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A Historical Approach to American Skill Differentials

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Abstract

This paper studies the evolution of three historical time series on skill premiums in the United States during the major part of both the 19th and the 20th century. A descriptive analysis leads us to asses the existence of a systematic relation between the series and the inflation rate, pointing towards the presence of a strong rigidity in the wages of skilled workers. We proceed by discriminating the real forces that may cause such pattern, considering four of such forces: aggregate demand, supply shocks caused by wars, technological progress biased towards skilled workers and capital skill complementarity. The results, robust both to an extension in the number of regressors and to a change in the sample period, suggest the existence of nominal forces causing the observed rigidity. This is a striking outcome difficult to insert within the literature on skill premiums.

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1 Introduction

This paper studies the evolution of five historical time series of skill premiums in the United States covering most of the 19th and the 20th century. It was conceived as a bridge paper that could connect the existing empirical evidence for the 20th century with the 19th century, acknowledging the more limited range of data sources available.

We study the behaviour of skill premiums in order to see to what extent the theoretical literature which has been applied to recent empirical work for the late 20th century is valid for our time series data set. Most of the existing empirical evidence were calculated using panel data and cross-sectional techniques which summarize data on American manufacturing industries. These data sets normally distinguish two categories of labour depending on their skill levels. The exercise becomes an interesting challenge: to compare a historical perspective with a more disaggregated late 20th century approach and to study whether similar conclusions can be drawn. The starting point is the following: If there are forces (of whatever nature) that cause the skill premiums to move in a specific fashion, we should be able to identify them across databases and over time.

Through a descriptive analysis of the data we find a systematic pattern that we try to explain by resorting to the existing literature on skill premiums. This pattern is a significant and negative relationship between the rate of change of the skill premiums and the rate of change of the price index. We resort to literature on skilled wage differentials to search for the real forces that might cause this pattern. Goldin (1980) suggests that **supply shocks caused by wars** played an important role in explaining the evolution of relative skilled wages. Empirical evidence on capital-skill complementarity and technological progress biased towards skilled labour has been extensively documented for the late 20th century data (see e.g., Berman at al (1994)). For earlier periods though, fewer empirical studies can be found. Goldin and Katz (1996) offer evidence of **technology-skill and capital-skill complementarities** from 1909 to 1929. But other authors such as Cain and Paterson (1986) or James and Skinner (1985) consider that rather than being the relative complement to human skill, physical capital was, for some time, a relative complement of raw materials and together, with unskilled labour, substituted for highly-skilled individuals. Those papers though, mainly cover the last half of the 19th century and/or the early 20th century. Here we take as a starting point, the possible existence of both capital-skill complementarity and biased technological progress, from the late 19th century. **Migration** to the United States (especially during the early 1920s) is another factor to control for. Some authors (Jerome (1929) and Thomas (1973)), suggest the existence of an integrated Atlantic labour market, at least for the less skilled, preceding WWI. Here we will not distinguish the supply of labour coming from outside the United States from national supply of labour (data are not available). We will rather focus on the impact of historical events on immigration to grasp the effect on the national American labour supply and try to capture migration flows jointly with the existing national labour supply through total civilian employment.

After introducing these real forces in the study and after performing some sensitivity analysis, results turn out to be very robust. In explaining the negative relationship between the rate of change of relative wages and the rate of change of price indices, none of these aforementioned real forces seem to have played a relevant role. From this perspective, this paper constitutes a challenge to the literature on skill premiums. To my knowledge, there is no work which presents similar evidence to that presented here. Other authors who have studied the rigidity of nominal wages (Allen (1992), Sundstron (1992), Mitchel (1985), Sachs (1980) or Hanes (1993)). This rigidity is normally studied by analyzing the amount of change in the rate of wage inflation associated with sharp changes in output and employment. This wage resistance is different from the relative nominal rigidity of skilled wages we find here. Though we also take into account the business cycle (and compute the coefficient of correlation between GNP and the relative skilled wages), the puzzling result that wages of skilled workers react much less to changes in prices remains.

The paper is organized as follows: Section 2 presents the five series which will be studied in the paper, Section 3 explains why we introduce price indices into the analysis. Section 4 describes the joint behaviour over time of skilled wage differentials and prices. We distinguish four subperiods: The early 19th century (1816-1860), from the Civil War until the end of the century (1861-1900), the early 20th century (1900-1928) and from the Great Depression to the Vietnam War period (1929-1970). In Section 5 we present the empirical evidence which leads to the concluding remarks of Section 6. Finally Appendix A goes through the construction and sources of all the series considered in the analyses while Appendices B and C contain tables with the empirical results and relevant figures respectively.

2 Presentation of the series

In this paper we will consider five series of skilled wage differentials. The first three series were obtained from Lindep and Williamson (1980). They are ratios of wages of different kinds of skilled workers to unskilled workers. The unskilled workers' wages correspond to the wage of labourers, while the skilled workers' wages differ across the series. A brief description of the series (in chronological order) follows:

Wages of urban skilled workers relative to labourers. This series extends from 1816 until 1939. This is the ratio of skilled to unskilled workers' wage rates in manufacturing and the building trades. The ratios are calculated from daily wage rates up to 1890, and from weekly rates thereafter.

Wages of public school teachers relative to labourers. This series covers the period 1841-1972. Data presented in Lindep and Williamson had different frequencies depending on the time period. In the appendix we explain how this problem was solved. This is the ratio of school teachers' pay per 180 days to the wages received by industrial

unskilled labourers per 2000 hours. The ratio is calculated by dividing the annual rate of pay for primary and secondary public school teachers firstly by the number of days in the school year and then by 2000 times the hourly unskilled wage rate in industry.

Wages of skilled workers in building trades relative to labourers. This series extend from 1907 until 1973 and was calculated from two previous series. Details about the calculations and the differing time coverage can be found in the appendix. The series are the average ratio of hourly wage rates of journeymen, helpers, and labourers in the building trades, averaged over a number of cities and relative to labourers.

The last two series, of much shorter coverage (1922-1952) were taken from Goldin and Margo (1991) and both are monthly wages of two different types of skilled workers relative to labourers. These series are the following:

Wages of clerical workers to labourers The clerical data are for clerks working on Class I Steam Railroads.

Wages of Machinists relative to labourers As before, the machinists' data are for machinists working on Class I Steam Railroads.

From now on we will identify unskilled workers with labourers. In order to make the exposition clearer, it should be taken into account that we will be mainly talking in terms of ratios. If we talk of skilled workers, this might refer to public school teachers, urban skilled workers, workers in building trades, clerical workers or machinists. Skilled workers should be understood as the numerator of all the ratios we present. Consequently, as the analysis is conducted over time, during some periods two or three series will overlap.

3 Introducing prices into the analysis

When we look at the evolution of relative skilled wages over time, it is interesting to see how their behaviour follows (in an inverse fashion) that of prices. Studying the history of American business cycles, we will see how the behaviour of relative skilled wages is consistent with a higher rigidity of the wages of skilled workers. This fact can be clearly observed during the 19th century and the beginning of the 20th century, when fluctuations are more pronounced and are often associated with financial panics.

In order to study whether the wages of skilled workers are more rigid, we introduce a price index into the analysis and analyze the joint behaviour of both series over time. The underlying idea is that the relationship linking changes in nominal wages and changes in the cost of living does not seem to be the same for skilled and for unskilled workers. If we find evidence supporting the existence of higher rigidity in the wages of skilled workers, we should then find out whether this rigidity comes from real or nominal forces.

The first step will be to construct some statistics capturing the relationship between relative skilled wages and prices. But before we have to ensure that the statistics can

be properly interpreted. We need to know whether the series are covariance-stationary. Several unit root tests have been performed on each of the series involved (see Table 4 in Appendix B). In almost all of the cases, the series turned out to be non-stationary. The series of urban skilled workers to labourers presents some sort of ambiguous result: according to the two tests around a constant, i.e., the augmented Dickey-Fuller and the Phillips-Perron test, the null of the existence of unit roots can be rejected. On the contrary, according to the two tests around a trend, the null cannot be rejected. It is not clear whether the series should be considered as integrated of order one. To overcome this problem, we shift the starting date forward in time to 1850, but the sample remains long enough so that the coverage guarantees the accuracy of the unit root tests. Previous years in time to 1850 did not yield unanimous outcomes when the same tests were performed.

Since none of the series are covariance-stationary, the data have to be treated. Multivariate detrending techniques (e.g. cointegration) are based on the existence of a common trend across all series. This seems too strong an assumption for such different series as those that will be presented here. Among the univariate detrending techniques, three are popular among economic historians. First, data can be detrended using polynomial functions of time. But this is only a sensible method insofar as the series do not present a unit root. In other words, as far as the secular component is non stochastic. We tried to detrend our series with a deterministic trend, but when unit root tests were performed on the detrended data, they still showed evidence of a unit root. The second most popular method consists of detrending using first order differences. In this case the secular component of the series is a random walk and the (stationary) cyclical component can be obtained after taking first differences. The third method would be to filter the series with the Hodrick- Prescott filter. This technique assumes that the trend is stochastic but moves smoothly over time, similar to a deterministic trend which changes several times over the sample period. Using the Hodrick-Prescott filter, which imposes a uniformly standardized penalization on the variability of the trend across series, may distort features of summary correlations[1]. We choose to detrend our data firstly by taking first differences and using the results as a bench mark; secondly with the Hodrick-Prescott filter. This enables us to study the robustness of our results.

It should be noted that, depending on the way we detrend our data, the cyclical component may be different because different detrending methods employ different concepts of business cycle fluctuations. From all the series we will use, the one we should be most concerned with is GNP, since it will be used as a guide of American business cycle fluctuations. For reasons of clarity, we present here a chronology of American business cycles from 1890 to 1976 taken from Sachs (1980). Though he does not use GNP data but Industrial Production data, his results are fully consistent with the NBER ranking of business cycle severity. He constructs a measure of severity from the percentage deviation of industrial output from its trend value at business cycle peaks and troughs (ΔGAP). Contractions are divided into mild ($-10 \leq \Delta GAP * 100 \leq 0$), moderate ($-15 \leq \Delta GAP * 100 \leq 0$) and

[1]For a summary on detrending methods, see Canova (1991)

strong ($\Delta GAP * 100 \leq -15$). This information can be found in Table 4, bellow.

For the previous period, we also present a chronology of unemployment in years of economic crisis from 1800 until 1959. This information is taken from Lebergott (1964) and presented in Table 2.

Table 3 presents the coefficients of correlation between the rate of change of two prices series (the consumer price index and the wholesale price index) and the rate of change in the skill premiums. An F-Snedecor test is also presented in the table. The F-Snedecor values point towards rigidity in all cases, excluding the series of urban skilled workers to labourers for the total period (1816-1939). Nevertheless, for the period 1850-1939, the statistic becomes significant. Furthermore, recalling the unit root test, from 1850 we can be certain about the existence of a unit root in the series of relative wages urban skilled workers to labourers. When filtering the series with the Hodrick-Prescott filter (HP filter henceforth), the same results are obtained (see Table 7). Now the correlation values are even higher, as well as the F-test statistics. Economic theory would suggest that we should disentangle the puzzle by resorting to the real forces that might be causing the correlation to be significant. Empirical evidence, as we will see, will yield unexpected results.

Table 1: CHRONOLOGY OF AMERICAN BUSINESS CYCLES

Year before peak Upturns	Peak to trough Contractions	Type of contraction
1892-1893	1893-1894	mild
1894-1895	1895-1897	mild
1898-1899	1899-1900	mild
1901-1902	1902-1904	mild
1906-1907	1907-1908	strong
1909-1910	1910-1911	mild
1912-1913	1913-1914	moderate
1917-1918	1918-1919	strong
1919-1920	1920-1921	strong
1922-1923	1923-1924	mild
1925-1926	1926-1927	mild
1947-1948	1948-1949	moderate
1952-1953	1953-1954	mild
1956-1959	1957-1958	moderate
1959-1960	1960-1961	mild
1968-1969	1969-1970	mild
1972-1973	1973-1975	strong

[a]Source: Sachs (1980), page 80.

Table 2: UNEMPLOYMENT IN YEARS OF ECONOMIC CRISIS: 1800-1959

% Labour Force Unemployed	1800-1819	1820-1839	1840-1859	1860-1879
3-5	1819			
6-8		1838	1858	
9-11				
12-14				1876
15 and over				
% Labour Force Unemployed	1880-1889	1900-1919	1920-1939	1940-1959
3-5			1927	1949, 1954, 1958
6-8	1885	1908	1924	
9-11		1915		
12-14			1921	
15 and over	1894		1930-1940	

[a]Source: Lebergott (1964).

4 The joint evolution of relative skilled wages and the CPI

4.1 The early 19th century: 1816-1860

The relative wages of urban skilled to unskilled workers reveals a pronounced increasing trend during the whole period, especially sharp from 1816 (the beginning of the series) until the Civil War (see Figure 1 in Appendix C). From the post-WWI period until the end of the series, the relative skill differentials stabilize. The series starts with the creation of the Second Bank of the United States, very close in time to the financial panic of 1819. Contemporaneously, there was a light economic depression (1818-1820) which had a positive effect on the relative wages of skilled workers. This illustrates the repeated phenomenon that depressions favor in comparative terms those with higher skill levels.

From 1820 until 1840, the US enjoyed economic growth during the expansion of the late 1820s and early 1830s, although at a high cost in terms of inflation and general instability. This included the financial panic of 1837 and the downturn of 1839, precipitating an economic slowdown and high unemployment lasting until the middle 1840s. The plot reveals an unbalanced impact of the depression, since the skilled wage differentials were growing at a high speed. The period 1845-1855 was marked by high population growth, especially due to the arrival of German and Irish immigrants which accounted for 65%-75% of total immigration (Chapter 6, Hughes (1987)). The Germans mostly went to the Ohio Valley and possessed a high level of skills, while the Irish settled mostly in the North and performed the most unskilled tasks. It is possible that, due to a differential rate of arrival of both immigrant groups, there was a positive supply shock of unskilled workers in the North[2]. This would have reinforced the upward trend of the skill premiums.

During the middle of the 19th century, the US experienced a period of reforms which included improvements in transportation (the first transcontinental railroad worked in 1869), important changes in technology (the invention of the telephone in 1876 and the first commercial light bulb invented by Edison in 1879) and the existence of a blossoming educational system. This last factor should have improved the general level of all future American workers, causing a positive real shock of skilled labour. The first factor probably operated in favor of both skilled and unskilled workers and it is difficult to assess in which proportions since a large amount of both categories of labour were involved in the construction of the transportation system. The introduction of new technologies into existing production processes or the creation of new ones should have had a positive relative effect in favor of the skilled workers. At the beginning of a new technology, specific (maybe new) tasks have to be performed. Certainly only those workers with a high level of preparation or formal education are able to perform them.

[2]In fact, during 1845-55, nearly 1.3 million Irish are known to have emigrated to the United States versus the almost 1 million immigrants from German speaking regions (see Hughes (1987), pages 103-104)

The ratio of the wages of public school teachers relative to labourers shows similar behaviour to the previous series, with an increasing trend almost until the Civil War (see Figure 3 and 4). During the 1840s a relatively well financed public education system emerged while the early fifties favored the wages of public school teachers because during this period education was fostered by national and federal governments.

The effects of this institutional change on the formation of the future national supply of labour were nevertheless dubious mainly because the system could not reach the whole population of children. First, there were not enough capacity for all the children eager to attend school. Second, child labour was still common and the cost of sending a child between 10 and 14 to school (in terms of forgone income) was considerable (Solmon 1975).

Throughout the mid-nineteenth century the patterns of school governance shifted from a village or rural model[3] towards an urban system, parallel to the American urbanization process, which between 1820 and 1860 proceeded at a faster rate than in any other period of American history.

Before the Civil War, during a period of continuous political crisis, 1857 represents a turning point in the trend of relative skilled wages. Up to 1857, the economy was booming while the ratio was decreasing. But after 1857, when the last financial panic took place, the American economy suffered a depression which caused the skill premiums to increase. Laborers lost more economic power than public school teachers and urban skilled workers during the depression.

4.2 From the Civil War until the end of the century: 1861-1900

The American Civil War started in 1861. At the beginning of the war, both administrations relied on volunteers for their armies. It was in 1862 (for the North) and 1863 (for the South) that the two governments resorted to conscription. By 1864, both administrations had recruited blacks to their ranks. Aggregating the Federal and Confederate armies, there were more than 2.3 millions soldiers involved, of which more than one million died or were wounded. It is sensible to think that most people joining the army were low wage earners and had a low level of education. The increase in the relative supply of skilled to unskilled labour (presuming that there was a higher proportion of the second in the military forces), affected the relative skilled wage differentials from 1861 to 1864. We can also attribute the behaviour of skilled/non unskilled wage differentials from 1864 to 1865 to a positive supply shock of unskilled relative to skilled workers: More than one million and a half of healthy (presumably unskilled) people came back to civilian life in 1865, soon after the war ended. To those, all the black Americans coming from the South should be added.

The two effects can be seen well in both plots: wages of public school teachers relative to labourers and wages of urban skilled workers relative to labourers. Here a positive

[3]Children from different ages and levels of knowledge were together in a single class.

supply shock of skilled to unskilled workers coexists with a decrease in relative skilled wages during the war. It seems likely that the after-war positive supply shock of unskilled to skilled workers caused an increase in the relative skilled wages.

During the Civil War, the US was not a war economy in the 20th century sense. In fact, neither of the two administrations were prepared for the war, neither performed a control policy on wages, prices or profits and they had no experience about how to finance it. This inexperience is reflected in the evolution of the CPI. The price index increased sharply during the war. The extended practice (pursued by both administrations) of printing money in order to finance military expenses, drove the economy into a run-away inflation. The delayed and not so effective policies of increasing taxes and using floating loans were not enough. When we plot together the CPI with each of our two skill wage differentials series we observe how, during this inflationary period, they both decrease. During the post-war depression of the late 1860s, the deflationary trend also coincides with an inflexion point in the two series of skilled wage differentials. Though there seems to be some lag in the response of relative wages, the whole episode is fully consistent with a nominal rigidity of public school teachers' wages and of urban skilled workers. In comparative terms, public school teachers' wages reacted more than wages of urban skilled workers. This is a somehow striking outcome since the wages of public school teachers were negotiated at county level and presumably less often than the contracts offered to urban skilled workers.

During the period 1865-1900, the United States had to deal with two big depressions at business cycle frequency, both of them associated with financial panics. Let us focus on the financial panic of 1873 which led to the long depression of the mid-1870s. As was also the case during the first half of the 19th century, the depression benefitted workers with higher skills either because their nominal wages were more rigid or because demand for skilled workers was less sensitive to the business cycle. The recovery and the following period of prosperity (1877-1879), on the contrary, benefitted the unskilled workers. The second and worse depression (with an unemployment peak in 1894) lasted from 1893 until 1897. It started with an agrarian depression which soon caused industrial and financial markets to collapse. According to Lebergott (in Engerman and Fogel, 1971), this depression led to the highest unemployment level of the century (18.4%). The deflationary period of the depression resulted again in an increase in the skill premiums. The adjustment was mostly suffered by labourers, who were the mayority of unemployed, while public school teachers and urban skilled workers enjoyed an increasing purchasing power relative to unskilled workers. This is fully consistent with the idea of unequal adjustment costs for employment of skilled and unskilled workers, but it would also fit in a model of nominal rigidity in the wage of skilled workers.

From a socio-political point of view, four factors played an important role during the last decades of the century. The first one is political and it concerns public school teachers. During this period, Southern governments were dominated by white Democrats who reduced considerably the magnitude of the programs of the State government that

benefitted poor people[4]. The public school system was one of the institutions which suffered the most from the new policy. According to the British Encyclopedia, in 1890 the per capita expenditure in the South for public education was only 97 cents, as compared with $2.24 in the country as a whole. It seems that these measures depressed the wages of public school teachers in the whole country. Also in 1890, a campaign of reform of the public school system started, the Centralization Movement. The attacks on the rural school system crystallized into some sort of Lancastarian system: the application of the factory model to the systematization of schools. Before the end of the century, urban schools were well adapted in structure and process to transform children into *modern workers*: Great stress was laid upon punctuality, regularity, attention and silence. Those were understood as the basic requiremnents for facing modern life.

The second factor deals with the unionization process in the United States. During the mid-1880s, the Knights of Labor (the first important labour organization in the US) reached its historical peak in its number of members. The organization, highly centralized, emphasized the uplifting of unskilled labour. But from 1886, after an unsuccessful strike, there was a shift of political power from the Knights of Labor to the American Federation of Labor, uniquely concerned with the skilled craftsmens' needs. The increase in the relative skilled wages during the late 1880s and beginning of the 1900s might be partially explained by this shift of power.

The third factor is of a legal nature: by the end of the 1890s, legislation to prevent child labour and to protect women workers had been approved in most of the American States[5]. During this period, laws on educational attendance were also approved, though in practice most of them were ineffective because there were not enough places for all children. These measures make us think of a negative supply shock of unskilled to skilled labour taking place during these years. The impact is difficult to assess but it is plausible that these forces might have pushed the skilled wage differentials down.

Finally, the last factor concerns a change in the characteristics of immigration from Northern to Central, Southern and Eastern Europeans. Though the main impact of immigration inflows on relative wages seemed to take place at the beginning of the 20th century, the change in the nature of immigrants who adding to national labour supply should be borne in mind. This trend can be easily identified by looking at a few simple figures: in 1890, new immigrants represented 35% of the total inflow while in 1896 they were 56% (Goldin 1993).

The late 19th century was also a period of fast technological progress, major inventions and economic advances in the US. Accumulation of capital and technology should have increased the relative demand for skilled to unskilled workers considerably. This phenomenon is reflected in the evolution of the relative wages of urban skilled workers to unskilled workers. However, the wages of public school teachers were not reacting as much

[4]We can extend the effects of this policy in the American South to the whole economy since migration to the Northern States was not difficult during the late 19th century.

[5]They were sponsored by labour unions eager to prevent competition from child labour

to market forces, but to some combination of socio-political factors. It can be argued that the increasingly important role of education in the United States caused this pattern. Public school teachers had minimal formal schooling (the typical teacher had only attended grammar school), but by 1880 nine out of ten white children between the ages of eight and eleven were being taught. This progressive increase in the average years of education per child, probably caused a real positive shock to the supply of skilled labour. Still, society tended to view extended education as superficial. In fact, by 1880 there were few occupations for which extended schooling was a pre-requisite, and in 1885 few employers required their employees to be High School graduates.

4.3 Early 20th century: 1900-1928

The 20th century starts with the financial panic of 1907 and the subsequent depression. The behaviour of skilled wage differentials show an increasing trend that corroborates the hypothesis presented above. In 1907, a new data series comes into our study. This is the wage ratio of skilled workers in building trades relative to labourers. This series shows a downward trend during the whole period with two brief increases at the beginning of the century and during the early twenties (see Figure 3). The United States proclaimed itself a neutral country when the first World War started in 1914. It was not until 1917, that the Senate declared war against the German empire. Between these dates, they become the chief external suppliers of food, raw materials and ammunition of the British and the French economies. It is possible that, because of these exports, the national supply of raw materials and food decreased, forcing their prices upwards. As a consequence, assuming a higher level of substitutability of both goods relative to unskilled workers than relative to skilled workers, a negative demand shock of skilled versus unskilled labour took place. This effect was reinforced by another political-economic factor: the Allied governments borrowed more than two billion dollars in order to finance the war effort. It might be argued that, due to the money lent to the Allies, there was an increase in the domestic interest rate and a subsequent decrease in the demand for private capital. Following the capital skill complementarity hypothesis, this would in part explain the sharp decrease in the series. The skilled wage differentials would be reacting to a lower relative demand for skilled relative to unskilled labour, partly caused by the decrease in the demand for physical capital.

WWI starts affecting the price series roughly when the United States officially enter the war in 1917. Prices went up with the steepest positive slope of the whole period. Apart from the logical inflationary tensions caused by the war, the slope was much steeper during WWI than during WWII. Thus, even though the involvement of the United States in WWI was less intense than during WWII, it seems that the economic authorities knew less about how to control inflation during the war or how to stimulate the economy during the post-war period. Two main factors have to be studied in relation to these wars: the joint evolution of the skilled wage differentials with the CPI and the effect of the supply

shocks to labour, caused by the wars, on relative wages.

The evolution of the CPI during both World Wars is consistent with our hypothesis of nominal rigidity in the wages of the skilled workers. Since the inflationary process during WWI was stronger than during WWII, the corresponding adjustment in the unskilled wages was greater during WWI. As a consequence, relative skilled wages reacted more[6]. Wartime legislation made the Federal government the single largest employer of the country in 1918. Primarily concerned with the production of war goods, for the Federal government unskilled workers become almost as valuable as unskilled ones. During WWII, level of technology level as well as the amount of capital stock in the economy was much higher than during WWI, favoring a transfer of duties from skilled to unskilled workers. It could be said that, in comparative terms, unskilled workers become more valuable during WWI than during WWII and therefore were enjoying higher wages (compared with skilled workers) in an economy with heavy State intervention.

The labour supply shock implied by WWI was of a similar nature to that of the Civil War. The more than four million people recruited by the American Army were also mainly unskilled, poor and young. This caused a positive shock in the relative supply of skilled to unskilled workers with a consequent decrease in the skill premium. The opposite phenomenon happened again after the war as a result of those unskilled young workers coming back to civilian life. Similarly to the American Civil War, it is hard to tell whether the strong relationship between inflation and nominal rigidities in the wages of the skilled workers are only due to a labour supply shock or to some other reason.

The last two series to be presented in this paper(relative wages of clerical workers to labourers and of machinists to labourers) start in 1922 shortly after the post-WWI depression period which again favoured skilled workers. The first series presents a sharp turning point in 1933 when relative wages of the skilled workers stop rising and start a steady decrease. Relative wages of machinists to labourers present an overall decreasing trend, with pronounced short-term movements.

The deflationary post-war depression period of 1920-1921 was pernicious for the American economy: the strong contraction drove the labour market into an unemployment rate of around 12-14%. Wages though decreased more for unskilled than for skilled workers, illustrating the recurrent event of a negative relation between economic activity and the relative skilled wages. In fact, the opposite phenomenon took place during the following period of prosperity (1923-1927), though it was less pronounced. Again, the deflationary spiral of the late 1920s and early 1930s was more favorable to skilled workers than the recovery of the Roosevelt New Deal which preceded WWII.

Partially supported by the discontent derived from the post-WWI economic depression, restrictive legislation on immigration was passed in 1917, with the introduction of

[6] However, there is another factor to take into account: during the WWI, a package of coercive measures were set up in order to prevent strikes while during the 1940s, Unions agreed not to strike. The hypothesis would still be valid if these coercive measures had affected roughly in the same way both categories of workers.

the literacy test[7]. This opened the way to the Emergency Quota Act passed in 1921, the Immigration Act of 1924 and eventually the National Origins Act passed in 1929. The effects of such restrictive policies on relative skilled wages can be understood when considering the huge immigration flows at the beginning of the century. From 1905 to 1914, over one million people a year entered the country. These (mainly new) immigrants possessed schooling levels and living standards below those of previous groups (see Goldin 1993). In fact, they frequently lacked rudimentary skills in reading and writing. Thus, immigration laws (in particular the Emergency Quota Act of 1921 which limited the entrance of Southern and Eastern Europeans to 156,000 per year) might help explain the inflexion point in relative wages around 1920[8]. Although it is difficult to assess the relative impact of immigration on the wage ratio, it is sensible to think that the rate of growth of the total stock of unskilled labour was reduced as a consequence of the Act of 1921. Its effect on wages is not straightforward, but the fact that manufacturing employment was more heavily populated by immigrants makes us think the sharp decrease in the flow of less skilled immigrants caused the skilled-unskilled wage ratio to decrease to some extent. These findings are also confirmed by applied work on the effect of immigration on wages during this period (see Goldin 1993 or David and Solar 1977).

The 1920s also brought a spectacular improvement in education at all levels, with a consequent increase in the real stock of future workers' skills. During the first two decades of the 20th century, compulsory schooling laws were increasingly effective, gradually schooling capacity began to catch up with demand, the size of classes diminished with a corresponding decrease in the pupil-teacher ratio and universal attendance (usually to the age of fourteen) was achieved. By 1930 almost all States had elaborated certification laws and High Schools became mass institutions[9]. Although federal and State aid was expanding school funds at a rapid rate, this progress did not translate into higher salaries for all public school teachers. Our series refers to wages of primary and secondary school teachers, but the impact on these two categories was extremely different. Elementary school teachers were very badly paid, and their financial situation had declined steadily since 1905 due to the increase in prices. This was so because elementary school teachers had limited political power, although some progress had been achieved since the foundation of the CTF (Chicago Teachers' Federation)[10]. Thus, the observed increase in the

[7]The literacy test was to be administrated to (male) adults to assess their ability to read and in some cases to write.

[8]Still, there was a constant flow of immigrants coming from Canada, North-Western Europe and Mexico until 1924, when an annual quota of 164,000 immigrants was introduced. With the National Origins Act of 1929 this number was reduced to a small 20,000 per year.

[9]From 1890 to 1918 attendance in High School increased 711%, while total population increased only by 68%.

[10]The CTF started a crude battle to get higher wages for primary school teachers (almost all of them women) around 1898. In order to achieve more political power, they allied with the CFL (Chicago Federation of Labor). The Chicago experience stimulated other public school teachers throughout the country to associate and fight for their rights, but it was not until the 1920s and 1930s that they obtained their main goals.

wage ratio of public school teachers relative to labourers during this period is mainly due to the increase in the wages of secondary school teachers. According to the plots, the expected pressure on relative skilled wages of both phenomena (education and immigration) roughly cancelled each other out.

4.4 From the Great Depression to the Vietnam War period: 1929-1972

The Great Depression began in 1929 and lasted until 1933. During these 4 years, a strong nominal rigidity in the wages of skilled workers acted in their favor, the only exception being the relative wages of machinists to labourers which stayed almost constant. It is impressive to see how the three ratios we are studying increased during the greatest depression in American history (by 1932, only three out of four workers had a job). Again, the CPI is negatively correlated with the series. During the early depressionary period (1929-1930), a sharp deflationary trend accompanied the increase in relative wages. With the post-inflationary recovery and the first New Deal, the trend was reversed. This decrease in the relative wage ratio might have been caused by the National Industrial Recovery Act which set minimum wages and maximum hours from June 1933 until May 1935. The creation of the National Relations Board (NRB) which introduced the right to collective bargaining and other wages-and-hours protection, did not favor skilled workers as much as unskilled ones. This can be noted in all of the series except that of urban skilled to unskilled workers which remains more or less steady until the end of its coverage (1939). It is only during the recession of 1937 that the three remaining series smooth their downward slope or even reverse it (as in the case of relative wages of machinists to labourers). Baily (1983) maintains that the availability of large pools of unemployed workers, particularly less skilled labour, put downward pressure on wage rates in the late 1930s. Goldin an Margo (1991) point out that data from the 1940 Census reveal that unemployment rates were considerably higher among less educated workers. Again, in comparative terms, things get better for skilled workers during "bad times".

The role of the United States in the WWII was more intense than in the First. Preparation for the war was planned sometime in advance, before the United States officially declared war against Japan in 1941. Around 15 million people went into uniform. The national government tried to control war production (in a complete war economy) by strongly intervening in the markets. In contrast to WWI, the kind of labour recruited for the American Army was better prepared, with a higher level of skills and higher average age. There was also more homogeneity across skill categories than during the Civil War and WWI. However, it is still likely that the war increased the public demand for less skilled relative to more skilled and educated labour. As a consequence, there was a minor positive supply shock of skilled workers relative to unskilled ones in the rest of the economy. This would have caused a decrease in the skill premiums with a subsequent increase shortly after the reintroduction to civilian life of the soldiers who fought in the

war. During the years from 1942 to 1945, labour markets could not freely adjust to demand or supply shocks by adjusting wages. Perhaps as a result of this, both the relative wages of clerical workers to labourers and machinists to labourers sharply decrease during this period. The National War Labour Board was responsible for approving all wage increases and decreases. Thus, neither the relative labour demand shock during the war nor the post-war relative labour supply shock could have been absorbed by the market until 1946. Maybe this fact jointly with a more equally distributed level of skills across war participants, caused the downward slope of the series not to be so steep as during WWI. The WWII also led to a sharp rise in inflation and to a post-war depression. The nominal rigidity in the wages of more qualified workers could have caused them to lose purchasing power relative to less qualified workers during the war years, while it would have benefitted the unskilled workers during the post-depression years.

In 1945, when WWII finished, the American education system suffered a series of (mainly financial) problems. The most serious one was the shortage of teachers; already serious before the baby boom of 13 million post-war babies. This shortage pushed the wages of public school teachers upwards (as can be seen in Figures 3 and 4), but it also implied a lower level of preparation of the educational body in general because of the need for contracting almost indiscriminately[11]. The increasing trend in the wage ratio also demonstrates the increasing political power enjoyed by public school teachers, which reaches its zenith at the end of the period. Finally during the 1940s, the role of education in determining future occupations became increasingly evident, entrance into white-collar occupations depended heavily on the degree of schooling, while employers required only minimal schooling for workers in unskilled, semiskilled and service jobs.

After WWII, the United States took a new role in world affairs, focused on the preservation of the American leadership and on the prevention of the spread of communism. This goal drove the Americans into the Korean War (1950-1953). We can observe how the slope in the downward trend of the four series (the wage ratios of building trade workers to labourers, public school teachers to labourers, clerical workers to labourers and machinists to labourers) became less steep during the period. The country was again placed on a war basis which led to a period of prosperity (1953-1956). This coincided with a steeper slope in the skill differentials. This pattern was not changed by the recession 1957-1958, which followed. The recovery of the 1960s, with a stable and buoyant economy, coincided with the Vietnam War (1961-1973). Again, the war caused a shock to the supply of labour[12]. The implied positive shock of skilled to unskilled labour in the private sector caused a decrease in the wage ratio of building trades workers to labourers. The sharp decrease in this series around 1970 picks up this effect. Although it took place while the Vietnam War spread to Cambodia, it coincides with the announcement of President Nixon of his policy of *Vietnamization*, through which he substantially reduced the American ground

[11] Less than half of the teachers in 1947 had completed a college education

[12] People who went to the Vietnam War had similar characteristics to those who joined the Army during WWI: young, poor and unskilled.

forces in Vietnam to fewer than 70.000 men by early 1972.

The United States had to deal with a period of high inflation, while continuing with an interventionist policy and the corresponding rise in military expenses. During the 1960s the cost of living increased by 30% and by mid-1971 unemployment had reached a 10-year peak of 6%. Still, skilled wage differentials did not collapse and again, during this last recession, public school teachers were not the ones absorbing the adjustment. The evolution of the skilled premium of building trades workers to labourers is different: The increase in the CPI is accompanied by a persistent decrease in the wage ratio of building trades workers relative to labourers, with a slight steeper decrease in the subperiod after the Korean War, coinciding with an expansion of the economy.

The last years of the century were years of high economic growth, technological advance and capital accumulation. Both biased technological progress towards skilled workers and capital-skill complementarity could cause an increasing demand for the labour of skilled relative to unskilled workers. But this is a phenomenon of the 1980s, which is outside our temporal scope.

5 Empirical analysis: Real versus Nominal reasons

5.1 What theory tells us and what the data say

We saw already in Tables 3 and 7 that there is a significant relationship between relative wages and price indices for the three series taken from Lindert and Williamson (1980). The relationship is also robust to the detrending method. We have also computed the same statistics for the two series taken from Goldin and Margo (1991). They are presented in Table 6 (when detrending by taking first differences) and Table 10 (when detrending with the HP filter). In the case of relative wages of clerical workers relative to labourers, we find a significant and negative relationship with prices in both tables. This is not the case for the series of relative wages of machinists to labourers which only present a significant F statistic when filtering data with the HP filter. Machinists' labour, because of the nature of the job they performed, is very much dependent on aggregate demand shocks. Thus, the relative labour demand for machinists to labourers is more procyclical than the relative labour demand for e.g. clerical workers to labourers. As a consequence, the relative wages of machinists to labourers is more acyclical. In other words, we might expect this wage ratio to be heavily influenced by demand shocks.

Before analyzing the real forces that might be causing the observed rigidity in the wages of skilled workers, we have performed some sensitivity analysis with the data from Lindert and Williamson. First, we split the whole period into different subsamples and compute the coefficients of correlation with the two detrending methods. Second, we take out of the sample what we call *atypical years*, these are the war years and the years associated to the Crack of 1929. In particular, the atypical years are the following: 1861,

1862, 1863, 1864, 1865, 1917, 1918, 1919, 1929, 1930, 1931, 1932, 1933, 1941, 1942, 1943, 1944 and 1945.

Tables 4 and 8 present the coefficient of correlation when detrending by taking first differences and with the HP filter respectively, for the different subsamples. In the tables we can find the corresponding statistics of the relative wages of public school teachers' wages to labourers for two subsamples: 1841-1916 and 1920-1972. As can be seen from both tables, the relationship is always significant, though the F statistics are much higher during the first subperiod. The series of relative wages of urban skilled workers to labourers has also been split into two subperiods: 1816-1860 and 1866-1939. As expected from the results in Table 3, for the two detrending methods, there is no significant linkage before 1860.

When the number of observations allowed, we performed the same exercise without the atypical years. Results do not depend on whether we detrend by taking first differences (Table 5) or by using the HP filter (Table 9). Indeed, they are also very close to the previous exercise, when all years were included. This makes us think that supply shocks caused by wars do not seem to account on their own own for the significant relationship between prices and relative skilled wages. On the contrary, they might be caused by real shocks which affect relative labour demand. If these forces are playing a strong role, we should be able to see how the significant correlation between skill premiums and prices turns out to be spurious. Within these forces we will distinguish three that have already been suggested in this paper: the existence of different adjustment costs for skilled and unskilled labour, capital skill complementarity and technological progress biased towards skilled labour. The first operates at business cycle frequencies while the other two affect skill premiums more in a long run perspective.

The descriptive analysis of the series has made clear how the relationship between **supply shocks caused by wars** and skill premiums would operate. Assuming that a higher proportion of unskilled labour joins the Army, we should observe a decrease in the skill premium during the war, caused by a negative supply shock of unskilled to skilled labour. Likewise, the post-war period should be accompanied by an increase in the same relative supply which would lead to an increase in the skill premiums.

If there were **different adjustment costs for skilled than for unskilled workers**, aggregate demand shocks would be driving the movements in the relative demand for skilled/unskilled labour. The correlation between changes in prices and changes in skill premiums would only be reflecting cyclical movements in aggregate demand. The wages of skilled labour would be more rigid during shocks because firms would face higher adjustment costs than for unskilled labour[13]. As a consequence, the demand for unskilled workers is more responsive to the business cycle and the relative demand of skilled to unskilled workers will be anticyclical while the associated relative wages will be procyclical.

[13]Firms invest more in skilled labour via e.g., training programs specific to the firm, in such a way that, in comparative terms, they become more valuable than unskilled labour.

If this is the case, relative skilled wages will increase during negative demand shocks and increase during positive demand shocks. We should therefore observe a negative relationship between the rate of change of the Gross National Product (GNP, proxing aggregate demand fluctuations) and the rate of change of skill premiums.

According to the literature in the field, movements in skill premiums could also be the consequence of two non-exclusive forces that operate in the long run affecting the relative demand for skilled/unskilled labour: **Technological progress biased towards skilled workers** and **capital skill complementarity**. Both would push the relative labour demand upwards, benefitting skilled workers. Technological progress should be understood in a broad sense, meaning both new technology applied to existing production processes and new production processes themselves. It is often argued that those with a higher level of formal education or acquired skills can better understand and work more effectively with new machines. They are also better at performing under new production processes because they find it easier to learn new tasks. The concept of technological progress is normally understood as *disembodied* (not embodied into physical capital). This is a convenient assumption that helps to distinguish it from the notion of capital-skill complementarity. As capital is being accumulated, more labour will be demanded by firms, but the demand for skilled labour will increase more than that for unskilled. This is so because unskilled labour is thought to be a better substitute in production for physical capital than skilled labour. Or alternatively, skilled labour complements better with capital. In summary, by focusing only on demand shocks we might not be able to fully understand the pattern.

5.2 Extending the model

We have already seen that by changing the sample period, the detrending method, and by ignoring the atypical years the results do not change. The goal of the next part of the paper is to discover whether, once we control for the factors mentioned, the significant relationship between prices and wage ratios disappears as theory would say or, on the contrary, it still prevails.

As a first step, we study whether there is any significant relationship between GNP and relative wages, which would be pointing to demand shocks (combined with the existence of adjustment costs) causing the pattern. The exercise is presented detrending with the two methods (first differences and the HP filter) for the whole period and for different subsamples, with and without atypical years, as we did before. The results are given in Tables 3 to 9. Almost in all the cases the F statistics are not significant. Data on relative wages of clerical workers to labourers present a significant and negative coefficient of correlation with GNP. This would be consistent with higher adjustment costs for clerical workers than for labourers. Relative wages of machinists to labourers do not exhibit any significant relationship. This is not a striking outcome. It simply suggests that the possible differences in adjustment costs between machinists and labourers are less important than

those between clerical workers and labourers. Demand features do not seem to play a key role in explaining why our coefficients of correlations between the change in relative wages and inflation are significant.

The second step consists of extending the model by adding three more regressors to the rate of growth of CPI, each one capturing a specific real force that might be influencing the dependent variable. The variable called ARMY is the ratio of people in the military forces over employment. If its coefficient is found to be significant and negative, this would mean that the observed behaviour of skill premiums and prices responds to supply shocks caused by wars. The existence of capital-skill complementarity will be studied through the ratio of capital to employment. If we find a positive and significant relationship linking this regressor with our dependent variable, this would indicate a complementarity relationship between capital and skilled labour. Finally, in order to study whether biased technical progress might be explaining the behaviour of the dependent variable, an index of technological progress (a Solow residual) is introduced into the regression. This will be represented as SR[14]. If its coefficient is positive and significant, this would sustain the idea of technical progress biased towards skilled workers.

The sample period of these extended regressions will be different from the period of the data taken from Lindert and Williamson. The two series causing the restrictions are the figures on the real stock of capital (which start in 1890) and the SR (which finishes in 1969). This means the potentially highest coverage will go from 1890 to 1969. We have computed the F statistics again for this new coverage and found that, as expected, they are significant. We first run a regression on each of these variables (CPI, SR, ARMY and K/N) separately, in order to control for collinearity[15]. Then, we run a regression on all the variables at the same time. As before, both exercises are performed filtering the data with the two detrending methods.

Tables 11, 13, 15, 17 and 18 summarize the outcome of these regressions. Filtering data with the HP filter makes some of the regressors that were not significant when taking first differences become significant. In general though, both methods yield similar conclusions. Results with data from Lindert and Williamson for individual regressors are presented in Tables 11 and 15. Results with the Goldin and Margo data are in Tables 13 and 17. We first comment on the tables with individual regressors and then move to the extended model case.

The SR does not seem to behave as a good proxy for technology. It tends to present a negative sign (only significant for relative wages of clerical workers to labourers in Table 13). This would be consistent with the existence of asymmetric adjustment costs as far as the procyclical component of the SR is dominating the regression. There is some evidence of capital skill complementarity (especially when filtering with first differences) since the estimated coefficient on the regressor is positive and significant in three of out of four series

[14] An explanation about how the SR was constructed can be found in Appendix A

[15] Sometimes the correlation between the SR and capital intensity was high enough to make the regression on all the variables present collinearity problems.

(public school teachers to labourers, urban skill workers to labourers and railroad clerical workers to labourers). Supply shocks caused by wars seem to play a more important role than first thought, according to the results in Tables 5 and 9 (when we computed the coefficient of correlation between relative wages and prices without atypical years). With the only exception being the relative wages of machinists to labourers (whose activity probably increased during wars), the estimated coefficient on ARMY always presents a negative sign, significant for two of the series (public school teachers to labourers and railroad clerks to labourers). The important result though, is the striking negative sign of the CPI in all of the series for both detrending methods, and overall its significance (with the exception of relative wages of machinists to labourers).

The results of the extended regression can be found in Tables 12 and 16 for the data from Lindert and Williamson and in Tables 14 and 18 for the data from Goldin and Margo. Few estimated coefficients which were not significant when running OLS on each segressor separately, turn out to be so now. Again the sign of the estimated coefficient on the SR makes us think it is proxying demand shocks rather than technological progress. Evidence on the existence of capital skill complementarity is very weak. Concerning supply shocks caused by wars, the results are close to Tables 11, 13, 15 and 17. We can therefore conclude that the strongest relationship is that between prices and relative wages. The rigidity in the wages of skilled workers does not seem to be the outcome of any of these real forces. The reasons for such a pattern could be therefore related to institutional forces.

6 Concluding remarks

In this paper we have found empirical support for the existence of nominal rigidities in the wages of skilled workers for four different historical time series: skill premiums of public school teachers to labourers, urban skilled workers to labourers, building trades workers to labourers and clerical workers to labourers. Such rigidities are captured through a negative and significant relationship between the skill premiums and the consumer price index. A similar outcome was not found when the linkage between aggregate demand shocks and skill premiums was studied. This result casts strong doubts on the assertion that real rigidities explain changes in skill premiums.

The finding is robust to the detrending method: taking first differences and filtering data with the HP filter. Further senstivity analysis (changes in the sample period and exclusion of the *atypical years*) also yielded the same result. Finally, an enlargement in the number of regressors which would control for a possible misspecification of the model is still consistent with the original results. The three added regressors are proxying for supply shocks caused by wars, for the rate of technological progress and for capital skill complementarity. Econometric results make us doubt the ability of the SR to proxy technological progress in this set up.

Our results point to a striking stylized fact not addressed by the literature on skill premiums: the rigidities observed in the wages of skilled workers are caused by institutional forces. Further study is needed in order to fully understand this result.

Appendix A: Data Appendix

Almost all the data used in this chapter were obtained from four basic sources: Lindert and Williamson (1980), Kendrick (1967), US Department of Commerce (1973) and US Bureau of the Census (1970), USBC hereafter. Sometimes the series were used as presented in the basic source, sometimes they were treated previously. In what follows, an description of all the series used in this paper is presented.

Data on prices, 1816-1975. In this paper we use two different price indices series. The first is the Consumer Price Index (1967=100), covering the period 1816-1970. It corresponds to Table E 135-166 from the USBC. The second is the Wholesale Price Index (1938=100), which was obtained from "International Historical Statistics: America and Australasia". The series were transformed in order to homogenize the base year of the index.

Data on relative wages of public school teachers to labourers, 1841-1972. This series has been constructed from two other identical series presented in Lindert and Williamson (1980). The first one covers the period 1841-1916 and the second one covers the period 1918-1973. The second series had only one observation for each two years. I calculated the average mean of each two years from 1818 to 1973 and added the resulted series (which now had one observation per year) to the first one.

Data on relative wages of urban skilled workers to labourers, 1816-1939. Obtained from Lindert and Williamson (1980). No transformations were made.

Data on relative wages building trades workers to labourers, 1907-1970. The presented series was constructed by splicing two series covering different periods. They both corresponded to relative wages of skilled workers in building trades to labourers and were obtained from the same source Lindert and Williamson (1980). The first one covered the period 1907-1952 while the second one extended from 1947 until 1970. There were therefore 6 years of overlap (1947-1952), which allowed the splicing. To splice two series simply consists of constructing a unique one from the existing two. Of course, a high parallelism of the series during the overlapping period is required. In our case, this parallelism is guaranteed by the value of the coefficient of correlation during the overlapping period of the series. The correlation coefficient in log levels is 0.90, while in the rate of change of the series (first difference of the logs) reaches 0.85. Their magnitude support the practice of splicing. The method followed here to splice the series is the one proposed by Hill and Fox (1995), and the splicing was performed with the log levels of the series. The resulting spliced series is presented and commented in the chapter.

Data on relative wages of clerical workers to labourers, 1922-1952. These data can be found in Table 2A in the Appendix, column (1)/(2) from Goldin and Margo (1991). Their source is the US Interstate Commerce Commission 1922 to 1952.

Data on relative wages of machinists to labourers 1922-1952. This series can be found in Table 2A in the Appendix, column (3)/(2) from Goldin and Margo (1991).

Their source is the US Interstate Commerce Commission 1922 to 1952.

Data on real net capital, 1889-1970. The series used as capital is the outcome of splicing two other index series on real capital. The first one, covering the period 1889-1953 is from Kendrick (1967) and refers to net private domestic real capital stock. The base year is 1929. The second one belongs to the USBC and it refers to private capital stock. It covers the period 1929-1970. In this case, 1958 was the base year. In order to make two real series compatible with different base years, the series were transformed into index numbers series, taking as base years 1929 and 1958 respectively. The new index number series, was spliced following the method explained in Hill and Fox (1995). During the overlapping period of the series (1929-1953), both behaved and moved very close to each other, with very high coefficients of correlation. In log levels, its value was 0.963, while in rates of change the computed statistic reached 0.891.

Data on GNP, 1816-1973. Real Gross National Product was obtained from "International Historical Statistics. America and Australasia". As the base year of the presented series changed three times during the period, the figures were treated so as to make 1958 the base year.

Data on employment, 1890-1973. This is a series on total civilian employment. It was made by using two series obtained from the US Department of Commerce. The first one corresponds to the series A78, its original source is Lebergott (1964) and covers the period 1890-1939. The second is from the Bureau of Labour Statistics (BLS) and corresponds with the series A79. It goes from 1929 till 1970. This series can also be obtained from the USBC, but with a shorter coverage, as series D 11-25 (column 15) and from Datapedia series D 11-25, when columns 16 and 17 are added up. Three more data points were added from this last source (1970-1973). The USBC explicitly remarks that the data on employment are based on those from Lebergott, that is why when both series are plotted together there are practically overlapping. Thus, no splicing method was used in this case, only the average mean was computed during the overlapping period (1929-1939).

Data on total factor productivity,1889-1969. For the period 1889-1956, these data were obtained from Kendrick (1967). The series is an index of output per unit of total factor input, constructed from industrial data. Figures on total factor input include labour and capital. Manhours worked are used as the measure of the flow of available labour services, properly weighted by the average hourly compensation in the base period. Capital corresponds to real net capital stock employed in the various industries, weighted by the base-period rates of return. In the appendix of his book all the information related to the way the TFP was constructed can be found. The rate of change of Kendrick's total factor productivity index was spliced with a Solow residual series constructed from the USBC data and covering the period 1929-1969. The series overlap from 1929 until 1956. The Solow residual is constructed as follows:

$$SR_t = \Delta lnY_t - \alpha_{nt}\Delta lnN_t - \alpha_{kt}\Delta lnK_t \quad (1)$$

where α_{nt} is the factor share of employees at time t and α_{kt} is the factor share which remunerates the capital services, such that $\alpha_{kt} = 1 - \alpha_{nt}$

When computing the proportion of income which remunerates employment or capital, the problem of self-employment arises. The are three options: to include all the proprietors' income into the share of capital, into the share of employment or to distribute it between capital and labour proportionally. This third option has been chosen in the paper. The labour share has been computed as the ratio of wages and salaries to wages and salaries plus profits plus net interest plus rental income of persons. The resulting labour share series has a value in between the other two possible labour shares. In any case, when the three SR series are computed differences among them are almost negligible.

The coefficient of correlation between the SR and the rate of change of Kendrick's TFP was of 0.768. All the series used in the computation of the labour shares were obtained from the USBC: Series F 163 185. The sources of the data on GNP, employment and capital which were used to construct the SR are explained above.

Data on military personnel on active duty 1816-1970. The figures were obtained from the USBC, series Y 904-916.

Appendix B: Econometric results

Note that the following remarks apply to all the tables.

- In what follows, * denotes significant at 5%.
- Relative wages have been abbreviated as follows: PTL: relative wages of public school teachers to labourers, WBTL: relative wages of workers in building trades to labourers, USL: relative wages of urban skilled workers to labourers, RCL: relative wages of railroad clerks to labourers, ML: relative wages of machinist to labourers.
- Other macroeconomic variables that have been abbreviated are: CPI: consumer price index, WPI: wholesale price index, GNP: Gross national product.
- Corrcoef stands for the coefficient of correlation and num. obs stands for number of observations.

Coefficients of Correlation: Data filtered with first differences

Table 3: COEFFICIENTS OF CORRELATION AND SIGNIFICANCE TESTS FOR THE WHOLE PERIOD

Corrcoef and F test	$\Delta log(CPI)$	$\Delta log(WPI)$	$\Delta log(GNP)$	period	num. obs
$\Delta log(PTL)$	-0.441	-0.444	-0.126		
F test	31.20*	31.81*	2.08	1841-1972	131
$\Delta log(WBTL)$	-0.598	-0.30	-0.100		
F test	35.186*	6.68*	0.63	1907-1972	65
$\Delta log(USL)$	-0.153	0.127	-0.006		
F test	2.91	1.99	0.004	1816-1939	123
$\Delta log(USL)$	-0.291	-0.242	-0.007		
F Test	5.90*	5.44*	0.53	1850-1939	89

Table 4: COEFFICIENTS OF CORRELATION AND SIGNIFICANCE TESTS FOR SUBSAMPLES

Corrcoef and F test	$\Delta log(CPI)$	$\Delta log(WPI)$	$\Delta log(GNP)$	period	num. obs
$\Delta log(PTL)$	-0.434	-0.428	0.04		
F test	30.07*	29.06*	0.29	1841-1916	75
$\Delta log(PTL)$	-0.496	-0.497	-0.26		
F test	16.34*	16.43*	3.80	1920-1972	52
$\Delta log(USL)$	0.122	0.096	0.237		
F test	0.641	0.395	2.50	1816-1860	45
$\Delta log(USL)$	-0.347	-0.33	-0.178		
F test	9.72*	8.82*	2.33	1866-1939	74

Table 5: COEFFICIENTS OF CORRELATION AND SIGNIFICANCE TESTS WITHOUT ATYPICAL YEARS

Corrcoef and F test	$\Delta log(CPI)$	$\Delta log(WPI)$	$\Delta log(GNP)$	period	num. obs
$\Delta log(PTL)$	-0.592	-0.527	0.088		
F test	59.99*	42.87*	0.867	1841-1972	113
$\Delta log(PTL)$	-0.374	-0.439	0.017		
F test	6.51*	9.59*	0.204	1920-1972	42
$\Delta log(WBTL)$	-0.80	-0.60	-0.26		
F test	94.86*	29.17*	3.80	1907-1972	52
$\Delta log(USL)$	-0.215	-0.169	0.161		
F test	5.25*	3.20	2.88	1816-1939	110
$\Delta log(USL)$	-0.536	-0.435	0.142		
F test	25.51*	14.76*	1.30	1866-1939	62

Table 6: COEFFICIENTS OF CORRELATION AND SIGNIFICANCE TESTS FOR THE GOLDIN AND MARGO (1991) DATA

Corrcoef and F test	$\Delta log(CPI)$	$\Delta log(WPI)$	$\Delta log(GNP)$	period	num. obs
$\Delta log(RCL)$	-0.667	-0.548	-0.731		
F test	22.45*	12.01*	37.16*	1922-1952	30
$\Delta log(ML)$	-0.340	0.0036	0.267		
F test	-3.67	0.00003	2.158	1922-1952	30

Data filtered with the Hodrick-Prescott filter

Table 7: COEFFICIENTS OF CORRELATION AND SIGNIFICANCE TESTS FOR THE WHOLE PERIOD

Corrcoef and F test	log(CPI)	log(WPI)	log(GNP)	period	num. obs
log(PTL)	-0.51	-0.615	-0.016		
F test	46.48*	78.76*	0.035	1841-1972	132
log(WBTL)	-0.77	-0.48	0.010		
F test	95.37*	19.62*	0.0067	1907-1972	66
log(USL)	-0.283	-0.22	0.118		
F test	10.61*	6.38*	1.71	1816-1939	124
log(USL)	-0.35	-0.31	0.137		
F Test	12.69*	9.45*	1.68	1850-1939	90

Table 8: COEFFICIENTS OF CORRELATION AND SIGNIFICANCE TESTS FOR SUBSAMPLES

Corrcoef and F test	log(CPI)	log(WPI)	log(GNP)	period	num. obs
log(PTL)	-0.605	-0.55	0.43		
F test	42.74*	33.06*	16.81*	1841-1916	76
log(PTL)	-0.36	-0.55	-0.265		
F test	7.57*	22.00*	3.79	1920-1972	53
log(USL)	0.097	0.209	0.135		
F test	0.401	1.936	0.783	1816-1860	45
log(USL)	-0.478	-0.469	0.085		
F Test	21.02*	20.08*	0.534	1866-1939	74

Table 9: COEFFICIENTS OF CORRELATION AND SIGNIFICANCE TESTS WITHOUT ATYPICAL YEARS

Corrcoef and F test	log(CPI)	log(WPI)	log(GNP)	period	num. obs
log(PTL)	-0.460	-0.510	0.126		
F test	30.47*	39.88*	1.83	1841-1972	114
log(PTL)	-0.445	-0.558	0.76		
F test	9.88*	18.08*	0.232	1920-1972	43
log(WBTL)	-0.833	-0.729	0.010		
F test	113.75*	56.95*	0.006	1907-1972	53
log(USL)	-0.148	-0.022	0.029		
F test	2.42	0.054	0.092	1816-1939	111
log(USL)	-0.388	-0.241	0.102		
F test	11.18*	3.92	0.67	1866-1939	63

Table 10: COEFFICIENTS OF CORRELATION AND SIGNIFICANCE TESTS FOR THE GOLDIN AND MARGO (1991) DATA

Corrcoef and F test	log(CPI)	log(WPI)	log(GNP)	period	num. obs
log(RCL)	-0.621	-0.688	0.841		
F test	17.63*	25.19*	67.63*	1922-1952	31
log(ML)	-0.424	-0.088	0.19		
F test	6.15*	0.22	1.12	1922-1952	31

OLS estimators

Data filtered with first differences

Table 11: OLS RESULTS FOR INDIVIDUAL REGRESSORS

Regressors	$\Delta log(CPI)$	SR	$\Delta log(K/N)$	$\Delta log(ARMY)$
$\Delta log(PTL)$	-0.664	-0.074	0.402	-0.044
1890-1969	-5.53*	-0.65	1.72*	-2.62*
$\Delta log(WBTL)$	-0.238	0.019	0.042	-0.004
1907-1969	-6.48*	0.43	0.45	-0.67
$\Delta log(USL)$	-0.145	-0.022	0.124	0.705
1890-1938	-3.34*	-0.58	1.61*	-0.25

[a]The coefficients and the t-ratios when we run OLS on each regressor separately.

Table 12: OLS RESULTS FOR THE EXTENDED MODEL

Regressors	Constant	$\Delta log(CPI)$	SR	$\Delta log(K/N)$	$\Delta log(ARMY)$
$\Delta log(PTL)$	0.015	-0.628	-0.023	0.103	-0.041
1890-1969	2.26*	-5.08*	-0.220	0.440	-2.86*
$\Delta log(WBTL)$	-0.002	-0.271	0.015	-0.156	-0.001
1907-1969	-1.18	-6.83*	0.42	-1.83	-0.316
$\Delta log(USL)$	0.004	-0.138	0.003	0.066	-0.001
1890-1938	-1.35	-2.81*	0.083	0.743	-0.180

[a]The coefficients and the t-ratios when we run OLS on all the regressors at the sime time.

Table 13: OLS RESULTS FOR INDIVIDUAL REGRESSORS: GOLDIN AND MARGO (1991) DATA

Regressors	$\Delta log(CPI)$	SR	$\Delta log(K/N)$	$\Delta log(ARMY)$
$\Delta log(RCL)$	-0.0054	-0.406	0.425	-0.026
1922-1952	-4.05*	-4.38*	2.36*	-1.64
$\Delta log(ML)$	-0.0025	-0.092	0.022	0.0249
1922-1952	-2.04*	0.99	1.51	2.05*

[a]The coefficients and the t-ratios when we run OLS on each regressor separately.

Table 14: OLS RESULTS FOR THE EXTENDED MODEL: GOLDIN AND MARGO (1991) DATA

Regressors	Constant	$\Delta log(CPI)$	SR	$\Delta log(K/N)$	$\Delta log(ARMY)$
$\Delta log(RCL)$	-0.331	-0.0049	-0.341	-0.161	-0.007
1922-1952	3.32*	-3.95*	-3.28*	0.99	-0.61
$\Delta log(ML)$	-0.187	-0.001	-0.158	0.312	0.018
1922-1952	-1.31	1.30	1.44	1.82	1.37

[a]The coefficients and the t-ratios when we run OLS on all the regressors at the sime time.

OLS estimators

Data filtered with Hodrick-Prescott filter

Table 15: OLS RESULTS FOR INDIVIDUAL REGRESSORS

Regressors	log(CPI)	SR	log(K/N)	log(ARMY)
log(PTL)	-0.579	-0.192	0.402	-0.074
1890-1969	-5.54*	-1.58	1.58	-3.82*
log(WBTL)	-0.263	0.018	0.0003	-0.0005
1907-1969	-11.30*	0.399	0.337	-0.073
log(USL)	-0.162	-0.026	-0.022	-0.178
1890-1939	-5.08*	-0.77	-0.29	-1.62

[a]The coefficients and the t-ratios when we run OLS on each regressor separately.

Table 16: OLS RESULTS FOR THE EXTENDED MODEL

Regressors	log(CPI)	SR	log(K/N)	log(ARMY)
log(PTL)	-0.567	-0.208	-0.194	-0.065
1890-1969	5.40*	-2.11*	-0.88	-3.91*
log(WBTL)	-0.300	-0.0027	-0.230	0.001
1907-1969	-13.40*	-0.115	-4.17*	0.452
log(USL)	-0.175	-0.036	-0.133	-0.076
1890-1939	-5.31*	-1.27	-1.98*	-0.84

[a]The coefficients and the t-ratios when we run OLS on all the regressors at the sime time.

Table 17: OLS RESULTS FOR INDIVIDUAL REGRESSORS: GOLDIN AND MARGO (1991) DATA

Regressors	log(CPI)	SR	log(K/N)	log(ARMY)
log(RCL)	-0.524	-0.181	0.781	-0.038
1922-1952	-4.43*	-1.08	5.83*	-2.85*
log(ML)	-0.215	0.115	0.116	0.024
1922-1952	-2.72*	1.19	1.07	3.37*

[a]The coefficients and the t-ratios when we run OLS on each regressor separately.

Table 18: OLS FOR THE EXTENDED MODEL: GOLDIN AND MARGO (1991) DATA

Regressors	log(CPI)	SR	log(K/N)	log(ARMY)
log(RCL)	-0.323	-0.209	-0.371	-0.026
1922-1952	-2.17*	-2.08*	1.80	-2.50*
log(ML)	-0.169	0.064	0.068	0.026
1922-1952	-1.53	0.86	0.449	3.35*

[a]The coefficients and the t-ratios when we run OLS on all the regressors at the sime time.

Appendix C: Figures and unit root tests

The following notes apply to all figures. Further remarks are made when necessary in the corresponding legends. In order to make it easier to look at certain joint plots (eg when log CPI was plotted with any series on log skill wage differentials), a positive real number has been added to the lower series (normally the log of the skilled wage differentials). The number is presented in the title of the figure for transparency reason, but it should be clear that it is an arbitrary number and, to some extent, it is only used to enhance clarity.

All the series in log levels (apart from the SR) were found to be non-stationary. Augmented Dickey Fuller tests around a constant (ADFK) and around a trend (ADFT) were performed. These results were reinforced with Phillips Perron Tests around a constant and around a trend (especially useful when the ADFK and ADFT had mathematical problems). We present here the results of testing the stationarity of the series both with the highest coverage (and the corresponding tests for the CPI and WPI) and the coverage of the extended regression with their corresponding regressors

Concerning the graphics, the continuous line always relates to skilled wage differentials, the discontinuous line refers therefore to the other plotted series.

Table 19: UNIT ROOT TESTS

Series	Period	ADFK	ADFT	PPK	PPT
log(PTL)		-2.63	-3.16	-2.22	-3.44
		CV=-2.88	CV=-3.44	CV=-2.88	CV=-2.12
log(CPI)	1841-1972	-0.245	-1.869	0.245	-1.69
		CV=-2.88	CV=-3.44	CV=-2.88	CV=-3.44
log(WPI)		-0.354	-1.558	-0.203	-1.65
		CV=-2.88	CV=-3.44	CV=-2.88	CV=-3.44
log(WBTL)		-0.16	-2.21	-0.28	-2.52
		CV=-2.90	CV=-3.47	CV=-2.90	CV=-3.47
log(CPI)	1907-1970	2.78	-2.42	-0.708	-2.03
		CV=-2.90	CV=-3.47	CV=-2.90	CV=-3.47
log(WPI)		CV=-0.64	CV=-1.69	CV=-0.77	CV=-2.11
		CV=-2.90	CV=-3.47	CV=-2.90	CV=-3.47
log(USL)		-3.36	-3.33	-4.03	-3.33
		CV=-2.88	CV=-3.44	CV=-2.88	CV=-3.44
log(CPI)	1816-1938	-2.33	-2.66	-2.39	-2.59
		CV=-2.88	CV=-3.44	CV=-2.88	CV=-3.44
log(WPI)		-2.41	-2.69	-2.35	-2.48
		CV=-2.90	CV=-3.47	CV=-2.90	CV=-3.47
log(USL)	1850-1939	-1.95	-3.26	-1.78	-3.08
		CV=-2.89	CV=-3.46	CV=-2.89	CV=-2.46
log(CPI)	1850-1939	-2.03	-2.25	-1.69	-1.90
		CV=-2.89	CV=-3.46	CV=-2.89	CV=-3.46
log(WPI)	1850-1939	-1.92	-2.02	-1.84	-1.96
		CV=-2.89	CV=-3.46	CV=-2.89	CV=-3.46
log(GNP)	1850-1939	-1.10	-1.22	-1.17	-1.34
		CV=-2.89	CV=-3.46	CV=-1.17	CV=-3.46

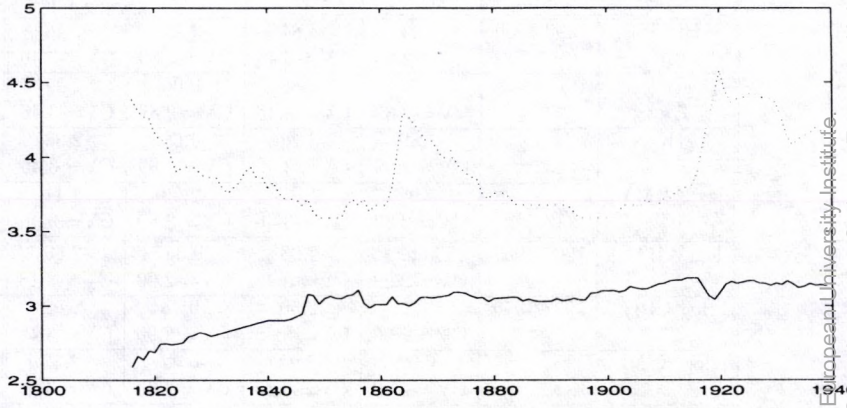
[a]Unit root tests for each of the series. CV: Critical value.

Table 20: UNIT ROOT TESTS FOR THE EXTENDED MODEL

Series	Period	ADFK	ADFT	PPK	PPT
log(PTL)	1890-1969	-3.41	-3.84	-2.24	-2.46
		CV=-2.89	CV=-3.46	CV=-2.89	CV=-3.46
log(CPI)		-0.33	-2.88	-0.06	-2.39
		CV=-2.89	CV=-3.46	CV=-2.89	CV=-3.46
log(K/N)		-1.89	-3.26	-0.68	-2.33
		CV=-2.89	CV=-3.46	CV=-2.89	CV=-3.46
log(ARMY)		-0.95	-1.87	-2.09	-3.44
		CV=-2.89	CV=-3.46	CV=-2.89	CV=-3.46
log(WBTL)	1907-1969	0.062	-4.93	0.33	-2.60
		CV=-2.90	CV=-3.48	CV=-2.90	CV=-3.48
log(CPI)	1907-1970	2.71	-2.50	-0.78	-2.02
		CV=-2.90	CV=-3.48	CV=-2.90	CV=-3.48
log(K/N)		-0.99	-2.92	-0.32	-2.36
		CV=-2.90	CV=-3.48	CV=-2.90	CV=-3.48
log(ARMY)		-0.72	-2.13	-1.84	-2.76
		CV=-2.90	CV=-3.48	CV=-2.90	CV=-3.48
log(USL)		-0.73	-3.07	-2.16	-1.75
		CV=-2.92	CV=-3.50	CV=-2.92	CV=-3.50
log(CPI)		-1.351	-2.00	-1.13	-1.70
		CV=-2.92	CV=-3.50	CV=-2.92	CV=-3.50
log(K/N)		-2.24	-2.48	-0.86	-1.75
		CV=-2.92	CV=-3.50	CV=-2.92	CV=-3.50

[a]Unit root tests for the extended model. CV: Critical value.

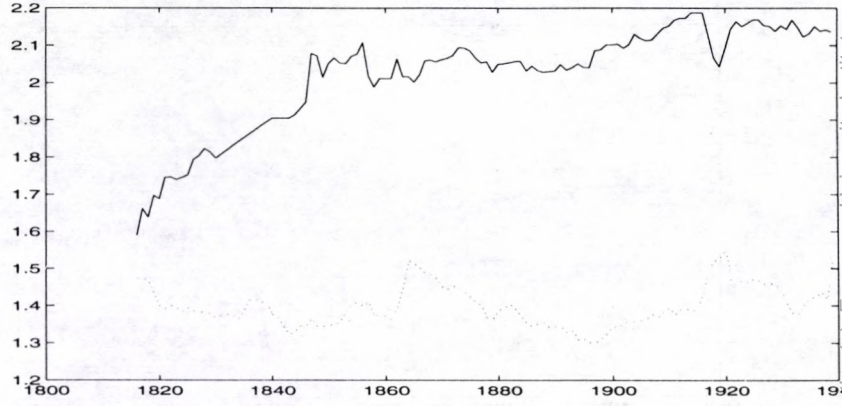
Figure 1: RELATIVE WAGES OF URBAN SKILLED WORKERS TO LABOURERS AND CONSUMER PRICE INDEX



[a]Variables are expressed in log levels

[b]Relative wages series + 2.5 : continous line; Consumer price index : discontinuous line

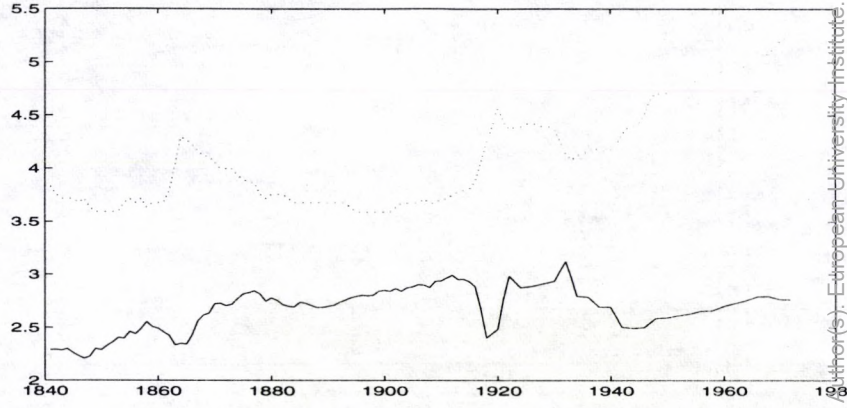
Figure 2: RELATIVE WAGES OF URBAN SKILLED WORKERS TO LABOURERS AND WHOLESALE PRICE INDEX



[a] Variables are expressed in log levels

[b] Relative wages series + 1.5 : continuous line; wholesale price index : discontinuous line

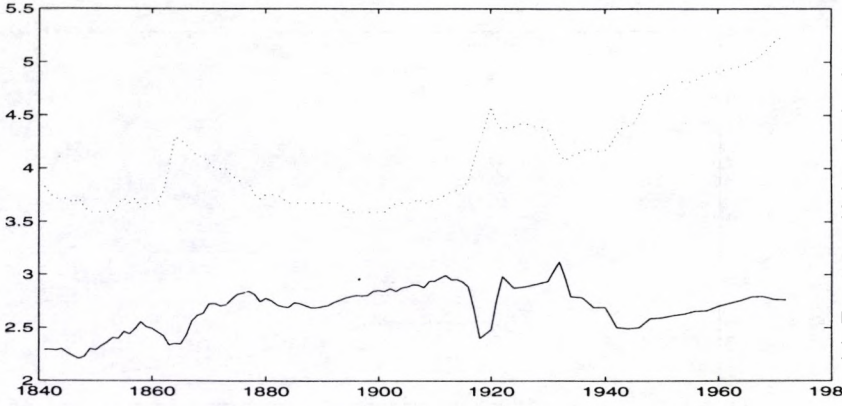
Figure 3: RELATIVE WAGES OF PUBLIC SHOOL TEACHERS TO LABOURERS AND CONSUMER PRICE INDEX



[a] Variables are expressed in log levels

[b] Relative wages series + 2.5 : continuous line; consumer price index : discontinuous line

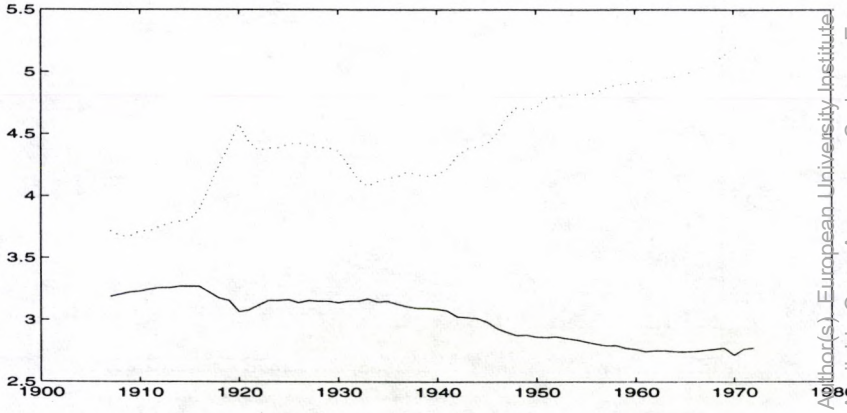
Figure 4: RELATIVE WAGES OF PUBLIC SHOOL TEACHERS TO LABOURERS AND WHOLESALE PRICE INDEX



[a] Variables are expressed in log levels

[b] Relative wages series + 2.5 : continuous line; wholesale price index : discontinuous line

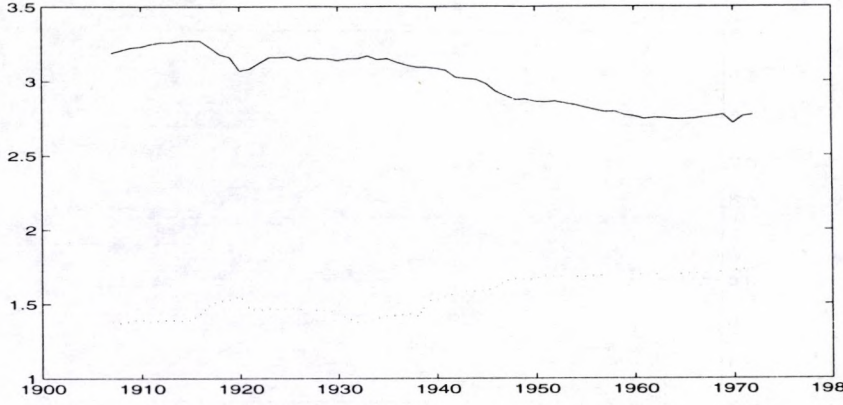
Figure 5: RELATIVE WAGES OF SKILLED WORKERS IN BUILDING TRADES TO LABOURERS AND CONSUMER PRICE INDEX



[a]Variables are expressed in log levels

[b]Relative wages series + 2.5 : continuous line; consumer price index : discontinuous line

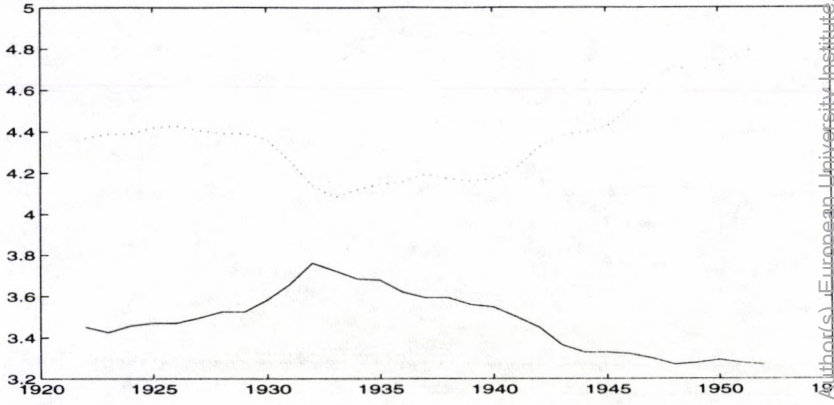
Figure 6: RELATIVE WAGES OF SKILLED WORKERS IN BULDING TRADES TO LABOURERS AND WHOLESALE PRICE INDEX



[a] Variables are expressed in log levels

[b] Relative wages series + 2.5 : continuous line; wholesale price index : discontinuous line

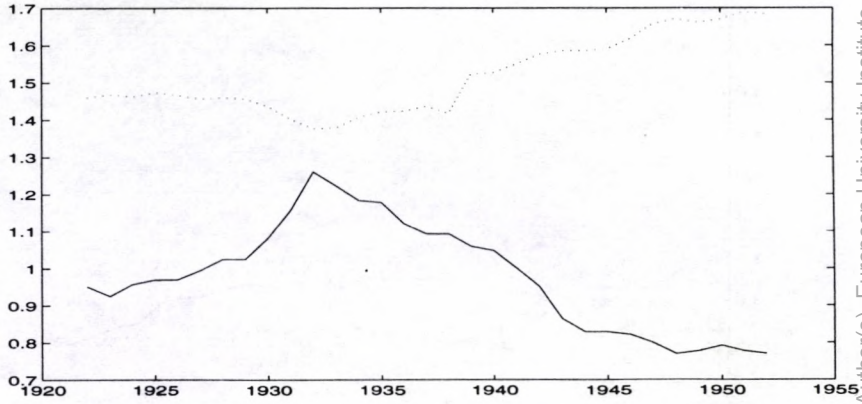
Figure 7: RELATIVE WAGES OF CLERKS TO LABOURERS AND CONSUMER PRICE INDEX



[a] Variables are expressed in log levels

[b] Relative wages series + 3 : continuous line; consumer price index : discontinuous line

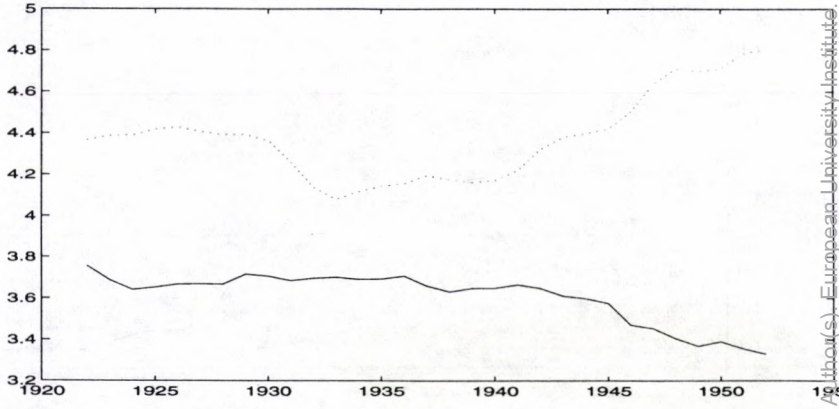
Figure 8: RELATIVE WAGES OF CLERKS TO LABOURERS AND WHOLESALE PRICE INDEX



[a] Variables are expressed in log levels

[b] Relative wages series + 0.5 : continuous line; wholesale price index : discontinuous line

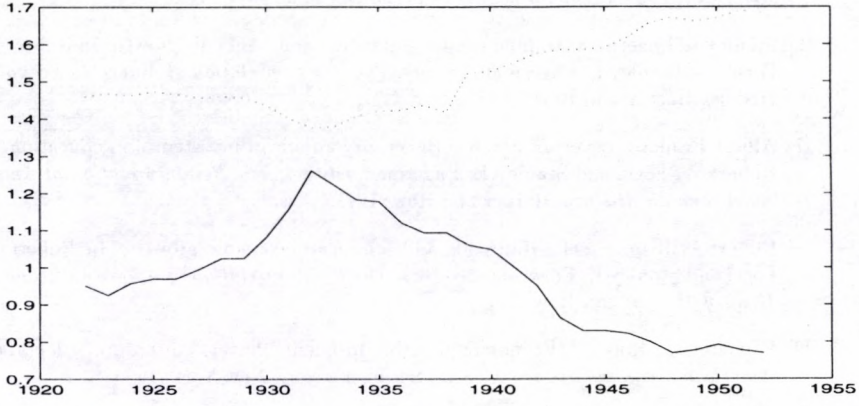
Figure 9: RELATIVE WAGES OF MACHINISTS TO LABOURERS AND CONSUMER PRICE INDEX



[a] Variables are expressed in log levels

[b] Relative wages series + 3 : continuous line; consumer price index : discontinuous line

Figure 10: RELATIVE WAGES OF MACHINISTS TO LABOURERS AND WHOLESALE PRICE INDEX



[a] Variables are expressed in log levels

[b] Relative wages series + 0.5 : continuous line; wholesale price index : discontinuous line

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