940 provided general and practical education, contributed to workers productivity and opened the gates for college education. This expansion facilitated social and geographic mobility and generated a large decrease in inequality in economic outcomes.

2.3 The Timing of Educational and Political Reforms

This research argues that education reforms were initiated by the capitalists in reaction to the increasing importance of human capital in sustaining their profit rates. An alternative hypothesis may be that political reforms during the 19th century shifted the balance of power towards the working class, and enabled workers to implement education reforms against the will of the elite.[25] The evidence, however, does not support this alternative hypothesis.

Education reforms took place in autocratic states that did not relinquish political power throughout the 19th century, and major reforms occurred in societies in the midst of the process of

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[25]See for instance, Acemoglu and Robinson (2000), where the extension of the franchise during the 19th century is viewed as a commitment devise ensuring future income redistribution from the elite to the masses.

democratization well before the stage at which the working class constituted the majority among the voters.

In particular, the most significant education reforms in the UK were completed before the voting majority shifted to the working class. The patterns of education and political reforms in the UK during the 19th century are depicted in Figure 3(a). The Reform Act of 1832 nearly doubled the total electorate, but nevertheless only 13% of the voting-age population were enfranchised. The artisans, the working classes, and some sections of the lower middle classes remained outside of the political system. The franchise was extended further in the Reform Acts of 1867 and 1884 and the total electorate nearly doubled in each of these episodes. However, working-class voters did not become the majority in all urban counties until 1884 (Craig (1989)).

The onset of England's education reforms, and in particular, the fundamental Education Act of 1870 and its major extension in 1880 occurred prior to the political reforms of 1884 that made the working class the majority in most counties. As depicted in Figure 3(a), a trend of significant increase in primary education was established well before the extension of the franchise in the context of the 1867 and 1884 Reform Acts. In particular, the proportion of children aged 5 to 14 in primary schools increased five-fold (and surpassed 50%) over the three decades prior to the qualitative extension of the franchise in 1884 in which the working class was granted a majority in all urban counties. Furthermore, the political reforms do not appear to have any effect on the pattern of education reform. In fact, the average growth rate of education attendance from decade to decade over the period 1855 to 1920 reaches a peak at around the Reform Act of 1884 and starts declining thereafter. It is interesting to note, however, that the abolishment of education fees in nearly all elementary schools occurs only in 1891, after the Reform Act of 1884, suggesting that the political power of the working class may have affected the distribution of education cost across the population, but consistent with the proposed thesis, the decision to educate the masses was taken independently of the political power of the working class.

In France, as well, the expanding pattern of education preceded the major political reform that gave the voting majority to the working class. The patterns of education and political reforms in France during the 19th century are depicted in Figure 3(b). Prior to 1848, restrictions limited the electorate to less than 2.5% of the voting-age population. The 1848 revolution led to the introduction of nearly universal voting rights for males. Nevertheless, the proportion of children aged 5 to 14 in primary schools doubled (and exceeded 50%) over the two decades prior to the qualitative extension of the franchise in 1848 in which the working class was granted a majority among voters. Furthermore, the political reforms of 1848 do not appear to have any effect on the

pattern of education expansion.

A similar pattern occurs in other European countries. Political reforms in the Netherlands did not affect the trend of education expansion and the proportion of children aged 5 to 14 in primary schools exceeded 60% well before the major political reforms of 1887 and 1897. Similarly, the trends of political and education reforms in Sweden, Italy, Norway, Prussia and Russia do not lend credence to the alternative hypothesis.

3   The Basic Structure of the Model

Consider a closed overlapping-generations economy in a process of development. In every period the economy produces a single homogeneous good that can be used for consumption and investment. The good is produced using physical capital and human capital. Output per-capita grows over time due to the accumulation of these factors of production.[26] The stock of physical capital in every period is the output produced in the preceding period net of consumption and human capital investment, whereas the stock of human capital in every period is determined by the aggregate level of public education in the preceding period.[27]

3.1   Production of Final Output

Production occurs within a period according to a neoclassical, constant-returns-to-scale, production technology. The output produced at time t, Y_t, is

$$Y_t = F(K_t, H_t) \equiv H_t f(k_t) = A H_t k_t^{\alpha}; \quad k_t \equiv K_t / H_t; \quad \alpha \in (0, 1), \tag{1}$$

where K_t and H_t are the quantities of physical capital and human capital (measured in efficiency units) employed in production at time t, and A is the level of technology.[28] The production function, $f(k_t)$, is therefore strictly monotonic increasing, strictly concave satisfying the neoclassical boundary conditions that assure the existence of an interior solution to the producers' profit-maximization problem.

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[26]Earlier growth models that focus on the role of physical and human capital in the process of development include, for instance, Lucas (1988), Caballe and Santos (1993) and Mulligan and Sala-i-Martin (1993). These models abstract from the analysis of income heterogeneity and credit market imperfections, and therefore, do not study the incentives of the rich to subsidize the education of the poor.

[27]The model abstracts from international factor movements. Land abundance in America have generated incentives for outflow of labor from Europe to America, intensifying the problem of labor scarcity and preventing the use of labor inflow (rather than investment in human capital) as a remedy for labor scarcity. In contrast, as argued by Taylor (1999) and ORourke, Taylor and Williamson (1996), international capital outflow from Britain was significant during the 19th century and hence could alleviate some of the need to invest in human capital in order to sustain the profit rates.

[28]The abstraction from technological change is merely a simplifying assumption. As will become apparent, the introduction of endogenous technological change would not affect the qualitative results. It should be noted, however, that this simplification is consistent with empirical evidence suggesting that TFP growth over the relevant period for this study is negligible and output growth is based primarily on factor accumulation.

Producers operate in a perfectly competitive environment. Given the wage rate per efficiency unit of labor, w_t, and the rate of return to capital, r_t , producers in period t choose the level of employment of capital, K_t, and efficiency units of labor, H_t, so as to maximize profits. That is, $\{K_t, H_t\} = \arg\max [H_t f(k_t) - w_t H_t - r_t K_t]$. The producers' inverse demand for factors of production is therefore

$$
\begin{aligned}
r_t &= f'(k_t) = \alpha A k_t^{\alpha-1} \equiv r(k_t); \\
w_t &= f(k_t) - f'(k_t)k_t = (1-\alpha)A k_t^{\alpha} \equiv w(k_t).
\end{aligned}
\tag{2}
$$

3.2 Individuals

In every period a generation which consists of a continuum of individuals of measure 1 is born. Each individual has a single parent and a single child. Individuals, within as well as across generations, are identical in their preferences and innate abilities. They may differ, however, in their family wealth and thus, due to borrowing constraints, in their capability to finance investment in human capital in the absence of public education.

Individuals live for two periods. In the first period of their lives individuals devote their entire time for the acquisition of human capital. The acquired level of human capital increases if their time investment is supplemented with capital investment in education. In the second period of their lives, individuals supply their efficiency units of labor and allocate the resulting wage income, along with their interest income, between consumption and transfers to their children.

An individual i born in period t (a member i of generation t) receives a parental transfer, b_t^i, in the first period of life. A fraction $\tau_t \geq 0$ of this capital transfer is collected by the government in order to finance public education, whereas a fraction $1 - \tau_t$ is saved for future consumption. Individuals devote their first period for the acquisition of human capital. Education is provided publicly free of charge.[29] The acquired level of human capital increases with the real resources invested in public education. The number of efficiency units of labor of each member of generation t in period $t + 1$, h_{t+1}, is a strictly increasing, strictly concave function of the government real expenditure on education per member of generation t, e_t.[30]

$$
h_{t+1} = h(e_t),
\tag{3}
$$

---

[29]As will become apparent, once the level of public education is chosen, individuals have no incentive to acquire private education. In particular, in early stages of development, when the tax rate τ_t equals zero, individuals do not acquire education.

[30]A more realistic formulation would link the cost of education to (teacher's) wages, which may vary in the process of development. For instance, $h_{t+1} = h(e_t/w_t)$ implies that the cost of education is a function of the number of efficiency units of teachers that are used in the education of each individual i. As can be derived from section 2.4, under both formulations the optimal expenditure on education, e_t, is an increasing function of the capital-labor ratio in the economy, and the qualitative results are therefore identical.

where $h(0) = 1$, $h'(0) = \gamma < \infty$, and $\lim_{e_t \to \infty} h'(e_t) = 0$. The assumption that the slope of the production function of human capital is finite at the origin along with the assumption that each individual has a minimal level of human capital, $h(0) > 0$, even in the absence of a real expenditure on education, assure that under some market conditions investment in human capital is not optimal.[31]

In the second period life, a member i of generation t supplies the acquired efficiency units of labor, h_{t+1}, at the competitive market wage, w_{t+1}. In addition, the individual receives the gross return on savings, $(1 - \tau_t)b_t^i R_{t+1}$. The individual's second period income, I_{t+1}^i, is therefore

$$I_{t+1}^i = w_{t+1}h(e_t) + (1 - \tau_t)b_t^i R_{t+1}, \tag{4}$$

where due to complete capital depreciation $R_{t+1} \equiv r_{t+1} \equiv R(k_{t+1})$.

Preferences of a member i of generation t are defined over second period consumption, c_{t+1}^i, and the transfer to their offspring, b_{t+1}^i.[32] They are represented by a non-homothetic, log-linear utility function that generates the property that the average propensity to bequest is an increasing function of wealth:[33]

$$u_t^i = (1 - \beta) \log c_{t+1}^i + \beta \log(\overline{\theta} + b_{t+1}^i), \tag{5}$$

where $\beta \in (0, 1)$ and $\overline{\theta} > 0$.[34]

Hence, a member i of generation t allocates second period income between consumption, c_{t+1}^i, and transfers to the offspring, b_{t+1}^i. That is,

$$c_{t+1}^i + b_{t+1}^i \leq I_{t+1}^i. \tag{6}$$

[31]These assumptions are necessary in order to assure that in the early stage of development the sole engine of growth is physical capital accumulation and there is no incentive to invest in human capital. It permits, therefore, a sharp presentation of the results regarding institutional transition. The typically assumed Inada condition (i.e., γ is infinite) is designed to simplify the exposition by avoiding a corner solution, but it is not a realistic assumption.

[32]For simplicity we abstract from first period consumption. It may be viewed as part of the consumption of the parent.

[33]This utility function represent preferences under which the saving rate is an increasing function of wealth. This classical feature (e.g., Keynes (1920), Lewis (1954), Kaldor (1957)) is consistent with empirical evidence. Dynan, Skinner and Zeldes (2000) find a strong positive relationship between personal saving rates and lifetime income in the United States. They argue that their findings are consistent with models in which precautionary saving and bequest motives drive variations in saving rates across income groups. Furthermore, Tomes (1981) and Menchik and David (1983) find evidence that the marginal propensity to bequeath increases with wealth. The choice of a non-homothetic utility function is necessary to assure that Workers do not invest in physical capital prior to the establishment of public schooling – a feature that has no qualitative bearing, but sharpens the presentation of the results. A choice of a homothetic utility function would not affect the results regarding the effect of capital skill-complementarity on institutional transition, but it would imply that the demise of the class structure would have necessarily occurred even in the absence of education reforms. Nevertheless, even under homothetic preferences, educational reforms would have a significant role in expediting the process.

[34]This form of altruistic bequest motive (i.e., the "joy of giving") is the common form in the recent literature on income distribution and growth. It is supported empirically by Altonji, Hayashi and Kotlikoff (1997). Utility from after tax transfers would reduce intergenerational transfers but would not affect the qualitative results. In particular, under utility from net transfers equation (7) below would be

$$b_{t+1}^i = b(I_{t+1}^i, \tau_{t+1}) \equiv \begin{cases} \beta(I_{t+1}^i - \theta/(1 - \tau_{t+1})) & if \quad I_{t+1}^i > \theta/(1 - \tau_{t+1}); \\ 0 & if \quad I_{t+1}^i \leq \theta/(1 - \tau_{t+1}), \end{cases}$$

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The individual chooses the level of second period consumption, c_{t+1}^i, and a non-negative transfer to the offspring, b_{t+1}^i, so as to maximize the utility function subject to the second period budget constraint (6).[35]

Hence the optimal transfer of a member i of generation t is:

$$b_{t+1}^i = b(I_{t+1}^i) \equiv \begin{cases} \beta(I_{t+1}^i - \theta) & if \quad I_{t+1}^i > \theta; \\ \\ 0 & if \quad I_{t+1}^i \leq \theta, \end{cases} \tag{7}$$

where $\theta \equiv \overline{\theta}(1-\beta)/\beta$.

3.3 Physical Capital, Human Capital, and Output

This section demonstrates that the stocks of physical and human capital and therefore the level of output are determined by the aggregate level of intergenerational transfers, the level of taxation, and governmental expenditure on public education, in the preceding period.

Let B_t denote the aggregate level of intergenerational transfers in period t. A fraction τ_t of this capital transfer is collected by the government in order to finance public education, whereas a fraction $1 - \tau_t$ is saved for future consumption.[36] The capital stock in period $t+1$, K_{t+1}, is therefore

$$K_{t+1} = (1 - \tau_t)B_t, \tag{8}$$

whereas the government tax revenues are $\tau_t B_t$.

Since population is normalized to 1, the education expenditure per young individual in period t, e_t, is

$$e_t = \tau_t B_t, \tag{9}$$

and the stock of human capital in period $t+1$, H_{t+1}, is therefore

$$H_{t+1} = h(e_t) = h\left(\tau_t B_t\right). \tag{10}$$

Hence, the capital-labor ratio $k_{t+1} \equiv K_{t+1}/H_{t+1}$ is

$$k_{t+1} = \frac{(1 - \tau_t)B_t}{h(\tau_t B_t)} \equiv k(\tau_t, B_t), \tag{11}$$

---

[35]It should be noted that the transfer, b_{t+1}^i, is necessarily non-negative due to the assumption that the offspring has no income in the first period of life.

[36]As will become apparent, this linear tax structure is the simplest structure that would generate the transition from a class society. It assures that the chosen level of taxation is independent of the structure of the political system. That is, independent of the distribution of political power or voting rights among members of society. Furthermore, Capitalists could have not effectively forced the poor to finance their own education due to the proximity of the income of the poor to the subsistence level of consumption and the positive effect of income of the outcome of the education process.

where $k(0, B_t) = B_t$, $\partial k(\tau_t, B_t)/\partial \tau_t < 0$, and $\partial k(\tau_t, B_t)/\partial B_t > 0$, and the output per-worker in period $t+1$ is

$$y_{t+1} = A[(1 - \tau_t)B_t]^\alpha h (\tau_t B_t)^{1-\alpha} \equiv y(\tau_t, B_t). \tag{12}$$

3.4 Optimal Taxation

This section derives the optimal tax rate and therefore the optimal expenditure on education from the viewpoint of each individual in society. It demonstrates that as long as taxation is used in order to finance public schooling, there is a consensus in society regarding the desirable tax rate. If the government would be engaged in direct transfers from the rich to the poor in addition to the provision of public schooling, then a conflict would emerge between the classes regarding the desirable tax rate. This would perhaps add some realism to but would obscure unnecessarily the focus on the role of cooperative forces in the demise of the class structure.

Given that the indirect utility function is a strictly increasing function of the individual's second period wealth, the optimal tax rate, τ_t^i, from the viewpoint of member i of generation t, (and hence the optimal expenditure on education, $e_t = \tau_t^i B_t$ from the viewpoint of this individual, given B_t) would maximize the individual's second period wealth, I_{t+1}^i.

$$\tau_t^i = \arg\max[w_{t+1}h(\tau_t^i B_t) + (1 - \tau_t^i)b_t^i R_{t+1}], \tag{13}$$

where $w_{t+1} = w(k_{t+1})$ and $R_{t+1} = R(k_{t+1})$.

As follow from (13), noting (2) and (11) the optimal tax rate from the viewpoint of a member i of generation t, τ_t^i, is given by[37]

$$\begin{aligned} w(k_{t+1})h'(\tau_t^i B_t) = R(k_{t+1}) \quad &for \quad \tau_t^i > 0; \\ w(k_{t+1})\gamma \leq R(k_{t+1}) \quad &for \quad \tau_t^i = 0, \end{aligned} \tag{14}$$

where $k_{t+1} = k(\tau_t, B_t)$. Hence, given B_t, τ_t^i is determined independently of b_t^i, and is therefore identical for all i.[38] That is $\tau_t^i = \tau_t^*$ for all i. Furthermore, there exists a unique capital-labor ratio $\widetilde{k}$, below which $\tau_t^i = 0$. That is, $R(\widetilde{k}) = w(\widetilde{k})\gamma$.

---

[37]Substituting (2) and (11) into (13),

$$\tau_t^i = \arg\max(1 - \tau_t^i)^\alpha h(\tau_t^i B_t)^{1-\alpha} B_t^\alpha [1 - \alpha + \alpha b_t^i/B_t].$$

The conditions in (14) follow from the optimization problem above, using (2).

[38]The unanimous agreement on the tax rate is a result of the linear tax rate and the unit elasticity of substitution between human and physical capital in production. Given a Cobb-Douglas production function, the shares of labor and capital are constant and wage and capital income are therefore maximized if output is maximized. If the elasticity of substitution would be larger than unity, then the poor would prefer higher taxes, whereas if the elasticity of substitution is smaller than unity, then the rich would prefer higher taxes.

Lemma 1 *(a) The optimal tax rate in period t, τ_t^*, from the viewpoint of each member of generation t is equal and uniquely determined.*

$$\tau_t^* = \tau(B_t) \begin{cases} > 0 & for \quad B_t > \widetilde{k} \\ \\ = 0 & for \quad B_t \leq \widetilde{k}; \end{cases}$$

$\widetilde{k} = \alpha/(1-\alpha)\gamma.$

(b) The optimal expenditure on public education, $e_t = \tau(B_t)B_t \equiv e(B_t)$ from the viewpoint of each member of generation t is strictly increasing for $B_t > \widetilde{k}$.

Proof. Noting (2), (11) and (14) it follows from the properties of $h(\tau_t B_t)$ that τ_t^* is uniquely determined by B_t and $e'(B_t) > 0$, where as follows from the definition of $\widetilde{k}$ and (2), $\widetilde{k} = \alpha/(1-\alpha)\gamma$. □

Hence, since the optimal tax rate in period t is identical from the viewpoint of each member of generation t, it follows that under any political structure, the chosen tax rate in period t is

$$\tau_t = \tau_t^* = \tau(B_t). \tag{15}$$

Proposition 1 *The tax rate in period t, τ_t is*

$$\tau_t \begin{cases} > 0 & for \quad k_{t+1} > \widetilde{k} \\ \\ = 0 & for \quad k_{t+1} \leq \widetilde{k}. \end{cases}$$

Proof. Since $h(0) = 1$, it follows from (11) (14) and Lemma 1 that $k_{t+1} = B_t$ for $B_t \leq \widetilde{k}$ and hence for $k_{t+1} \leq \widetilde{k}$. Thus the Proposition follows. □

Corollary 1 *The chosen level of taxation in every period maximizes output per-worker in the following period. That is,*

$$\tau_t = \arg\max y_{t+1} \equiv \arg\max y(\tau_t, B_t).$$

Proof. Maximizing $y(\tau_t, B_t)$ with respect to τ_t yield the optimality conditions given by (14). That is, the optimality conditions for the desired level of taxation from the viewpoint of each individual. □

Hence, as long as the rate of return to human capital is lower than the rate of return on physical capital (i.e., as long as $k_{t+1} \leq \widetilde{k}$) the chosen level of investment in public education is zero – the level of investment that maximizes output per-worker. Once the rate of return to human capital equals the rate of return on physical capital (i.e., once $k_{t+1} > \widetilde{k}$) the chosen investment in public education is positive and it maximizes output per-worker.

3.5 The Dynamical System

This section derives the properties of the dynamical system that governs the evolution of the economy in the transition from a class society to a classless society. It demonstrates that the evolution of the economy is fully determined by the evolution of intergenerational transfer within classes in society.

Suppose that in period 0 the economy consists of two groups of individuals in their first period of their lives - Capitalists and workers. They are identical in their preferences and differ only in their initial wealth. The Capitalists, denoted by R (Rich), are a fraction λ of all individuals in society, who equally own the entire *initial* stock of wealth. The Workers, denoted by P (Poor), are a fraction $1 - \lambda$ of all individuals in society, who have no ownership over the *initial* physical capital stock.[39] Since individuals are initially homogenous *within* a group, the uniqueness of the solution to their optimization problem assures that their offspring who acquire the same level of education and are taxed equally are homogenous as well . Hence, in every period a fraction λ of all adults are homogenous descendents of the Capitalists, denoted by members of group R, and a fraction $1 - \lambda$ are homogenous descendents of Workers, denoted by members of group P.

The optimization of groups P and R of generation $t - 1$ in period $t > 0$, determines the aggregate intergenerational transfers in period t, B_t.

$$B_t = \lambda b_t^R + (1 - \lambda)b_t^P \equiv B(b_t^R, b_t^P), \tag{16}$$

where b_t^i is the intergenerational transfer of individual i in period t; $\; i = P, R$.

Hence, as follows from (11), (15), (16), and Proposition 1

$$k_{t+1} = \frac{[1 - \tau(B_t)]B_t}{h[\tau(B_t)B_t]} \equiv \kappa(b_t^R, b_t^P), \tag{17}$$

where as follows from (2) and (14), $\partial \kappa / \partial b_t^i > 0$, $i = R, P$. Furthermore, $\kappa(0, 0) = 0$ (since in the absence of transfers and hence savings the capital stock in the subsequent period is zero).

Since members of group R equally own the entire *initial* stock of wealth in period 0 and members of group P have no ownership over the initial stock of wealth, it follows that $b_0^R > 0$ and $b_0^p = 0$. Furthermore, it is assumed that

$$b_0^R < \widetilde{k}/\lambda. \tag{A1}$$

As established in Lemma 2, and consistently with empirical evidence about the process of development, this assumption assures that in early stages of development there is no investment in public education.

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[39] As will become apparent this class distinction will dissipate over time. In particular, descendents of the working class will ultimately own some physical capital.

Lemma 2 *Under A1, $k_1 < \widetilde{k}$.*

Proof. Since $b_0^p = 0$, (11),(16) and Lemma 1, given the properties of (3), imply that $k_1 = B_0 = \lambda b_0^R$. Hence it follows from Assumption A1 that $k_1 < \widetilde{k}$. $\qquad\square$

The evolution of transfers within each group $i = R, P$, as follows from (7), is given by

$$b_{t+1}^i = \max\{\beta[w(k_{t+1})h(\tau(B_t)B_t)) + (1 - \tau(B_t))b_t^i R(k_{t+1}) - \theta], 0\}; \qquad i = R, P. \qquad (18)$$

The evolution of transfers within *each* of the two groups, as follows from the fact that $k_{t+1} = \kappa(b_t^R, b_t^P)$, and $B_t = B(b_t^R, b_t^P)$ is fully determined by the evolution of transfers within *both* types of dynasties. Namely, the dynamical

system is uniquely determined by the joint-evolution of the intergenerational transfers of Workers, P and Capitalists, R. Hence, the evolution of the economy is given by the sequence $\{b_t^P, b_t^R\}_{t=0}^\infty$ that satisfies in every period

$$
\begin{aligned}
b_{t+1}^P &= \psi^P(b_t^R, b_t^P); \\
b_{t+1}^R &= \psi^R(b_t^R, b_t^P),
\end{aligned}
\tag{19}
$$

where $b_0^p = 0$ and $b_0^R > 0$.

4 The Process of Development

This section analyzes the endogenous demise of the Capitalists-Workers class structure as the economy evolves from early to mature stages of development. As will become apparent, if additional plausible restrictions are imposed on the basic model, the economy endogenously evolves through two fundamental regimes:

- Regime I: This early stage of development, is characterized by a stable class structure. Capitalists generate a higher rate of return from a direct investment in physical capital, rather than from supporting the education of Workers that would complement their capital in the production process. Capitalists therefore have no incentive to financially support the education of the Workers.

- Regime II: These later stages of development are characterized by the onset of the gradual demise of the Capitalists-Workers class structure. The importance of human capital in sustaining the profits of Capitalists increases sufficiently. The Capitalists find it beneficial to financially support public education, and ultimately Workers, as well as Capitalists, are engaged in physical capital accumulation.

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4.1 Regime I: Physical Capital Accumulation

This early stage of development is characterized by a stable class structure. Capitalists generate a higher rate of return from a direct investment in physical capital, rather than from supporting the education of Workers that would complement their capital in the production process. Capitalists therefore have no incentive to financially support the education of the Workers.

Regime I is defined as the time interval $0 \leq t < \widetilde{t}$, where $\widetilde{t} + 1$ is the first period in which the capital labor ratio exceeds $\widetilde{k}$ (i.e., $\widetilde{t}$ is the first period in which investment in human capital takes place). In this early stage of development the capital-labor ratio in period $t + 1$, k_{t+1}, which determines the investment in public education in period t, is lower than $\widetilde{k}$. As follows from Proposition 1 and Corollary 1, the tax rate is zero, there is no public education, and both groups of individuals acquire only basic skills. That is, $H_{t+1} = h(0) = 1$.

Let $\check{k}$ be the level of the capital-labor ratio such that $w(\check{k}) = \theta$. As follows from (4), $\check{k}$ is the critical level of the capital-labor ratio in time $t+1$ below which in the absence of public investment in education in period t individuals who do not receive transfers from their parents in period t do not transfer income to their offspring in period $t + 1$. That is, $I_{t+1}^i \leq \theta$ and therefore $b_{t+1}^i = 0$.

In order to assure that investment in human capital will begin in a period where the poor do not invest in physical capital, it is assumed therefore that[40]

$$\widetilde{k} \leq \check{k}. \tag{A2}$$

As follows from (2), $\check{k} = [\theta/(1 - \alpha)A]^{1/\alpha}$. Since $\widetilde{k} = \alpha/(1 - \alpha)\gamma$, Assumption A2 implies therefore that $\gamma > (\alpha^\alpha (1 - \alpha)^{1-\alpha} A/\theta)^{1/\alpha}$.

Lemma 3 *Under Assumptions A1 and A2, there are no intergenerational transfers among workers (i.e., $b_t^P = 0$) as long as public education is not established, i.e.,*

$$b_t^P = 0 \quad for \quad 1 \leq t \leq \widetilde{t}$$

Proof. As follows from Proposition 1, the definition of $\widetilde{t}$, and Assumption A1 that assures that $\widetilde{t} > 1$, for $0 \leq t < \widetilde{t}$, there is no investment in public education and hence $h_{t+1} = 1$. Hence, since Assumption A2 implies that $k_t \leq \check{k}$ and therefore $w(k_t) \leq \theta$, it follows that $b_{t+1}^P = \max[\beta[w(k_{t+1}) - \theta], 0] = 0$ if $b_t^P = 0$. Since $b_0^P = 0$ it follows therefore that $b_t^P = 0$ for $1 \leq t \leq \widetilde{t}$. $\square$

The capital-labor ratio in period $t + 1$, as follows from (16), (17), proposition 1, and Lemma 3, is

$$k_{t+1} = \kappa(b_t^R, 0) = \lambda b_t^R \quad for \quad t \in [0, \widetilde{t}) \tag{20}$$

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[40]This assumption is designed to simplify the presentation of the results. As will become apparent, even if Assumption A2 would be violated, the Capitalists would have an incentive to support the education of Workers.

and the level of output per-worker in period $t+1$, y_{t+1}, as follows from (1) and (20), is[41]

$$y_{t+1} = A[\lambda b_t^R]^\alpha \quad \text{for} \quad t \in [0, \widetilde{t}). \tag{21}$$

The Dynamics of Output Per-Worker

The evolution of output per-worker in Regime I is driven in this regime by physical capital accumulation. The income of the Workers is not sufficiently high to permit intergenerational transfers and therefore savings, and the evolution of intergenerational transfers among Capitalists determines therefore the accumulation of physical capital and thus the growth of output per-worker over Regime I.

The evolution of the intergenerational transfers in the economy, as follows from (19) and Lemma 3, are

$$\left.\begin{array}{l} b_{t+1}^R = \psi^R(b_t^R, 0) = \max[\beta[w(\lambda b_t^R) + b_t^R R(\lambda b_t^R) - \theta], 0]; \\[2mm] b_{t+1}^P = 0, \end{array}\right\} \quad for \quad t \in [0, \widetilde{t}) \tag{22}$$

where $b_0^R > 0$ is given. Hence in Regime I the dynamical system is fully determined by the evolution of transfers across members of group R.

Hence, the evolution of the entire dynamical system in Regime I can be represented by the evolution of output per-worker. Since the aggregate income of the Capitalists (group R) is $(\lambda(1-\alpha)+\alpha)y_t$, (where α is the share of capital in total output that is fully owned by the Capitalists and $\lambda(1-\alpha)$ is the labor share

of group R), it follows from (7), (21) and (22) that the evolution of output per-worker in the time period $t \in [0, \widetilde{t})$ is

$$y_{t+1} = \max\left[A\{\beta\{[\lambda(1-\alpha)+\alpha]y_t - \lambda\theta\}\}^\alpha, 0\right] \equiv \phi^I(y_t), \quad for \quad y_t \in [0, \widetilde{y}), \tag{23}$$

where $\widetilde{y} = A\widetilde{k}^\alpha$.

In order to assure that the economy would ultimately take off from Regime I to Regime II (i.e., in order to assure that consistently with empirical evidence the process of development is marked by human capital accumulation) it is assumed that the technology is sufficiently productive. That is,

$$A > \widetilde{A} \tag{A3}$$

where $\widetilde{A}$ is the critical level of technology such that $\phi^I(\widetilde{y}) = \widetilde{y}$.[42]

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[41]Note that since the size of the population is 1, $Y_{t+1} = y_{t+1}$.

[42]As follows from (23), $\widetilde{A} = [1 + \lambda(1-\alpha)^\alpha \beta\gamma^\alpha \theta\alpha^{-\alpha}]/[\beta(\alpha + (1-\alpha)\lambda)]$. It should be noted that a sufficiently high level of A that satisfies Assumption A3 does not violate Assumption A2. An increase in A and γ^α holding their ratio unchanged, does not affect A2 and increases A relative to $\widetilde{A}$.

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Figure 4 depicts the properties of $\phi^I(y_t)$ over the interval $y_t \in (0, \widetilde{y}]$, as established in the following Lemma and Corollary..

Lemma 4 *Under Assumptions A2 and A3, there exists $\underline{y} \in (0, \widetilde{y})$; $\widetilde{y} = A\widetilde{k}^\alpha$, such that the properties of $\phi^I(y_t)$ in the interval $y_t \in [0, \widetilde{y}]$ are*

$$
\begin{array}{lll}
\phi^I(y_t) = 0 & for & y_t \leq \underline{y} \\
\partial\phi^I(y_t)/\partial y_t > 0 & for & \underline{y} < y_t \leq \widetilde{y} \\
\partial^2\phi^I(y_t)/\partial[y_t]^2 < 0 & for & \underline{y} < y_t \leq \widetilde{y} \\
\phi^I(y_t) > y_t & for & y_t = \widetilde{y}
\end{array}
$$

Proof. As follows from (23), $\phi^I(y_t) = 0$ for $y_t \leq \underline{y} = \lambda\theta/(\lambda(1-\alpha)+\alpha)$, and $\partial\phi^I(y_t)/\partial y_t > 0$, and $\partial^2\phi^I(y_t)/\partial[y_t]^2 < 0$ for $\underline{y} < y_t \leq \widetilde{y} = A\{\alpha/[(1-\alpha)\gamma]\}^\alpha$. Consistently with Assumption A2, there exist a sufficiently small γ such that $\widetilde{y} > \underline{y}$.[43] Furthermore, Assumption A3 assures that $\phi^I(y_t) > y_t$ for $y_t = \widetilde{y}$ $\square$

Corollary 2 *Under Assumptions A2 and A3, the dynamical system $\phi^I(y_t)$ has two steady-state equilibria in the interval $y_t \in [0, \widetilde{y}]$; A locally stable steady-state, $\overline{y} = 0$, and an unstable steady-state, $\overline{y}^u \in (\underline{y}, \widetilde{y})$.*

The dynamical system $\phi^I(y_t)$ has two steady-state equilibria in the interval $y_t \in [0, \widetilde{y}]$; A locally stable steady-state, $\overline{y} = 0$, and an unstable steady-state, $\overline{y}^u \in (\underline{y}, \widetilde{y})$. If $y_t < \overline{y}^u$ then output per worker contract over time and the system converges to the steady-state equilibrium $\overline{y} = 0$. If $y_t > \overline{y}^u$ then output per worker expand over the entire interval $(\overline{y}^u, \widetilde{y}]$, crossing into Regime II. Hence, in order to assure that the process of development takes off it is assumed that

$$
y_0 \in (\overline{y}^u, \widetilde{y}). \tag{A4}
$$

implying that $b_0^R \in ([\overline{y}^u/A\lambda^\alpha]^{1/\alpha}, [\widetilde{y}/A\lambda^\alpha]^{1/\alpha}) = ([\overline{y}^u/A\lambda^\alpha]^{1/\alpha}, \widetilde{k}/\lambda)$. Hence, Assumption A1 is a subset of Assumption A4.

The accumulation of physical capital by the Capitalists in Regime I raises gradually the potential role of the education of the Workers in sustaining the profit rates of the Capitalists. Ultimately, the Capitalists find it beneficial to support public education, and the economy enters into Regime II where the process of development is fueled by human capital accumulation as well as physical capital accumulation.

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[43]If $\underline{\gamma} < \gamma < \overline{\gamma}$ where $\underline{\gamma} = [\alpha^\alpha(1-\alpha)^{1-\alpha}A/\theta]^{1/\alpha} < \overline{\gamma} = [\alpha^\alpha(1-\alpha)^{1-\alpha}A/\theta+\alpha^{1+\alpha}(1-\alpha)^{-\alpha}A/\lambda\theta]^{1/\alpha}$, then Assumption A2 and $\widetilde{y} > \underline{y}$ are satisfied simultaneously. Furthermore, as discussed in the previous footnote, Assumptions A3 and $\widetilde{y} > \underline{y}$ are mutually consistent.

4.2 Regime II: Education and Decline of the Class Structure

These later stages of development are characterized by the onset of the gradual demise of the Capitalists-Workers class structure. The importance of human capital in sustaining the profits of Capitalists increases sufficiently. The Capitalists find it beneficial to financially support public education, and ultimately Workers, as well as Capitalists, are engaged in physical capital accumulation.

4.2.1 Stage I: The Birth of Public Schooling

In Stage I of Regime II, the economy witnesses the birth of public education. The Capitalists invest in human capital as well as in physical capital, whereas workers acquire education financed by the Capitalists. The wage income, however, is not sufficiently high so as to permit physical capital accumulation by the Workers.

Stage I of Regime II is defined as the time interval $\widetilde{t} \leq t < \widehat{t}$, where $\widehat{t}$ is the first time period in which Workers (group P) are engaged in intergenerational transfers, permitting physical capital accumulation by the offspring. Although workers acquire education financed by the Capitalists, their income level is not sufficiently high so as to permit transfer to their offspring.

The capital-labor ratio in period $t+1$, as follows from (16), (17), proposition 1, and Lemma 3,

$$k_{t+1} = \kappa(b_t^R, 0) = \frac{(1 - \tau_t)\lambda b_t^R}{h(\tau_t \lambda b_t^R)} \quad \text{for} \quad t \in [\widetilde{t}, \widehat{t}). \tag{24}$$

where $\partial \kappa(b_t^R, 0)/\partial b_t^R > 0$. The level of output per-worker in period $t+1$, y_{t+1}, as follows from (1) and (24), is

$$y_{t+1} = A[(1 - \tau_t)\lambda b_t^R]^\alpha [h(\tau_t \lambda b_t^R)]^{1-\alpha} \quad \text{for} \quad t \in [\widetilde{t}, \widehat{t}). \tag{25}$$

The Dynamics of Output Per-Worker

The evolution of output per-worker in Stage I of Regime II is driven by the accumulation of human capital as well as physical capital. The income of the Workers is still not sufficiently high to permit intergenerational transfers. Intergenerational transfers among the Capitalists are the sole source of physical capital accumulation, as well as of governmental expenditure on public education, and they determine therefore the growth of output per-worker over Stage I of Regime II.

The evolution of the economy in the time interval $\widetilde{t} \leq t < \widehat{t}$, as follows from (19), is given by

$$\left. \begin{array}{l} b_{t+1}^R = \psi^R(b_t^R; 0) = \beta[w(k_{t+1})h(\tau_t \lambda b_t^R) + (1 - \tau_t)b_t^R R(k_{t+1}) - \theta] \\[2mm] b_{t+1}^P = \psi^P(b_t^R; 0) = 0 \end{array} \right\} \quad for \quad t \in [\widetilde{t}, \widehat{t}), \tag{26}$$

where $k_{t+1} = \kappa(b_t^R, 0)$.

Hence, the evolution of the entire dynamical system in Stage I of Regime II can be represented by the evolution of output per-worker. Since the aggregate income of the Capitalists (group R) is $(\lambda(1-\alpha)+\alpha)y_t$, as is the case in Regime I, it follows from (7) (21) and (26) that the evolution of output per-worker in the time period $t \in [\widetilde{t}, \widehat{t})$ is,

$$y_{t+1} = A\{(1-\tau_t)\beta\{[\lambda(1-\alpha)+\alpha]y_t - \lambda\theta\}\}^\alpha\{h(\tau_t\beta\{[\lambda(1-\alpha)+\alpha]y_t - \lambda\theta\})\}^{1-\alpha}$$

$$\equiv \phi^{II}(y_t) \qquad for \qquad y_t \in [\widetilde{y}, \widehat{y}), \tag{27}$$

where $\widetilde{y} = A\widetilde{k}^\alpha$, $\tau_t = \arg\max \phi^{II}(y_t)$, and $\widehat{y} = \theta/(1-\alpha)$, is the critical level of the output per-worker such that the income level of individuals who do not receive transfer from their parents (i.e., members of group P) equals θ. As follows from (4), as long as $y_t < \widehat{y}$, the Workers (members of group P) do not transfer income to their offspring. Hence, since $\widetilde{y} = A\{\alpha/[(1-\alpha)\gamma]\}^\alpha$, it follows from assumption A2 that $\widehat{y} > \widetilde{y}$.

In order to assure that the economy would ultimately take off from Stage I to Stage II within Regime II it is assumed that the technology is sufficiently productive. That is,

$$A \geq \widehat{A} \equiv 1/\beta\alpha \tag{A5}$$

where as follows from (27) and Corollary 1, $\widehat{A}$ is a sufficiently high level of technology such that $\phi^{II}(\widehat{y}) > \widehat{y}$.[44]

If Assumption A5 is violated then there are two feasible scenarios. The economy may converge to a steady-state equilibrium in the interval $(\widetilde{y}, \widehat{y})$ with public education, where individuals are identical in their level of human capital and in their wage income, but they differ in their level of wealth. Alternatively, the economy may proceed, nevertheless, to a long-run steady-state equilibrium above $\widehat{y}$, where offspring of the Capitalists and the Workers are indistinguishable.

Figure 4 depicts the properties of $\phi^{II}(y_t)$ over the interval $y_t \in [\widetilde{y}, \widehat{y}]$, as derived in the following Lemma and Corollary.

Lemma 5 *Under Assumptions A2 and A5, the properties of $\phi^{II}(y_t)$ in the interval $y_t \in [\widetilde{y}, \widehat{y}]$ are*

$$\partial\phi^{II}(y_t)/\partial y_t > 0$$
$$\partial^2\phi^{II}(y_t)/\partial y_t^2 < 0$$
$$\phi^{II}(y_t) > y_t$$

Proof. Follows from (27), Assumptions A2 and A5, and the concavity of $h(e)$, noting that $\tau_t = \arg\max y_{t+1}$. $\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad \square$

Corollary 3 *The dynamical system $\phi^{II}(y_t)$ has no steady-state equilibria in the interval $y_t \in [\widetilde{y}, \widehat{y}]$.*

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[44]Assumptions A3 and A5 imply that $A \geq max[\widetilde{A}, \widehat{A}]$, where $\widetilde{A} < \widehat{A}$ if and only if $\gamma < (\alpha^{\alpha-1}(1-\alpha)^{1-\alpha}/\beta\theta)^{1/\alpha}$.

The dynamical system $\phi^{II}(y_t)$ has no steady-state equilibria in the interval $y_t \in [\widetilde{y}, \widehat{y}]$ and the transfers within each dynasty of type R expand over the entire interval crossing into Stage II.

Hence, in stage I of Regime II, the economy witnesses the birth of public education. The Capitalists invest in physical capital, and workers as well as the Capitalists acquire education financed by the Capitalists. The wage income, however, is not sufficiently high so as to permit physical capital accumulation by the Workers. During Stage I of Regime II, the accumulation of physical and human capital increases wage income further, and ultimately the economy enters Stage II of Regime II in which the wage income is sufficiently high so as to permit the accumulation of physical capital by the Workers.

4.2.2   Stage II: The Demise of the Class Society

The accumulation of physical and human capital during Stage I of Regime II, increases wage income further and ultimately, the economy enters Stage II of Regime II in which the wage income is sufficiently high so as to permit the accumulation of physical capital by the Workers.

Stage II of Regime II is defined as $t \geq \widehat{t}$. In this time interval all individuals acquire education and transfer income to their offspring.

The level of output per-worker in stage II of Regime II, as established in Appendix 2, exceeds $\widehat{y}$ and the wage income of members of all individuals exceeds θ. Hence, it follows from (16) and (7), that

$$B_t = \lambda b_t^R + (1 - \lambda)b_t^P = \beta[y_t - \theta]. \tag{28}$$

The capital-labor ratio in period $t + 1$, as follows from (11) and (28), is therefore

$$k_{t+1} = \frac{(1 - \tau_t)\beta[y_t - \theta]}{h(\tau_t\beta[y_t - \theta])} \quad \text{for} \quad t \in [\widehat{t}, \infty). \tag{29}$$

and the level of output per-worker in period $t + 1$, y_{t+1}, as follows from (1) and (29), is

$$y_{t+1} = A[(1 - \tau_t)\beta[y_t - \theta]]^\alpha[h(\tau_t\beta[y_t - \theta])]^{1-\alpha} \quad \text{for} \quad y_t > \widehat{y}. \tag{30}$$

The Evolution of Output Per-Worker

The evolution of output per-worker in Stage II of Regime II is driven by the accumulation of human capital as well as physical capital. The income of the Workers is sufficiently high to permit intergenerational transfers and the Workers as well as the Capitalists contribute to physical capital accumulation and governmental expenditure on public education, and they determine therefore the growth of output per-worker over Stage II of Regime II.

The evolution of output per worker in Stage II of Regime II is independent of the distribution of intergenerational transfers across classes and hence the evolution of the economy can be fully

characterized by the evolution of output per-worker. As follows from (1) and (29), the evolution of output per worker over the time interval $t > \hat{t}$ is

$$y_{t+1} = A[(1 - \tau_t)\beta[y_t - \theta]]^\alpha [h(\tau_t \beta[y_t - \theta])]^{1-\alpha} \equiv \phi^{III}(y_t) \quad \text{for} \quad y_t > \hat{y}. \tag{31}$$

where $\tau_t = \arg\max \phi^{III}(y_t)$, and therefore $\partial \phi^{III}(y_t)/\partial y_t > 0$. Furthermore, it follows from the concavity and the boundary conditions of $h(e)$ and the aggregate production function that $\partial^2 \phi^{III}(y_t)/\partial y_t^2 < 0$, and $\lim_{y_t \to \infty} \partial \phi^{III}(y_t)/\partial y_t = 0$.

Corollary 4 *Under A2-A5, output per worker y_t increases monotonically in Stage II of Regime II and converges to a steady-state equilibrium $\overline{y} > \hat{y}$.*

Proof. Follows directly from the properties of $\phi^{III}(y_t)$. □

Proposition 2 *Under A2-A5, the economy converges to a steady-state equilibrium in which the income gap between the offspring of the Capitalists and the Workers is eliminated.*

Proof. As follows from the properties of (9),(15),(28),(29) and Corollary 4, the economy converges to a unique steady-state vector $(\overline{y}, \overline{k}, \overline{\tau}, \overline{h})$. Since

$$b_{t+1}^i = \beta[w(k_{t+1})h_{t+1} + (1 - \tau_t)b_t^i R(k_{t+1}) - \theta] \quad for \quad t > \hat{t}, \qquad i = P.R \tag{32}$$

where as follows from (14) $h_{t+1} = h(k_{t+1})$ and $\tau_t = \tau(k_{t+1})$ and therefore

$$b_{t+1}^i = \zeta(b_t^i, k_{t+1}). \tag{33}$$

Hence, given $\overline{k}$ it follows that, in the steady state, $b^i = \overline{b}^i$ where $\overline{b}^i = \zeta(\overline{b}^i, \overline{k})$, otherwise (since $\partial \zeta(b^i, \overline{k})/\partial b^i \geq 0$) either $[b^i$ decreases (increases) for all i and thus k decreases (increases)] or $[b^R$ increases indefinitely and b^P decreases to zero, and thus k increases] in contradiction to the stationarity of $\overline{k}$. Hence, $\overline{b}^R = \zeta(\overline{b}^R, \overline{k})$, $\overline{b}^P = \zeta(\overline{b}^P, \overline{k})$, and $\overline{k} = \kappa(\overline{b}^R, \overline{b}^P)$. Since $b^P > 0$, the steady-state equilibrium is $(b^R, b^P) >> 0$, where $b^P = b^R$ since ζ is independent of $i = P, R$. □

Hence, in stage II of Regime II the economy witnesses the demise of the class society. The descendents of Workers as well as Capitalists acquire human capital as well as physical capital, the income gap between the classes narrows and vanishes in the long-run, and class characteristics fade.

4.3 Analysis

In Regime I, physical capital is scarce, the contribution of human capital to the production process does not justify investment in human capital, and the process of development is fueled by capital

accumulation. The wage rate is lower than the critical level that would enable individuals who do not own any capital to engage in intergenerational transfers (and thus savings). Workers, therefore, consume their entire wages; they are not engaged in saving, capital accumulation, and intergenerational transfers. Their descendents, therefore, are also unable to engage in saving and intergenerational transfers and Workers are in a temporary steady-state equilibrium in which there is no investment in either physical or human capital. In contrast, the income of the Capitalists, who own the entire stock of capital in the economy, is sufficiently high, permitting intergenerational transfers and capital accumulation. Intergenerational transfers among the Capitalists increase over time and the stock of physical capital in the economy, therefore, increases as well. During this regime, physical capital accumulation by the Capitalists decreases the return to physical capital and the importance of potential human capital formation in sustaining the return to capital increases. However, as long as the Capitalists generate a higher rate of return from a direct investment in physical capital, rather than from supporting the education of Workers, which would complement their capital in the production process, the qualitative structure of the economy remains unchanged. The Workers remains in a poverty trap, the Capitalists get richer, and the process of development is based solely on physical capital accumulation.

The accumulation of physical capital by the Capitalists in Regime I gradually raises the potential role of the education of the Workers in sustaining the profit rates of the Capitalists. Ultimately, the Capitalists find it beneficial to support public education, and the economy enters Regime II where the process of development is fueled by human as well as physical capital accumulation.

Regime II is subdivided into two stages. In stage I of Regime II, the economy witnesses the birth of public education. The Capitalists invest in physical capital, and workers, as well as the Capitalists acquire education financed by the Capitalists. The wage income, however, is not high enough to permit physical capital accumulation by the Workers. During Stage I of Regime II, the accumulation of physical and human capital increases wage income further, and ultimately the economy enters Stage II of Regime II in which the wage income is high enough to permit the accumulation of physical capital by the Workers.

In stage II of Regime II the economy witnesses the demise of the class society. The descendents of Workers as well as Capitalists acquire human capital as well as physical capital, the income gap between the classes narrows, vanishing in the long-run, and class characteristics fade.

5   Evidence from the Balfour Act – UK 1902

The basic premise of this research, regarding the positive attitude of the capitalists towards education reforms, is examined based on the voting patterns on the Balfour Act of 1902 – the proposed education reform in the UK that marked the consolidation of a national education system and the creation of a publicly supported secondary school system. In light of the proposed theory, one would expect that variations in the support of MPs for the Balfour Act would reflect the variations in the skill intensity in the counties they represent. Higher support for the Balfour Act would be expected from MPs who represent industrial skill-intensive counties.

We construct a data set gathered from a variety of historical sources on the third (and final) vote on the Balfour act.[45] The data, as described in detail in the Appendix, combines the home district and party affiliation for each MP with his voting record on the Balfour Act. In addition, the data includes county level data on the percentage of employment in skill-intensive industries, income per capita, degree of urbanization, and religious affiliation.

As is apparent from Table 1, which summarizes the voting patterns on the Balfour Act according to party affiliation, Conservatives and Unionists were predominantly supportive of the Balfour Act while Liberals were predominantly opposed. Nevertheless, variations in the voting patterns within each of the parties due to a significant number of abstentions, is sufficient for a significant identification.

We perform ordered probit regressions to examine the effect of percent employment in industrial skill-intensive sectors in each MP's county on the voting patterns on the Balfour Act. As documented in Table 2, there exists a significant positive effect of percent employment in industrial skill-intensive sectors in a county on the propensity of their MPs to vote in favor of the education reform proposed by the Balfour Act of 1902.

Regression (1) in Table 2 examines the effect of the employment in industrial skill-intensive sectors in each MP's county on the voting patterns on the Balfour Act, controlling for county's per-capita income. Consistent with the main hypothesis of this research, the regression shows a significant positive effect of the ratio of employment in industrial skill-intensive sectors in each MP's county on the propensity to vote for the proposed education reform.

The proposed Balfour Act of 1902 provided a role for the Anglican Church in the provision of education. As a result the non-conformists objected to the Act. In Regression (2), therefore,

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[45]In previous education acts, the third and final vote was conducted by voice, and no record exists of the distribution of votes across MPs. Some records of votes on various amendments for these education bills do exist, but it is not possible to specify clearly which of the votes were crucial or even whether an affirmative vote is actually in support of the ultimate education bill.

we control for the percentage of non-conformists in each county. The regression indeed shows a significant negative effect of the fraction of non-conformists in the county on the support for the Act by the MPs representing that county. Nevertheless, the effect of the ratio of employment in industrial skill-intensive sectors on the vote remains significantly positive.

In Regression (3) we add dummy variables to control for counties in Scotland and Wales. Scotland and Wales tended to view themselves as independent nations within the UK. This may have led them to vote systematically for or against certain measures based solely on nationalistic grounds (e.g., being against universal education because it imposes "English" education). Since counties in Scotland and Wales were characterized by lower income, a higher fraction of Catholics, a smaller urban sector, and a smaller skill-intensive industrial sector, relative to England, excluding these controls might cause omitted variable biases in the other coefficient estimates. However, despite the incorporation of the Scotland and Wales dummies, the effect of the ratio of employment in industrial skill-intensive sectors on the vote remains significantly positive.

In Regression (4) we control for party affiliation. As is apparent from Table 1, there is a strong correlation between party affiliation and voting patterns: Conservatives and Unionists were predominantly supportive of the Balfour Act while Liberals were predominantly opposed. Indeed, the regression shows that affiliation with the Liberal party has a highly significant negative effect on support for the Balfour Act, and affiliation with the Conservative party therefore has a highly significant positive effect on support for the Act. Nevertheless, the effect of the ratio of employment in industrial skill-intensive sectors on the vote remains significantly positive. Further, as established in Table 3, the ratio of employment in industrial skill-intensive sectors has a significantly positive effect on support for the Conservative party, which, in turn, supports the education act.

Finally, in Regression (5) of Table 2, we control for the percentage of the urban population within each county. This is an attempt to separate between demand for education that stems from skill-intensive industrial development, and other sources of demand for education in an urban environment. In particular, support for public education may reflect the desire to reduce crime, which is prevalent in an urban environment.[46]. Interestingly, urbanization has no significant effect on support for the education act and the effect of the weight of the skill-intensive industrial sector remains significantly positive.

Table 3 reports the results of probit regressions of the effect of the ratio of employment in the skill-intensive industrial sector in each MP's county on party affiliation, controlling for the percentage of employment in skill-intensive industries, per-capita income, degree of urbanization,

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[46]Unfortunately, direct crime statistics at the county level are unavailable for this period.

and religious affiliation in each county, and incorporating the Scotland and Wales dummies. It shows that the ratio of employment in the skill-intensive industrial sector in each MP's county has a significant positive effect on affiliation with the Conservative party.[47]

Hence, it is apparent from Tables 2 and 3 that the ratio of employment in the skill-intensive industrial sector has a significant positive impact on the vote on the Balfour Act through two channels. The first is the direct channel, holding party constant. The second is through its influence on the MP's party itself.[48]

6   Concluding Remarks

This paper hypothesizes that the demise of the class structure that existed in Europe in the 19th century reflects a deliberate transformation of society orchestrated by the capitalists. In contrast to the prevailing wisdom, the research suggests that the transition from the European class structure of the 19th century may be viewed as the outcome of an optimal reaction of the capitalists to the increasing importance of human capital in sustaining their profit rates. The paper argues that the process of capital accumulation gradually intensified the relative scarcity of skilled labor and generated an incentive for human capital accumulation. Due to the complementarity between physical and human capital in production, the capitalists were among the prime beneficiaries of the potential accumulation of human capital by the masses. They therefore had the incentive to support the provision of public education that would improve their economic well-being, although it would ultimately undermine their dynasty's position on the social ladder and would lead to the demise of the class structure. The basic premise of this research, regarding the positive attitude of capitalists towards education reforms, is supported empirically by a newly constructed data set on the voting patterns on England's education reform proposed in the Balfour Act of 1902.

Unlike the conventional wisdom, the paper argues that the demise of the capitalists-workers class structure was an outcome of a cooperative, rather than divisive process. The political reforms that accompanied education reforms can be viewed as an attempt by the capitalists to broaden the coalition that supports public vocational (utilitarian) education, against the wishes of the clergy and the landlords for whom human capital was less complementary in production,[49] or as a

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[47]Adjusting the probit results to obtain marginal effects, we find that a one percentage point increase in the ratio of employment in the industrial sector raises the probability of belonging to the Liberal party by approximately 1.7 percentage points.

[48]It should be noted that the voting patterns of the industrial-intensive counties on alternative bills in the same year differed significantly. In particular, the share of employment in the industrial sector is an insignificant explanatory variable for the 1902 vote on an income tax bill using an ordered probit with the same set of controls. This result suggests that representatives from industrial-intensive counties do not vote uniformly on each bill.

[49]Cultural differences across societies may have resulted in the failure of some societies to adopt efficient institutions

by-product of the educational reforms that made political inequality harder to sustain or justify.

One may argue that political reforms during the 19th century shifted the balance of power towards the working class and enabled workers to implement education reforms against the will of the capitalists. The evidence, however, does not support this alternative hypothesis. Education reforms took place in autocratic states that did not relinquish political power throughout the 19th century, and major reforms occurred in societies in the midst of the process of democratization well before the stage in which the working class constituted the majority among the voters.

(e.g., Greif (1994)). Therefore, the timing of education reforms relative to the process of development may differ across countries.

Data Appendix

Vote on the Balfour Act – The voting record of each MP on the Balfour Act is gathered from the supplement to the British Parliamentary Papers, the Division Lists. The record specifies who voted in favor of and who voted against the bill.[50] The list of the names and home districts of each of the British MPs during the vote on the Balfour Act is collected from The British Parliamentary Papers. Party affiliation for each MP during the vote on the Balfour Act is taken from Who's Who of British Parliament.[51]

Income per capita – Income per capita in each county is estimated for each county using income tax data. Source: Hechter (2001).

Percent in skill-intensive occupations – the proportion of the population in a county that is employed in skill-intensive industrial occupations. Sources: British Regional Employment Statistics, 1901, Lee (1979) and Hechter (2001).[52] Based on the British Regional Employment Statistics, 1901, Hechter divides the total employment in each county into four categories: Agricultural, Manufacturing, Middle Class, and Civil Servant. The Middle Class category consists of skill-intensive manufacturing occupations (Mechanical Engineering, Instrument Engineering, Electrical Engineering, Distributive Trades, Insurance/Banking/Finance, Professional and Scientific, and Miscellaneous). Employment in theses occupations is used in the regression to capture the percentage of employment in skill-intensive occupations.

Percent non-conformists – the proportion of the population in a county that are non-conformists. Source: Hechter (2001).

Percent urban – the proportion of the population in a county that resides in urban areas. Source: Hechter (2001).

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[50] Any member not listed abstained. Of the 562 MPs, 226 abstained.

[51] We used only those MPs in either the Liberal or Conservative parties, the dominant parties of the time. The only other party of significance was the Unionist party, but membership in this party was not mutually exclusive with the other two. Many members of the Liberal and Conservative parties were Unionists as well. In addition, there are a number of Unionist-only members. Excluding pure Unionists and other members of smaller parties, we remove 101 MPs from the sample. In addition, we were unable to locate party affiliation data on six of the MPs, and removed them from the sample.

[52] The British Regional Employment Statistics provides a breakdown of employment by industry in each county in the UK, an area that encompasses several districts. Unfortunately, the employment data is not at a district level and each MP was therefore assigned the percentage appropriate to the county within which his district existed.

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Table 1. Voting patterns according to party affiliation and the regional distribution of party affiliation

	Yes	No	Abstain	Total
Liberal	19	98	92	209
Conservative	155	3	94	252
Unionist	43	0	26	69
Other	4	14	14	32
Total	221	115	226	562

	Scotland	Wales	England	Total
Liberal	46	20	143	209
Conservative	18	2	232	252
Unionist	6	1	62	69
Other	2	7	23	32
Total	72	30	460	562

Table 2. The effect of the weight of the skill-intensive sector on the support for the Balfour Act

Exp Variable	(1) Vote on Balfour Act	(2) Vote on Balfour Act	(3) Vote on Balfour Act	(4) Vote on Balfour Act	(5) Vote on Balfour Act
Income per capita	-0.0011	-0.0030	-0.0033	-0.0118	-0.0120
	(0.12)	(0.33)	(0.36)	(1.33)	(1.33)
% in skill-intensive occupations	5.7298 **	4.1818 **	4.2554 **	2.6177 *	2.6171 *
	(4.49)	(3.09)	(3.20)	(1.93)	(1.94)
% non-conformists		-1.9109 **	-1.4129	0.7349	0.7395
		(3.95)	(1.59)	(0.67)	(0.67)
Scotland dummy			0.0215	-0.1246	-0.1216
			(0.09)	(0.50)	(0.46)
Wales dummy			-0.7289 **	-0.9086 **	-0.9057 **
			(2.01)	(2.01)	(1.99)
Party affiliation				-1.7404 **	-1.7399 **
				(11.44)	(11.46)
% urban					0.0246
					(0.10)
Chi-square p-val	0.0000	0.0000	0.0000	0.0000	0.0000
Total observations	455	455	455	455	455
Method	Oprobit	Oprobit	Oprobit	Oprobit	Oprobit

Absolute values of t-ratios are given in parentheses
** indicates significance at 5%
* indicates significance at 10%

Vote on Balfour: 2=Yes, 1=Abstain, 0=No
Party Affiliation: 1=Liberal, 0=Conservative
Standard errors are adjusted by clustering by county

Table 3. The effect of the weight of the skill-intensive sector on MP's party affiliation

Exp Variable	(1) Party Affiliation	(2) Party Affiliation	(3) Party Affiliation	(4) Party Affiliation
Income per capita	-0.0139	-0.0119	-0.0112	-0.0009
	[-0.00548]	*[-0.00469]*	*[-0.0044]*	*[-0.0035]*
	(1.03)	(1.02)	(0.97)	(0.81)
% in skill-intensive occupations	-7.2551 **	-4.6358 **	-4.3282 **	-4.1988 **
	[-2.8581]	*[-1.8287]*	*[-1.7091]*	*[-1.6587]*
	(3.69)	(2.31)	(2.23)	(2.23)
% non-conformists		3.3908 **	4.1208 **	4.2180 **
		[1.3375]	*[1.6272]*	*[1.6664]*
		(4.66)	(2.78)	(3.01)
Scotland dummy			-0.3227	-0.3936
			[-0.1239]	*[-0.1499]*
			(0.72)	(0.98)
Wales dummy			0.1406	0.0815
			[0.0559]	*[0.03234]*
			(0.28)	(0.17)
% urban				-0.2887
				[-0.11402]
				(0.72)
Chi-square p-val	0.0003	0.0000	0.0000	0.0000
Total observations	455	455	455	455
Method	Probit	Probit	Probit	Probit

Absolute values of t-ratios are given in parentheses
** indicates significance at 5%
* indicates significance at 10%

Marginal effects are reported in square brackets

Vote on Balfour: 2=Yes, 1=Abstain, 0=No
Party affiliation: 1=Liberal, 0=Conservative
Standard errors are adjusted by clustering by county

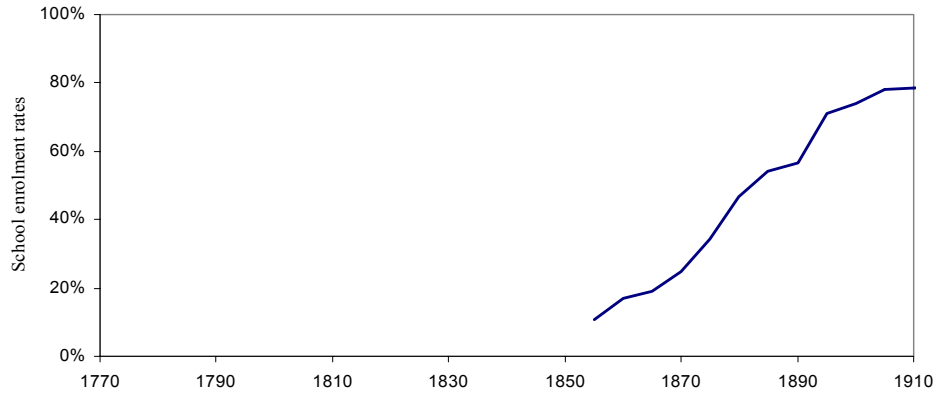# Figure 1. Schooling, Factor Prices and Inequality
England 1770-1920

Figure 1(a). The evolution of the fraction of children aged 5-14 in public primary schools: England 1855-1920
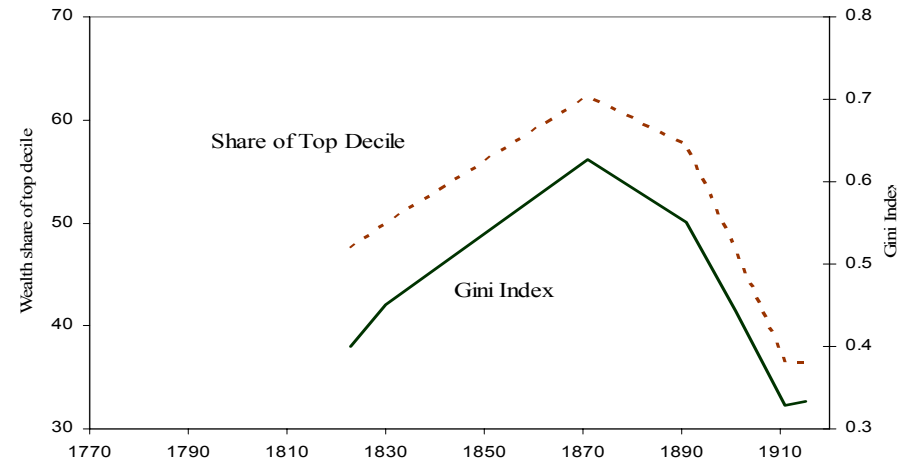Source: Flora et al. (1983)

Figure 1(b). The evolution of wealth inequality: England, 1820-1913
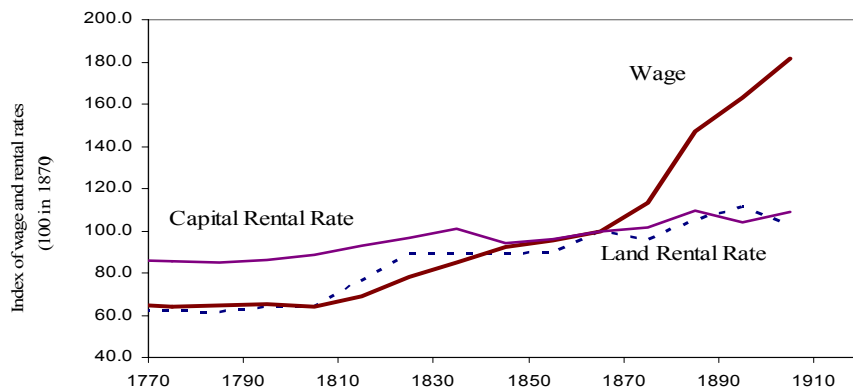Source: Williamson (1985)

Figure 1(c). The evolution of wages and rental rates: England, 1770-1920
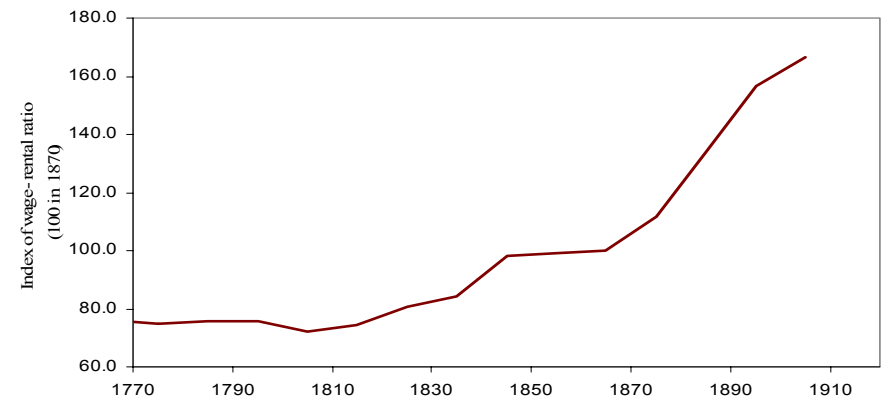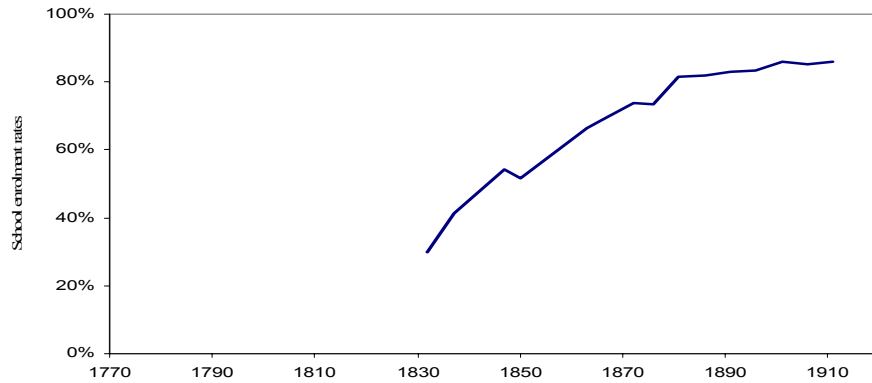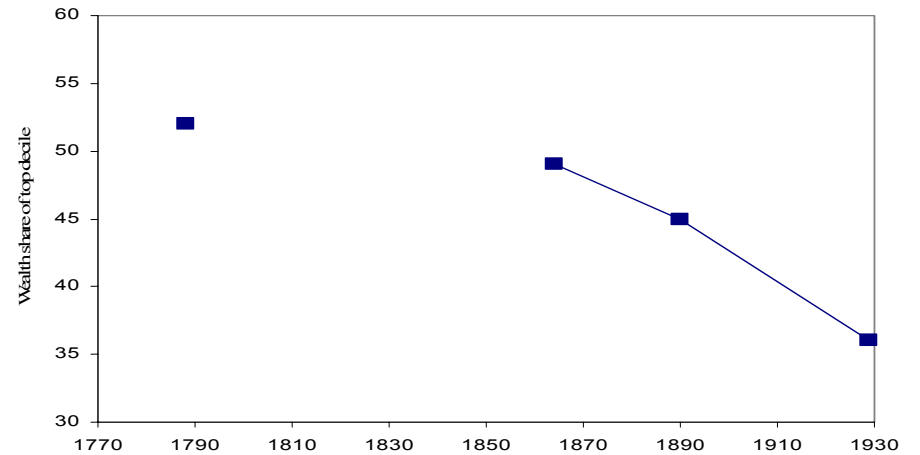Source: real wage (Clark (2003)); rental rates (Clark (2002))

Figure 1(d). The evolution of the wage-rental ratio: England, 1770-1920
Source: real wage (Clark (2003)); return to capital (Clark (2002))

Figure 2. Schooling, Factor Prices and Inequality
France 1770-1930

Figure 2(a). The evolution of the fraction of children aged 5 -14 in primary schools: France, 1830 -1910
Source: Flora et al. (1983)

Figure 2(b). The evolution of wealth inequality: France, 1788-1929.
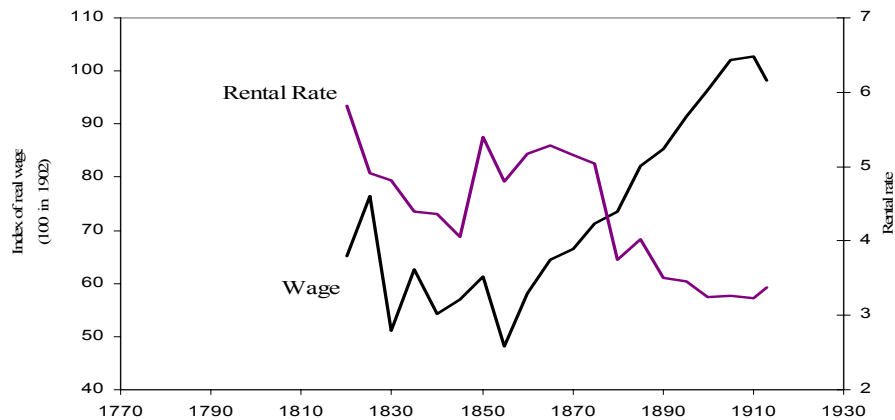Source: Morrisson and Snyder (2000)

Figure 2(c). The evolution of the real wage and rental rate: France 1820 -1913
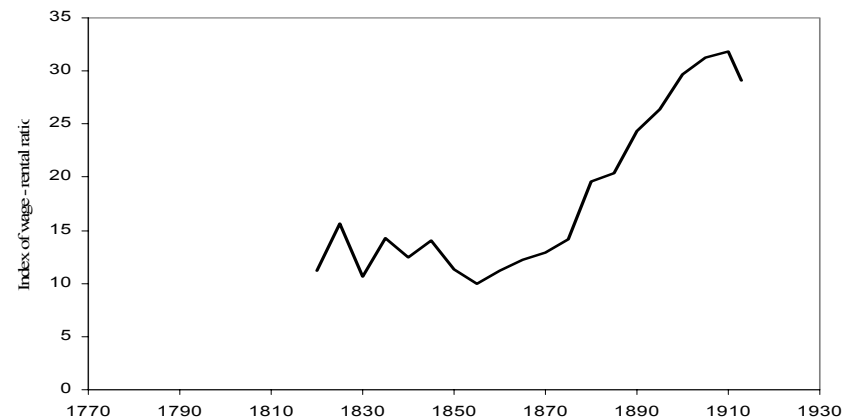Source: Levy-Leboyer and Bourguignon (1990)

Figure 2(d). The evolution of the wage-rental ratio: France 1820 -1913
Source: Levy-Leboyer and Bourguignon (1990)

Figure 3. The Evolution of Voting Rights and School Enrolment
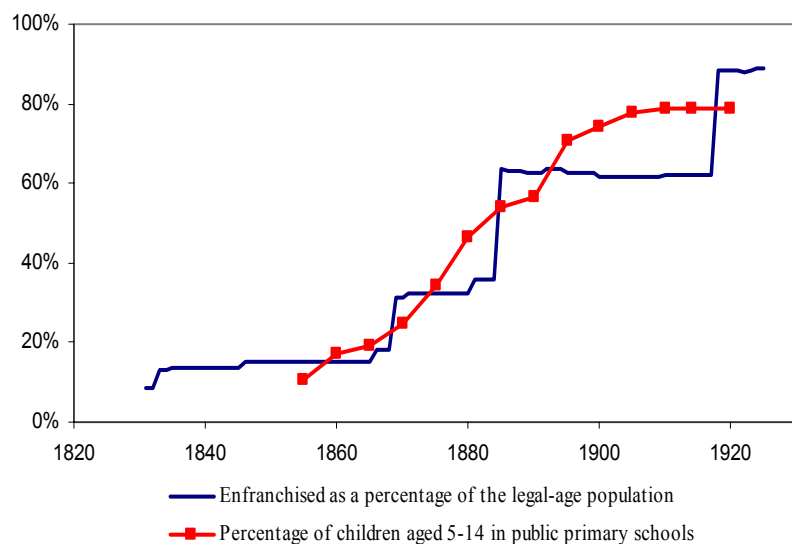# England and France 1820-1925

Figure 3(a). The evolution of voting rights and school enrolment: England 1830-1925 Source: Flora et al. (1983)
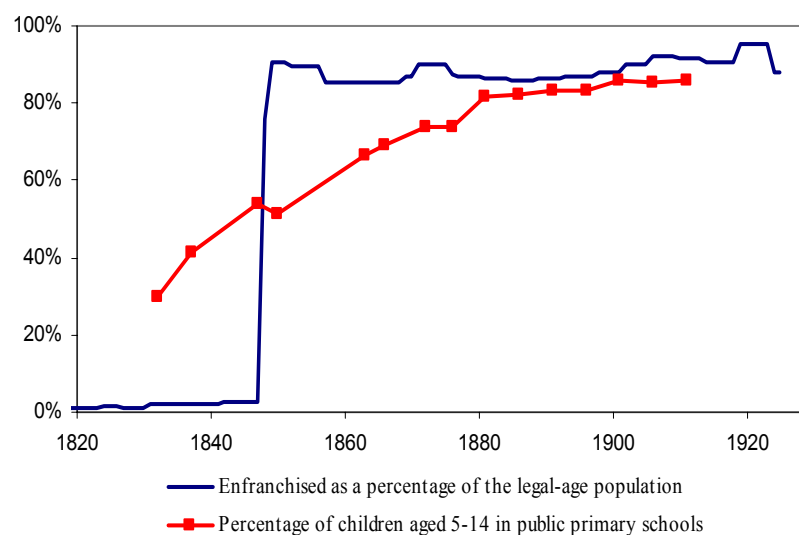

Figure 3(b). The evolution of voting rights and school enrolment: France 1820-1925 Source: Flora et al. (1983)

Figure 4. The evolution of output per worker in the process of development