Explaining UK Wage Inequality in the Past Globalization Period, 1880-1913

Abstract

The current era of globalisation has witnessed a rising premium paid to skilled workers resulting in increasing wage inequality in most OECD countries. This pattern differs from that observed during the past globalisation period (1880-1913), in which wage inequality decreased in most of the Old World countries. The present debate over wage inequality focuses on the implications of globalisation, technological change, the role of labour market institutions and education. Similar factors were at work in the past globalisation process. In order to disentangle the main factors that contribute to wage inequality, we calibrated a general equilibrium model for the UK economy in the past globalisation period. The results show that a trade shock and a skilled-biased technology shock increased wage inequality. However, education and emigration had a more significant impact and led to a decrease in wage inequality.

JEL classification: N30, C68, J31
1. Introduction

The current debate surrounding the rise in wage inequality which took place in the 1980s and 1990s in most OECD countries focuses mainly on the implications of globalisation and technological change. The main globalisation factor is trade, as a result of given falling barriers to international transactions (Wood 1998, Slaughter 1998, Feenstra 2000). Skilled-biased technological change is considered, as we are presently immersed in a process of diffusion of General Purpose Technologies in which computers have led to important advances in communication and other related innovations (Machin and Van Reen 1998, Aghion and Howitt 2002, Aghion, Howitt and Violante 2002, Card and Di Nardo 2002). However, the consensus of research in this field concentrates on the importance of technological change. Other researchers have incorporated additional variables into the debate such as the role of labour market institutions and education. Labour market institutions are important as a consequence of the reduction of the minimum wage and the loss of trade union power (Lee 1999, Card, Lemieux and Ridde 2003, Goslin and Lemieux 2001), whereas education enters into the debate because the labour force does not seem to be adapting to the demand for skills required by new technologies (Wälde 2000, Goldin and Katz 2008).

Similar changes also took place during the past globalisation process, 1880-1913. In the second half of the nineteenth century there was a globalisation process with an increase in commodity trade and important movements of capital and labour across countries (O’Rourke and Williamson 1999). The technological and organisational changes at the end of the nineteenth century, namely the Second Industrial Revolution, increase affected the demand for skilled workers relative in relation to unskilled workers (electricity, as a General Purpose Technology, and the transport and
communication revolution). Moreover, there was also an important institutional upheaval: this period witnessed the emergence of trade unions and a significant number of socialist organisations. The so-called “labour movement” was very active at the end of the nineteenth century and throughout the early decades of the twentieth century in many countries. Subsequently, labour institutions improved labour conditions and played a different role to that played at present. Finally, most countries made an effort to improve education resulting in a considerable increase in literacy rates and school enrolment. Both these factors have had a positive direct bearing on the number of skilled workers in OECD countries.

The purpose of this paper is to analyse the main factors that contributed to wage inequality during the globalisation period by focusing on the implications of globalisation (trade and migration), technological change, capital, education and population growth. Looking into how the above mentioned factors affected wage inequality in the past could shed light on the current debate surrounding the factors competing in the current globalisation process that is still to be completed. We calibrate a general equilibrium model (CGE) that enabled us to determine the importance of each of these factors or, in other words, the contribution of each individual shock (trade, migration, education and demographic factors) on the decrease of wage inequality in the UK in 1880-1913. Contrary to the rise of in wage inequality that witnessed during the 20th century, we will show in this paper that in the in the past globalisation process trade and technology increased wage premium as in the present time, but other off-setting factors such as improvements in education and migration come into play reducing wage inequality. We will also aim to contribute to the debate about whether the technological change of the Second Industrial Revolution was skilled deplacing or skilled biased. Our results, in the same line as in Betrán and Pons (2004), indicate that in the past
globalisation process, as in most of the research on wage inequality for the present, technology change played an important role against a reduction in wage inequality, therefore technological change was skilled biased.

Our paper has been inspired by the methodological and theoretical sources of Williamson (1976, 1990), O’Rourke and Williamson (1994), O’Rourke, Taylor and Williamson (1996) and Abrego and Whalley (2000, 2003). The seminal work using a CGE model to decompose the source of inequality in the US is due to Williamson (1976). Williamson studies the contribution of both supply (labour supply and capital formation) and long term demand forces (including sectoral total factor productivity growth, factor saving bias, and final demand changes) in explaining the secular behaviour of two measures of inequality: the unskilled wages’ share in national income and the wage productivity ratio. In his study, time periods for the empirical model are selected so as to capture the main dimensions of America’s long-term inequality swing from 1896 to 1948. He concluded that factor supply forces only explained a modest portion of the change in American inequality after 1896 and that the demand forces were very important in the explanation of Americas’ inequality history. Although factors supply tended to increase inequality other larger offsetting factors decreased inequality after the WWI.

Also O’Rourke and Williamson (1994), by means of a two country CGE model, analysed the empirical relevance of the Heckscher-Ohlin theory in the late nineteenth century. To isolate the contribution of factor-price equalization due to commodity trade they focus on the wage-rental ratio. In the same way, O’Rourke, Taylor and Williamson (1996) examine the factor price convergence between Old and New world countries in the globalization period 1870-1913 using a CGE and an econometric estimation. The result they obtain, following Heckscher-Ohlin and Stopper-Samuelson model, is that
commodity price convergence due to the increase in trade was the main factor explaining factor-price convergence. They improve the explanatory power of the CGE model in O’Rourke and Williamson (1994) by adding a combined shock on land, labour and capital.

An important issue in all these papers is the way the external sector affects the economy under study. The assumptions about both how domestic markets react to external shocks and how external demand reacts to domestic conditions are crucial. Regarding the first question, Abrego and Whalley (2000) use a CGE to discuss a theoretical point related to the reaction of domestic markets to external shocks: the difficulty of the Heckscher-Ohlin model to explain the observed changes in the terms of trade in a small open economy. Moreover, Abrego and Whalley (2003) show how an Armington heterogeneous goods trade model overcomes the problem and can capture demand side effects with little or no impact on relative wage rates and as consequence of that technological change has a more important effect in wage inequality. Regarding the second question, the relevance of external demand elasticity is discussed from a historical point of view by Williamson (1990), who shows that the size of the impact of the Repeal of the English Corn Laws in 1846 is conditional on the assumption of small open or large open economy.

The empirical implementation of our model differs in some points with respect to the previous ones. Firstly, we use a measure of wage inequality that is based on the difference between the skilled and the unskilled labour wages. On the other hand, Williamson (1976) uses a measure of wage diversity based on the difference between the unskilled wage rate and an aggregate of the rental rate of machines and skilled labour, whereas O’Rourke and Williamson (1994) and O’Rourke, Taylor and Williamson (1996) focus on a measure of wages over rents of land. Secondly, we separate between
the demand and supply factors affecting wage inequality. Williamson (1976) identifies the demand forces with a residual that includes both: demand forces and error in variables, whereas the residual in O'Rourke and Williamson (1994) and Abrego and Whalley (2000, 2003), also includes variations in factor endowments. However, in our empirical model, we explicitly model variations in the terms of trade as a factor of demand in addition to a number of supply side forces (migration, population and capital growth, and education). In this way, we minimize the error component of the residual, and therefore capture better the true contribution of the technological change. Finally, we make an effort to separate capital, land, skilled labour and unskilled labour, and we decompose the growth of the labour force into natural rate of growth, changes in education and migration. Therefore, we calculate the individual contribution of trade, migration, technological change, population growth, capital accumulation and education to the explanation of wage inequality.

To summarise, up to our knowledge it is the first time that a CGE model has been used for studying the contribution of international trade, emigration, education, natural population growth, capital accumulation and technical change, all acting together, on the ratio of skill over unskilled wages in the late nineteenth century globalisation period in the UK.

Other studies have tackled the same issue from a different methodological approach. Anderson (2001), using a ‘relative wage of skilled labour’ measure, mainly in the building sector, as indicator of wage inequality, estimates the impact of migration, trade and domestic forces (such as fluctuations in the level of aggregate demand) for eight developed countries and for the period 1870-1970. However, this research does not include either technology or other factors such as education and estimates the influence of each factor separately without taking into account the interactions amongst
them. More recently, Betrán and Pons (2004) estimated the importance of globalisation, technological and structural change, education, population growth and trade unions in explaining the changes in wage inequality (the skill premium) over the period 1870-1930 by means of a panel data set for five countries (the USA, France, the UK, Italy and Spain).

With respect to Betrán and Pons (2004) our approach can be considered a complementary way to explore the robustness of the results. There is a wide consensus that general equilibrium models are the best way to study resource allocation and the distributional issues raised by the exogenous variations in the economy (Williamson, 1990). Moreover, general equilibrium models have been used by economic historians to resolve the problems which arise in the long run when there are a lot of interrelationships and variable changes\(^1\). There are several advantages of using a general equilibrium approach against a reduced from: first, it is based on an explicit model structure from which most of the reduced form models can be derived; second, it avoids the identification problem implicit in the reduced form approach meaning that multiple model parameterisations are consistent with the same reduced form (see Abrego and Whalley 2000) and finally it takes into account the interactions among all the variables.

Thus, the general equilibrium model chosen is capable of simulating and sorting out the off-setting factors that are operating to different degrees and in different directions when explaining wage inequality. The quantitative results are conditioned by the deep structural parameters calibrated in the model. Therefore, we also checked the sensitivity of the results to these parameters to assess the extent to which the conclusions obtained in research hold. Also, the calibration of the model provides some

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\(^1\) In addition to already mentioned references see also, for example, Taylor and Williamson 1997, Harley 2002 and Voigtländer and Voth 2006.
insight to be able to assess the role of technological change in explaining the wage premium.

The structure of the paper is as follows: in Section 2, we show the main pattern of wage inequality over the period 1880-1930. We compare the trend in the UK with a representative sample of European countries and with other measures of inequality and we discuss the main factors that compete in the explanation of wage inequality. In Section 3 we present and calibrate a general equilibrium model for the UK in the past globalisation period, which allows us to sort out the off-setting factors that explain wage inequality. Section 4 analyses the results, in Section 5 we defend the model chosen considering other alternative specifications and in the Section 6 we present the main conclusion.

2. Wage inequality in past globalisation processes

In this section we document the evolution of wage inequality in the past globalisation process of for a set European countries. We define wage inequality as the ratio of the wages of skilled male workers to the wages of unskilled male workers in the industrial sector. For each country we have chosen the main industrial sectors and for each sector we have compared the average wage of a skilled worker with the wage of an unskilled worker: the labourer. After obtaining the skilled-unskilled wage ratio for each industrial sector, we construct a weighted average of all these ratios where the weights are the labour force employed in each sector. We use manual workers because our wage data are only available for this kind of workers, which were the most important at that time. With the term “skilled worker” we are referring to occupational classifications, considering ability or job training and we are therefore not necessarily identifying skills
with education. In this sense, our measure of wage inequality is a proxy of the skill premium (sources can be found in the data appendix).

We compare the evolution of wage inequality in the UK with a sample of European countries, characterised by being labour-abundant and emigrating countries. The countries considered besides the UK are France, Sweden, Italy and Spain. There are two main reasons for taking the UK economy as our focus of study. Firstly, the UK is a good representative of the Old World countries and moreover as we are interested in analyzing the impact of globalization on wage inequality the UK was the most globalised country in the world at that moment. The second reason for using the UK economy is that the calibration of general equilibrium models requires a certain quantity and quality of information about the economy under study, such as the composition of the labour force, the classification of workers in skilled and unskilled labour, and the production and trade composition, and in this sense the UK is one of the countries with the most complete data for the period under consideration.

The main patterns of wage inequality, as a measure by the skill premium, are displayed in Figure 1, where we observe a decrease in wage inequality in the UK, France, Sweden and Italy between 1880 and 1913. However, after the WWI in all these countries, with the exception of Italy, the decrease in wage inequality was even stronger. Spain was the only country which recorded an increase in wage inequality in both periods, and Italy only after the WWI. As Betrán and Pons (2004) point out, several factors such as later and lower emigration and a lack of education could explain this increase in Spanish wage inequality, and in the Italian case, the increase in wage inequality after the WWI was due to the lower education and the fact that globalisation forces did not act. Therefore, the general pattern indicates a decrease in wage inequality
in the UK as in most of labour-abundant and emigrating countries during the globalisation period.

**Figure 1: Wage Inequality in the Past globalisation process (1880-1930)**

Therefore, according to Figure 1 the fall in the skill premium in the UK was around 7.5 percentage points between 1880 and 1913. Of course, the skilled premium is not the only measure of inequality. There are other measures that have been estimated for the UK during this period, such as the evolution of the top income, the wage-rental ratio, the distribution of income and the distribution of wealth. If we place our measure of inequality in context to these other indicators, we obtain that the size of the reduction in inequality is rather conditional on the particular measure of inequality we choose. For instance, according to Atkinson (2002) the shares in total gross income of top incomes (the percentile group 0.05%) from 1908 to 1913 shows stability, and only from 1913 it started to fall. The ratio of wages to land values, following O’Rourke, Taylor and Williamson (1996) boomed in the Old World countries during 1870-1910. In the UK
from 1880 to 1914 the increase was of 47.5 percent. With respect to the distribution of income, according to Lindert and Williamson (1983), income gaps widened between 1759 and 1867 and decreased between 1867 and 1913. Finally, the distribution of wealth according to Lindert (1986) estimations shows that there is not clear widening or narrowing of the distribution of net worth between 1740 and 1913. To sum up, most of these indicators, including the skilled premium, show that in this period the UK had a decrease in inequality due to the increase on unskilled labour wages and the diminishing importance of land.

After documenting the evolution of wage inequality, we are going to analyse the main determinants of wage inequality over this period. As mentioned in the introduction, three groups of factors are mainly considered. Regarding the first group of factors, globalisation forces (trade and migration) were very strong, especially migration (O’Rourke, Williamson and Hatton 1994). As far as trade is concerned, the Heckscher-Ohlin theory argues that countries specialise in those commodities intensively use the factors which they are well endowed. Hence, trade growth may increase skilled (unskilled) labour demand in skilled (unskilled) labour-abundant countries, thus increasing the real wages of the skilled (unskilled) workers. In this case, trade may increase (decrease) wage inequality.

Migration changes the relative supply of skilled and unskilled workers and therefore also affects wage inequality. In the past globalisation period, since migrants tended to be unskilled (Hatton and Williamson 1998), mass migration from the European countries to New World countries (USA, Canada, Argentina, etc), implied a reduction of unskilled labour in labour-abundant (European) countries and an increase in labour-scarce (New World) countries. As a result, migration tended to reduce wage inequality in European countries and increase it in the New World countries.
With respect to the second group of factors, the technological advances in the 1870-1913 period that were part of the so-called Second Industrial Revolution were spectacular. There was a change in the main sources of energy (from coal to electricity, and petroleum), there was a revolution in transport (with steamships and the growth in the railroad system) and there were also important advances in communications (with telegraph). These technological changes come along with important organisational changes, such as Fordism and Taylorism (Chandler 1996, Rosenberg 1976, David 1991). Technology changes affected the relative demand for skilled and unskilled labour and thus wage inequality. There is a debate as to whether technological change was skill deplacing or skill-biased. Although assembly line techniques resulted in capital and unskilled labour substituting skilled labour, the number of supervisors and other new professions increased at the same time due to capital becoming more important in the production process. Moreover, assembly line techniques were not the only ones applied at that time. As Goldin and Katz (1996, 1998, 2001, 2008) indicate, the technological change may have increased the relative demand for skilled labour by means of two channels: firstly, the change from artisanal shops or factories to continuous and batch-process methods (applied in petroleum refining, dairy products, chemicals and non-ferrous metals) and second, the change from steam and water power to electricity, Thus, the predominant effect is not so clear and, therefore, the impact of technology on the demand for skilled labour and hence on wage inequality, is an open empirical question.

Finally, in the case of the third group of factors, the period also witnessed a significant effort to enhance education. This was important in order for the technological change to be applied, as the increase in education facilitated the learning of these new technologies. However, population growth and the subsequent effect on the labour force produced an increase in the supply of unskilled labour that saw wage
inequality rise. The increase in education may have offset this effect by increasing the supply of skilled labour.

In the case of the changes in labour market institutions, there was an outstanding increase in the importance of labour organisations, such as trade unions, labour affiliations and active participation in strikes and protests to improve working conditions and wages. However, the impact of such activity on wage inequality is not so clear. We do not know whether trade unions represented the interests of skilled workers more than the interests of unskilled workers. When these organisations first emerged, they represented skilled workers’ interests, but later in the period they became trade unions that defended the welfare of the working class. Even the UK, which had mass and general unions during this period, there has been a debate about the contribution of trade unions to wage inequality, but no consensus has yet been reached. Pollard (1999) considers that there is no relationship between labour movements and wage inequality while Hobsbawm (1985) and Hunt (1973) maintain that at least after 1900, the labour movement contributed to the progressive reduction of wage differentials.

3. General Equilibrium Model Approach

We have elaborated a structural but simple general equilibrium model in order to analyse the principal factors affecting wage inequality in the UK economy in the past globalisation. This type of model allows us to specify the fundamental relationships among all the endogenous variables that act simultaneously in the explanation of wage inequality. By means of this model we illustrate how globalisation factors (particularly trade and migration), technological change, population growth and access to education affected the observed wage inequality change. We also check the sensitivity of the results to different parameterisations and assumptions of the model, which is not
possible in the reduced-form equations estimated in the literature. In this general equilibrium approach we are not going to include the impact of labour movements because it would be necessary to make a significant number of ad-hoc assumptions regarding the power of skilled and unskilled workers in the wage negotiation process and what the result was in terms of the relative increase of skilled and unskilled wages.

3.1 The base model

We use a two-sector (skilled labour intensive, $X_1$ and unskilled labour intensive, $X_2$) three-factor (skilled labour, $S$, unskilled labour, $U$ and capital, $K$) model of a price-taker economy. The reason to invoke the Ricardo’s small country assumptions is driven by the fact to adequately capture the actual fall in the terms of trade that took place in the UK economy during the globalization period. As we are aware that this can be considered a strong assumption, in Section 5 we will check the robustness of the model when the large open economy assumption is used. In this base model external trade differs from the traditional Heckscher-Ohlin model because imports and domestically produced goods are imperfect rather than perfect substitutes (the Armington assumption). The reason for using the Armington model is that the H-O model finds it difficult to adapt to a substantial change in terms of trade such as the one observed in the globalisation period, because the model would display full specialization.

The model includes all the basic components required to decompose wage inequality, understood as the wage premium: it has two traded and two produced goods, but considers three different goods in consumption, as imports are seen as a different good from the domestically produced good that substitutes imports. Both sectors of the economy use capital ($K^*$) and a different combination of skilled ($S^*$) and unskilled labour ($U^*$) to produce output by means of a two-level constant elasticity of substitution
(CES) technology. In this base model land is not included. However, we have split up the capital in the unskilled sector between ‘machines’ and a factor specific land in Section 5.

Producers decide on the demand for skilled and unskilled labour and how much capital and aggregated labour (L) is used by each sector. X₁ is the initially skilled labour intensive sector that produces the exportable domestic good (X₁) from which E₁ is exported. X₂ is the initially unskilled labour intensive sector that produces the non-exportable domestic good (X₂) that competes with imports (M). Although the sector classification of X₂ and M can coincide in the data, the fact that both goods are imperfect substitutes in consumption implies different prices. All three goods (imports, the non-exportable domestic good and the exportable domestic good) make up total consumption, which is derived from a two-level CES utility function.

The representative consumer decides on the consumption of the two closest goods (the non-exportable domestic good and the import good) and also chooses between the exportable domestic good and the composite of X₂ and M (call this composite Y). Although the economy is considered a price-taker of export and import prices, the price of X₂ (unskilled labour intensive sector) is endogenously determined and this makes a difference with respect to the H-O model, because changes in world prices do not necessarily transmit entirely to the domestic economy. Finally, the macroeconomic closure states that the current external deficit in the model is fixed. Figure 2 sketches the model.

Capital and each type of labour are mobile between sectors and as a consequence of the profit maximization in each sector, a demand for each type of factor arises. There is full employment for all factors. Equilibrium is characterised by a set of prices resulting in optimal good and factor allocation so that producers maximise profits and
consumers maximise utility. Optimal allocation simultaneously satisfies the zero profit condition for sectors, market clearing in goods and factors, income constraints and the macroeconomic closure. The complete set of equations, variables and parameters that determine the base model can be found in Appendix 1.

![Flowchart](image)

Figure 2. The model in a Figure

### 3.2 Calibration and Data

We calibrate the model to 1913, the benchmark year for the UK data, represented by the social accounting matrix that is shown in Table 1. The calibrated parameters and exogenous variables appear in Table A.1 in Appendix 1. The basic assumption underlying calibration is that the economy is in equilibrium in the base year and the objective of calibrating the model is to ensure that the solution of the model yields the appropriate model parameters and replicates the benchmark data set in the social accounting matrix. We use the software package GAMS/MPSGE (Rutherford, 1998) to accomplish this objective. For an analytical solution of calibrated parameters

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2 Unfortunately, calibration does not allow us to offer confidence intervals for the results.

In order to obtain the social accounting matrix, we distinguish between skilled and unskilled labour and separate the production of skilled and unskilled labour-intensive sectors. Each sector employs skilled and unskilled labour as well as capital. As all the factors are mobile, there is a rental price for each factor that is independent of the sector. We require data on skilled and unskilled wages in order to calculate the rents of each type of labour in each sector. The rents of capital are calculated as a residual subtracting the rents of labour from the value of the production of each sector. All these rents are incomes of the representative consumer. We calculate the exports of the skilled labour intensive sector and the imports of the unskilled labour intensive sector to obtain the domestic consumption of both goods.

As we can see in the rectangular social accounting matrix representation in Table 1, a positive entry denotes income (a sale in a private market or a factor supplied by a consumer), whereas a negative result is an expense (an input purchase in a market or a consumer demand). If we read further down the columns, the entire set of transactions linked to an activity can be found. The sum of each column must be equal to zero to meet the condition of zero profit. In the same way, the sum of each row must be zero to meet the condition of market clearing (the sales of a commodity must be the same as the total purchases of that good). The sum of the consumer’s column equal to zero indicates the condition of balanced revenue. Thus, this social accounting matrix is consistent with general equilibrium conditions, as it satisfies the zero profit conditions (the sum of each column is zero) and market clearing (the sum of each row is zero). The figures of the social accounting matrix represent values (prices multiplied by quantities). However, in our model we need to identify prices and quantities separately.
The way figures are divided up into prices and quantities is arbitrary. Given that in general equilibrium modeling we are usually concerned with proportionate changes in quantities and prices, it is common practice to choose units so that the greatest numbers of variables possible are equal to one in the benchmark equilibrium. In our economy with no taxes or other distortions, prices and levels of activity have been normalised to one (the so called Harberger convention). This is why, for example, the figures in Table 1 can be understood as the quantities involved in the production of an activity that operates at a unitary level3.

The cornerstone of our data elaboration is the 1911 census. It has been chosen for being the census that is closest to 1913, which is the turning point between the globalisation and the deglobalisation periods. Unfortunately, the 1911 census does not contain information on the skills of labourers for all industries. As a result, we have also made use of the data elaborated by Routh (1980) for 1951. Both censuses are comparable because they were previously homogenised by Routh. In order to estimate the number of skilled and unskilled workers for each of the two domestic sectors, we have employed the 1951 percentages of skilled manual labour on unskilled manual labour in each industry and apply these to the 1911 census, where we have the labour force working in each industry. We select some sectors from 1911 for which we have data for skilled and unskilled workers to test the validity of this assumption and we find that these proportions are not very different in 1951. For example, the proportion of skilled on unskilled workers for the building sector in 1911 was around 220% and in 1951 in Routh’s data it was 197%. As the weight of each industry changes over time, so does the weight of total skilled on unskilled manual workers. In the case of the

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3 As Kehoe (1996) points out, one can think of these variables as price indices, which are naturally set to one in the base case. Only one of these prices (or a combination of some prices) can be considered the numeraire. That means that all prices change after a shock except the numeraire. Thus, the problem is defined in terms of relative prices.
industrial sector, for the earlier years in which we can use the homogenized census data, the total percentage of skilled to unskilled labour is estimated at 79.83% in 1911 and at 86.48% in 1951.

We have focused on the agriculture and industrial sectors to obtain $X_1$ and $X_2$, assuming that agriculture belongs to the unskilled sector. In the base model, the service sector is not included because of the lack of data on skilled and unskilled wages. However, we have made a broadly estimation of the services sector wage inequality and the consequences for the model will be discussed in Section 5. We take into account agriculture and 16 more industries giving us a total of 17 economic activities. We define the skilled industries as those with an above average proportion of skilled manual workers and unskilled industries as those with a below average proportion. The skilled sector, $X_1$, consists of the following industries: Leather, Wood, Building, Vehicles, Paper printing, Textiles, Engineering, shipbuilding and electrical, Other manufacturing, Metal goods and instruments, Metal manufacture and Cement, ceramics and glass. In the theoretical model we assume for simplification that the skilled sector, $X_1$, produces the exportable domestic good and that the unskilled sector, $X_2$, produces the non-exportable domestic good. When we apply the model to the UK economy, we obtain that the skilled sector is the net exporter and we identified it with the producer of exportable domestic goods. The unskilled sector is the net importer and we assimilate this sector as a non exporter. The unskilled sector, $X_2$, comprises: Mining and quarrying, Clothing, Gas, electricity and water, Food, drink and tobacco, Chemicals and Agriculture. This classification between exportable and non-exportable sectors is broadly consistent with the pattern of trade in the UK in the considered period. The UK was an important exporter of textiles, iron, steel and metal goods, all of which belong to $X_1$. The most important imports ($M$, in our model) in the UK were agricultural products
(mainly wheat, meat, cotton and wool)\(^4\). These are products that in our model directly compete in consumption with the domestic production of \(X_2\).

Feinstein (1972) is used to calculate the production of each sector, whereas the exports and imports for the skilled and unskilled sectors were obtained from *British Historical Statistics* (1990). We find that the skilled sector accounts for 48% of total production and the unskilled sector 52%. Appendix 2 contains more details on the estimated data.

### Table 1. Estimated social accounting matrix for UK economy in 1913
(Millions of pounds)

<table>
<thead>
<tr>
<th></th>
<th>X1</th>
<th>X2</th>
<th>E</th>
<th>M</th>
<th>W</th>
<th>CONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>(P_1)</td>
<td>836</td>
<td>-171</td>
<td>-665</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>(P_2)</td>
<td>906</td>
<td>-906</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(P_{F2})</td>
<td>234</td>
<td></td>
<td>-234</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(W_S)</td>
<td>-276</td>
<td>-129</td>
<td>405</td>
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</tr>
<tr>
<td>(W_U)</td>
<td>-121</td>
<td>-202</td>
<td>323</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(P_K)</td>
<td>-439</td>
<td>-575</td>
<td>1014</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(P_W)</td>
<td></td>
<td>1805</td>
<td></td>
<td>-1805</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(P_{FX})</td>
<td>171</td>
<td>-234</td>
<td>63</td>
<td></td>
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</table>

**Note:** X1: production for skilled good; X2: production for unskilled good; E: export for skilled good; M: import for unskilled good; W: welfare; CONS: income level for the consumers; P1: price for skilled good; P2: price for unskilled good; PF2: price for imported unskilled good; WS: skilled wage; WU: unskilled wage; PK: rental price of capital; PW: welfare price; PFX: real exchange rate.

The social accounting matrix for the UK economy in 1913 allows us to calibrate some parameters of the model (mainly distributional and scale parameters in the utility

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\(^4\) Although the exports of mining and quarrying were very important (due mainly to exports of coal) the UK imported other mining and quarrying products such as iron ore, copper, lead, or petroleum. The trade statistics did not show exactly whether the sector was net exporter or importer. We have estimated it and obtained that the mining and quarrying sector in 1880 and 1900 was a net importer.
and production functions), but additional information is still required on elasticities of substitution. Table 2 shows the basic elasticities of substitution considered in our simulations. The elasticity of substitution in consumption between the skilled intensive good and the unskilled intensive good; between skilled and unskilled labour in production; and between capital and aggregated labour have all been set to a low value of 0.5, indicating difficulty in substituting among goods and factors when prices change at these levels of aggregation. Conversely, the Armington elasticity has been set to a relatively high value of 5, which means that substituting imports for domestic production is relatively easy. These elasticities are in accordance with previous economic history research using a calibrated general equilibrium model, such as Harley and Crafts (2000), Harley (2002) and Federico and O’Rourke (2000).

Table 2: Elasticities of substitution used to calibrate the model

<table>
<thead>
<tr>
<th></th>
<th>Utility</th>
<th>Skilled sector</th>
<th>Unskilled sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Armington</td>
<td>5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Sk. Good/ Unsk. Good</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Sk. Labour/ Unsk. Labour</td>
<td>0.5</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Capital/Labour</td>
<td>0.5</td>
<td>0.5</td>
<td></td>
</tr>
</tbody>
</table>

3.3 Estimation of the shocks

To make the model operational, in addition to the information contained in the social accounting matrix, we calculate the changes over the period 1880-1913 in the skill premium, as the endogenous variable we want to explain, and also the shocks in variables that can be considered exogenous in an accounting sense: trade (measured by the terms of trade), emigration, education, population, capital and technological change.
We have plugged all these different estimated shocks to the benchmark year, 1913. We work backwards, so that when subtracting the shock from the data in 1913 we hypothetically place the UK economy in 1880. However, for the sake of clarity, we transform the results and the tables present the changes between 1880 (as the initial year) and 1913 (as the final year). The rate of growth of the variables between 1880 and 1913 can be found in Table 3.

**Table 3: The UK changes in the variables**

<table>
<thead>
<tr>
<th></th>
<th>1880-1913</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wage premium (W_s/W_u)</td>
<td>-7.58</td>
</tr>
<tr>
<td>Terms of trade (P_1/P_2)</td>
<td>12.27</td>
</tr>
<tr>
<td>Labour force (manuals):</td>
<td>22.19</td>
</tr>
<tr>
<td>- Net emigration (unskilled workers)</td>
<td>15.97</td>
</tr>
<tr>
<td>- Education (skilled workers)</td>
<td>16.86</td>
</tr>
<tr>
<td>- Natural population growth</td>
<td>19.62</td>
</tr>
<tr>
<td>Capital</td>
<td>87.16</td>
</tr>
</tbody>
</table>

*Note: Relative variation between 1880 and 1913, in percentages
Sources: See data appendix.

As for the endogenous variable, the decrease in the skill premium over the period was 7.58%. Regarding the exogenous variables, with respect to trade, the UK was an open economy with an external openness rate (exports plus imports on GDP) that averaged around 55% in 1880-1913. The main trade shock during the globalisation period was the so-called “grain invasion”. Declining transport costs and the cultivation...
of enormous amounts of land in the New World countries (USA, Argentina or Canada) increased the supply of agricultural products, mainly cereals (wheat, barley, oats and rye), and grain prices, principally wheat, fell sharply. Cheaper wheat had great consequences for European income distribution that differed substantially across countries (O’Rourke 1997). In the UK, a grain importing country, the main impacts of the grain invasion were that agricultural rents collapsed due to the reduction in the demand for land and that real wages increased as a consequence of the raise in the purchasing power. Moreover, the grain invasion altered terms of trade (Hadass and Williamson 2001 and Williamson 2008) and in the UK, an export manufacturing country improved. As agricultural products represented 63% of total imports for the UK, wheat being one of the most important, such a decrease in price had a significant influence on UK terms of trade, which rose by 12.27%. We model this shock as a variation in the price of imports, which in the model is a purely exogenous variable determined by world prices. This factor tends to increase inequality by relatively augmenting the price of the exportable skilled-intensive good.

With respect to the changes in the labour force, emigration was the most significant. The UK was an earlier emigration country and between 1853 and 1913 nearly 13 million people left the UK, around 6 million after 1870 (Hatton 2004). An important effort in education was also made, resulting in the literacy rate rising from around 80% in 1880 to 96.4% in 1913. The schooling ratio jumped from 46.5% to 81.2% over the same period. Finally, the British population grew at a rate of 23% from 1880 to 1913.

In our model the changes in the labour force are captured by means of three variables: emigration, education and natural population growth, following the expression,
\[
\rho_p \left( \rho_e S_{1880} + \rho_m U_{1880} \right) = S_{1913} + U_{1913}
\]  
(1)

where \( S_{1880} \) and \( U_{1880} \) are the endowments of skilled and unskilled labour in 1880 and \( S_{1913} \) and \( U_{1913} \) represent the endowments of skilled and unskilled labour in 1913. \( \rho_e \) stands for the factor affecting the skilled labour endowment due to educational change, \( \rho_m \) captures the factor affecting unskilled labour during the period due to migration, and \( \rho_p \) stands for the part of the growth in the labour force that is due to natural population growth, which affects skilled and unskilled labour equally. To set \( \rho_e \) we take the evolution in the literacy rate between 1880 and 1913 (Flora, 1973), which provides us with a more moderate educational factor than we would have obtained had we chosen the schooling ratio as the basis for the estimation. Thus, according to Table 3 we set \( \rho_e = 1.1686 \). We fix \( \rho_m \) to a value of 0.8403 (meaning a net emigration during the period of 15.97% of the unskilled labour force) taking the O’Rourke, Williamson and Hatton (1994) estimations on the number of unskilled workers emigrating during the period. Finally, \( \rho_p \) has been obtained as the unknown in expression (1) that can be solved for a value of 1.1962.

The capital growth rate has been borrowed from Mitchell’s (1990) estimations of total stock of capital during the period of study. However, in our simulations Mitchell’s figures have been corrected downwards because part of our capital in the social accounting matrix is formed by land (in the unskilled intensive sector) which was in fairly fixed supply over the period. Even so, our estimation shows an important increase in capital of 87 percent (see Appendix 2 for further details).

The technology shock is calibrated as the residual in a way that when simultaneously adding the other exogenous shocks, the model solution replicates the observed change in wage inequality. There exist two types of technology shocks: 1) the unskilled/skilled biased technological change, that we assume is of the same size in all
the sectors of the economy, but of different size between skilled and unskilled labour and 2) the Hicks neutral technological change that affects differently to the sectors in the economy but equally to all the factors. In a first step we include the technology change in the model assuming that it is biased (positively or negatively) towards unskilled workers, meaning that the demand for unskilled labour in each sector changes exogenously as a consequence of technology. Under this assumption we impose that the technology shock is the same in all the sectors of the economy, but different between skilled and unskilled labour. Note that the effects of a positively biased technology shock in favour of unskilled labour can be mimicked by means of a biased technology shock against skilled labour, thus the factor receiving the shock is not relevant as we do not impose an *a priori* sign for it. The same method for calibrating the technology shock can be found in Abrego and Whalley (2000) and Abrego and Whalley (2003). This idea is broadly similar to that of using any decision rule in a dynamic general equilibrium model to calibrate technology shocks (see King and Rebelo, 2000 and Nakamura, 2005). In second step we also consider a Hicks neutral technology shock at the end of section 4.

### 4. Results

In this section we will present the results in three different ways. First, we estimate the individual contribution of the change in each factor to the explanation of the wage inequality change. Second, we calculate the elasticities of the skill premium to each factor. Finally, we estimate what the wage inequality would be in the absence of one factor, thus providing an approximation of the opportunity cost of an individual factor.

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5 Latter on, we will check the robustness of the results when a Hicksian technology shock is considered.
4.1 Individual contribution of each factor

The first set of results is displayed in Table 4. In each column we have isolated the individual effect of each contributing factor, including the calibrated technology shock, to explain the wage inequality change. As prices have been normalised to one, we are interested in explaining a decrease in relative wages up to 0.9242 in 1913, equivalent to a reduction of 7.58% between 1880 and 1913. This is the result that we have obtained in all the simulations, once the technology shock is included in the last row. Note that the sum of the individual effects in explaining the percentage increase in wages does not necessarily result in the observed variation in relative wages, because there are also interaction effects which cannot be attributed to any one individual factor, but which are a consequence of the interaction of the different factors in the model acting simultaneously.

Column (1) represents the effects in the skill premium for the baseline simulation, that is, taken as given the elasticities of substitution in Table 2 and the shocks of Table 3. When the effect is above one, this means that the shock considered works against the observed variation in inequality. When the effect is below one, the shock works in favour of the observed variation in inequality. According to Table 4, international trade, natural population growth (via demand) and the technology shock all acted against the observed reduction in inequality, whereas emigration, education and capital growth favoured the reduction in inequality. If only the trade shock had existed, the wage premium would have increased by around 11 per cent. In the same way, if only an emigration shock had occurred, the skill premium would have decreased by around 29 per cent. Without the educational shock, wage inequality would have increased by around 23 per cent. Each isolated factor creates important effects on wage inequality, with the variation in labour force composition (due to emigration and
education) overcoming the effects of international trade. The most important contribution would correspond to technology, because in the absence of a technology shock wage inequality would have decreased by around 47 per cent. This means that the technology shock compatible with the observed reduction in wage inequality has a very important negative effect on unskilled wages. As Abrego and Whalley (2000) argue, contrary to the simple Heckscher-Ohlin case, in a model of finite elasticity of substitution between domestic and imported production, trade shocks can be partially absorbed on the import demand side, without full transmission to domestic producer prices, resulting in a smaller trade effect and a larger technology effect.

**Table 4. Simulated W/\text{W}_u \text{ in 1913 due to exogenous factors}**

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trade</td>
<td>1.107</td>
<td>1.052</td>
<td>1.104</td>
<td>1.040</td>
<td>1.092</td>
</tr>
<tr>
<td>Emigration</td>
<td>0.712</td>
<td>0.703</td>
<td>0.732</td>
<td>0.877</td>
<td>0.717</td>
</tr>
<tr>
<td>Education</td>
<td>0.768</td>
<td>0.746</td>
<td>0.769</td>
<td>0.903</td>
<td>0.781</td>
</tr>
<tr>
<td>Population growth</td>
<td>1.042</td>
<td>1.022</td>
<td>1.017</td>
<td>1.016</td>
<td>1.053</td>
</tr>
<tr>
<td>Capital growth</td>
<td>0.826</td>
<td>0.938</td>
<td>0.942</td>
<td>0.930</td>
<td>0.795</td>
</tr>
<tr>
<td>Tech. change</td>
<td>1.626</td>
<td>1.701</td>
<td>1.493</td>
<td>1.178</td>
<td>1.664</td>
</tr>
<tr>
<td>Wage inequality without tech. change</td>
<td>0.534</td>
<td>0.529</td>
<td>0.611</td>
<td>0.789</td>
<td>0.512</td>
</tr>
<tr>
<td>Wage inequality including tech. change</td>
<td>0.924</td>
<td>0.924</td>
<td>0.924</td>
<td>0.924</td>
<td>0.924</td>
</tr>
</tbody>
</table>

(1) Baseline simulation; (2) Armington elasticity set to half the baseline value; (3) Elasticity of substitution between labour and capital set to double the baseline value; (4) Elasticity of substitution between skilled and unskilled labour increased to 1.5; (5) Elasticity of substitution between goods X1 and X2 increased to 1.5

In columns (2) to (5) we perform a sensitivity analysis, consisting of how the results change when the elasticities of substitution are modified. This analysis is important in order to mitigate the critique of the dependence of the results at both the level of disaggregation and the choice of the base structural parameters. It should be
noted that the sign of the results is robust to different elasticities of substitution, in all cases the positive effects of emigration and education reducing wage inequality, overcoming the negative effect of trade increasing wage inequality. As mentioned previously, the influence of technology on wage inequality during the period has been subject to debate. Here we show that for a wide range of sensible parameters, and in the presence of more shocks than just international trade, technology changes always raise the skill premium. Conversely, both natural population growth and capital accumulation have smaller effects on wage inequality.

The two most important changes in the effects of the shocks arise when we vary the elasticity of substitution between skilled and unskilled labour and the Armington elasticity. Regarding the elasticity of substitution between skilled and unskilled labour (column 4), the higher the value of this elasticity the lesser the effects of all the individual shocks on wage inequality, as it is now easier to replace the more expensive labour with the cheaper labour. However, a higher elasticity of substitution mainly modifies the emigration and education effects, as these two variables directly affect the relative endowments of labour.

A reduction in the Armington elasticity (column 2), which implies that it is more difficult for domestic production to substitute imports, mainly alters the effect of the trade shock, weakening the transmission of world prices to domestic prices. The Armington elasticity also modifies the effect of capital accumulation considerably. The explanation is as follows: an increase in the stock of capital tends to reduce the rental price of capital originating two effects. On the one hand, a decrease in the cost of capital makes production cheaper in the sector where capital is relatively more abundant. As the capital-intensive sector is unskilled, this pushes down the price of the goods that the unskilled industry produces. This shifts the demand from imports to domestic goods and
then pushes up unskilled wages and thus pushes down the wage premium. This effect depends on the Armington elasticity. The lower the Armington elasticity, the weaker the shift in demand towards domestic industry is and, therefore, the lower the decrease in the wage premium.

On the other hand, the reduction in the cost of capital means that entrepreneurs in each industry wish to augment the demand for capital and decrease the demand for labour, as far as technology allows. When the elasticity of substitution between capital and labour is low, the demand for labour augments together with the demand for capital and the result is a decrease in the rental price of capital (a supply effect) and a rise in unskilled wages which reduces the ratio $W_s/W_u$ (a demand effect). The increase in unskilled wages depends on the elasticity of substitution between labour and capital (column 3) and between skilled and unskilled labour (column 4), in both cases the increase in unskilled wages is lower (and the fall in the wage premium is less pronounced) as long as substitution possibilities widen.

4.2 General equilibrium elasticity

Now, we can solve the model by controlling for the magnitude of the shocks and simulating the elasticity of the wage premium to every different shock. The results would be in this way comparable with the coefficients of a log-reduced-form model. Table 5 shows the percentage variation in the ratio $W_s/W_u$ with respect to a 1 per cent change in each shock. In the baseline simulation, the greatest elasticity (in absolute terms) would correspond to emigration (-1.86), followed by education (-1.64), trade (0.95), the technology shock (0.85), natural population growth (0.23) and capital growth (-0.20). This order of importance is maintained whatever parameters are considered in

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Note that our measure of capital also does include land.
the sensitivity analysis, except for the Armington parameter, which does reduce the importance of trade and increase that of technology in wage inequality.

Table 5. Elasticity of $W_s/W_u$ to different shocks to 1913 situation (per cent)

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trade</td>
<td>0.947</td>
<td>0.447</td>
<td>0.926</td>
<td>0.367</td>
<td>0.824</td>
</tr>
<tr>
<td>Emigration</td>
<td>-1.860</td>
<td>-1.940</td>
<td>-1.706</td>
<td>-0.716</td>
<td>-1.820</td>
</tr>
<tr>
<td>Education</td>
<td>-1.640</td>
<td>-1.831</td>
<td>-0.630</td>
<td>-0.631</td>
<td>-1.544</td>
</tr>
<tr>
<td>Population growth</td>
<td>0.234</td>
<td>0.126</td>
<td>0.095</td>
<td>0.091</td>
<td>0.288</td>
</tr>
<tr>
<td>Capital growth</td>
<td>-0.198</td>
<td>-0.084</td>
<td>-0.058</td>
<td>-0.076</td>
<td>-0.253</td>
</tr>
<tr>
<td>Tech. change</td>
<td>0.851</td>
<td>0.931</td>
<td>0.704</td>
<td>0.285</td>
<td>0.812</td>
</tr>
</tbody>
</table>

(1) Baseline simulation; (2) Armington elasticity set to half the baseline value; (3) Elasticity of substitution between labour and capital set to double the baseline value; (4) Elasticity of substitution between skilled and unskilled labour increased to 1.5; (5) Elasticity of substitution between goods X1 and X2 increased to 1.5

4.3 Opportunity cost

Finally, we answer the question of what wage inequality would have been at the end of the period in the absence of each of the considered shocks. The results are in Table 6 and they would be comparable to multiply the estimated coefficients in a reduced-form regression by the actual change in the explanatory variables. Table 6 and 4 are not strictly comparable, as now the results include the interaction effects among the remaining shocks and can be interpreted in terms of opportunity costs (positive or negative). Taking into account price normalization, we know that the actual ratio of wages in 1913 was 0.924, meaning that wage inequality decreased by 7.58% (being: 1-0.924) between 1880 and 1913. But, for instance, if there had not been a trade shock between 1880 and 1913, we find that wage inequality would have decreased over the period by around 20 per cent. Conversely, if no workers had migrated, the wage dispersion in 1913 would have been 30% higher than in 1880 and without education
improvements wage inequality would have been 21% higher. Finally, if there had been no technology change, the wage dispersion in 1913 would have been almost 47% smaller than in 1880. According to these results, the presence of the technology shock had the highest opportunity cost in terms of the reduction in inequality. Although, the definition of technology change is not strictly comparable, Betrán and Pons (2004) also find that technological change made the largest contribution to wage inequality change.

Table 6. Simulated \( W_s/W_u \) in 1913 in different scenarios

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( W_s/W_u )</td>
<td>0.924</td>
<td>0.802</td>
<td>1.300</td>
<td>1.214</td>
<td>0.890</td>
<td>1.042</td>
<td>0.534</td>
</tr>
</tbody>
</table>

(1) Baseline shocks; (2) No trade shock; (3) No emigration; (4) No education change; (5) No population growth; (6) No capital growth; (7) No technological change

4.4 Calibration with added restrictions

All the exercises above involve comparing two years (1880 and 1913). Starting from the benchmark year (1913), for which we have information on all the variables, the strategy used to calibrate the technology shock consists of obtaining a model solution that is consistent with the wage inequality change that will not generally match other observed data for the other year (1880). To check the validity of our calibration strategy we add new information on 1880. Namely, we take the ratio of production between the skilled labour and the unskilled labour intensive sectors \( X_1/X_2 \) in 1880 together with the wage premium \( W_s/W_u \). This new information implies that exact calibration of the parameters does not hold for 1880. As a result, a similar approximated calibration procedure to that of Abrego and Whalley (2003) has been used.

The approximated calibration allows us to obtain another dimension for the technology shock in addition to the already considered unskilled biased technological
change. In particular, we have considered a Hicks neutral technological change that affects the unskilled intensive sector (see Appendix 1 for further details). We compare the results with the exact calibration procedure in Table 7.

While the results vary depending on the calibration method, the quantitative differences are small. The main result that technical change worsens the unskilled wage in comparison to the skilled wage during the period 1880-1913 still holds. Moreover, once the model is calibrated using the new information in the second year, the effect of technology change in the wage premium is slightly larger (1.748 as opposed to 1.626). As the results show, this overall impact is a consequence of the unskilled biased technology change having a smaller effect (1.515 as opposed to 1.626) together with an increase in the wage premium caused by the Hicks neutral technology change (1.115 as opposed to 1). In short, here we show that both a technology shock biased against unskilled labour and a Hicks neutral technology shock in the unskilled labour intensive sector worsened unskilled wages relative to the skilled wages.

Table 7. Simulated \( W_s/W_u \) in 1913 due to technical change

<table>
<thead>
<tr>
<th>Exact calibration to wage premium</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total technical change</td>
<td>1.626</td>
</tr>
<tr>
<td>Unskilled biased technical change</td>
<td>1.626</td>
</tr>
<tr>
<td>Hicks neutral technical change in ( X_2 )</td>
<td>1.000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Inexact calibration to wage premium and production ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total technical change</td>
</tr>
<tr>
<td>Unskilled biased technical change</td>
</tr>
<tr>
<td>Hicks neutral technical change in ( X_2 )</td>
</tr>
</tbody>
</table>
5. A discussion on the structure of the model

To check up the robustness of the base model in this section we extend it by considering three different modeling strategies. Firstly, we have included a non tradable service sector. As there is no data on skilled and unskilled wages in services, we have made a broadly estimation of wage inequality in this sector using the only available data: the wages for “Transport and Railways” sub-sector. After obtaining the wage inequality for this sub-sector in 1906 (the only year we have data) it has been observed that wage inequality was very similar to the average for the industrial sector\(^7\). Then, we have made the assumption that the service sector has the same wage inequality as the industrial sector. It is a quite hard assumption because this sub-sector represented only the 17.56% of the total labor force in the service sector in 1911. The simulations corresponding to the inclusion of services can be found in the column 2 of Table 8 and show that considering this sector does not alter substantially the basic results, although it diminishes the positive effect of trade on the wage premium by five points and the negative effect of capital accumulation by ten points. As the service sector is unskilled intensive\(^8\) and non tradable, unskilled wages are less sensitive to the shocks that affect unskilled wages through external trade.

Second, we split up the capital factor in the non-service unskilled sector between ‘machines’ and a land specific factor. Columns 3a and 3b of Table 8 show the results when land is taken into account. The difference between both columns depends on the

\(^7\) The wage inequality for “Transport and Railways” sub-sector in 1906 was 1.57 and the average for the industrial sector was 1.58.

\(^8\) Following the same procedure that for the industrial sector, we have obtained that in the service sector the 71.5 per cent of the labour force was unskilled. Although in this sector there were some high skilled sub-sectors such as “Insurance, banking and finance” (with the 69.3 per cent of skilled workers) or the “Professional services” (with the 74.4 per cent of skilled workers), they only represented a very small portion of the total labour force of the service sector (the two sectors represented only the 11.78 per cent of total labour force in the service sector in 1911). However, the majority sectors such as “Miscellaneous” (pubs, hotels, domestic service, etc) and “Distributive trades” (both sectors represented the 61.3 per cent of the total labour force in the service sector) were unskilled labour sectors (with the 83.2 and the 81.6 per cent of unskilled workers on total labour force respectively).
elasticity of substitution of consumption between $X_1$, $X_2$ and services considered in the utility function. For the baseline elasticity of 0.5, trade with the rest of the world stops for the skilled sector when all the shocks are included. That is why we also try an elasticity of substitution of 1.5 in column 3a. The more striking result of considering land in the model is the reversion of the impact of capital accumulation on the wage premium. This is due to the fact that the increase in the rents of land with respect to the base model (without land) spoils the gain in competitiveness that capital accumulation introduces on the unskilled sector via reduction in the rents of capital. Therefore, the contribution of capital accumulation to wage inequality depends on the structure of the model chosen: in the base model (without separating land and ‘machines’) capital growth reduces wage inequality, but if land is considered as a specific factor in the model, capital growth increases wage inequality. However, the contribution of the main determinants of wage inequality: globalization (trade and migration), technological change and education is not affected by the inclusion or not of land as a specific factor in the model.

Third, we have also checked the robustness of the model to the Ricardian small open economy assumption by adding an external demand with a negative slope, that is, a large open economy assumption (LOE) in the export of the skilled sector. In this case we have introduced the external shock by changing the world exogenous price of imports, on the basis that British agricultural market did not have a very big impact on world prices (Williamson 1990). Results are displayed in the last two columns of Table 8 corresponding to different characterizations of foreign demand, which is more inelastic in column 4a, meaning that the market power of the UK in the international markets is bigger, and thus, an augment in the exports of $X_1$ decreases $P_1$ by more. The main conclusion arising of working with the LOE assumption is the reduction in the
weight of trade as a factor that contributed to push up wage inequality. The explanation of this result is the following: a reduction in the price of imports increases the demand of imports and decreases the demand of the domestic competing good $X_2$ produced by the unskilled sector. This, in turn, causes the production of $X_2$ to contract, thus reducing the needs for unskilled workers in this sector. As the labor factor is completely mobile there is a leakage of unskilled workers from the unskilled to the skilled sector which is now more able to increase production. However, the additional production of $X_1$ creates a pressure for $P_1$ to go downwards because it faces a low elasticity of external demand. To hold extraordinary profits constant the unitary cost in sector $X_1$ has to be reduced. As this sector is more intensive in skilled workers, it means a relative more important reduction of the skilled wages, thus easing the increase in wage inequality.

To sum up, working with different modeling strategies does not alter too much the sign of the effects of the shocks on wage inequality, the main exception being the impact of capital accumulation when land is included as a specific factor. A reduction in the size of the impact of trade in inequality is detected as we go from the base model to an alternative model including services, land and external price dependence of domestic conditions.
Table 8. Simulated $W_s/W_u$ in 1913 due to exogenous factors:
sensitivity analysis to different modelling strategies

<table>
<thead>
<tr>
<th></th>
<th>Model (1) Baseline model</th>
<th>Model (2) (1) + Services</th>
<th>Model (3a) (2) + Land (1.5)</th>
<th>Model (3b) (2) + Land (0.5)</th>
<th>Model (4a) (3) + LOE (-1.1)</th>
<th>Model (4b) (4) + LOE (-2.5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trade</td>
<td>1.107</td>
<td>1.059</td>
<td>1.043</td>
<td>1.040</td>
<td>1.017</td>
<td>1.026</td>
</tr>
<tr>
<td>Emigration</td>
<td>0.712</td>
<td>0.704</td>
<td>0.706</td>
<td>0.701</td>
<td>0.698</td>
<td>0.699</td>
</tr>
<tr>
<td>Education</td>
<td>0.768</td>
<td>0.749</td>
<td>0.758</td>
<td>0.741</td>
<td>0.724</td>
<td>0.728</td>
</tr>
<tr>
<td>Population growth</td>
<td>1.042</td>
<td>1.025</td>
<td>1.035</td>
<td>1.018</td>
<td>0.996</td>
<td>1.002</td>
</tr>
<tr>
<td>Capital growth</td>
<td>0.826</td>
<td>0.922</td>
<td>1.031</td>
<td>1.105</td>
<td>0.990</td>
<td>1.020</td>
</tr>
<tr>
<td>Tech. change</td>
<td>1.626</td>
<td>1.678</td>
<td>1.560</td>
<td>1.570</td>
<td>1.815</td>
<td>1.730</td>
</tr>
<tr>
<td>Wage inequality</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>without tech. change</td>
<td>0.534</td>
<td>0.533</td>
<td>0.573</td>
<td>0.570</td>
<td>0.506</td>
<td>0.529</td>
</tr>
<tr>
<td>Wage inequality</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Including tech. change</td>
<td>0.924</td>
<td>0.924</td>
<td>0.924</td>
<td>0.924</td>
<td>0.924</td>
<td>0.924</td>
</tr>
<tr>
<td>Terms of trade ($P_1/P_2$)</td>
<td>1.123</td>
<td>1.123</td>
<td>1.123</td>
<td>1.053</td>
<td>0.763</td>
<td>0.843</td>
</tr>
</tbody>
</table>

(1) Baseline model. (2) Baseline model with a non tradable service sector. (3a) Baseline model with a non tradable service sector and land in the unskilled sector $X_2$; the elasticity of consumption between $X_1$, $X_2$ and Services is assumed to be 1.5. (3b) Baseline model with a non tradable service sector and land in the unskilled sector $X_2$; the elasticity of consumption between $X_1$, $X_2$ and Services is assumed to be 0.5. (4a) Large open economy model with a non tradable service sector and land in the unskilled sector $X_2$. The elasticity of external demand with respect to price is assumed to be -1.1. (4b) Large open economy model with a non tradable service sector and land in the unskilled sector $X_2$. The elasticity of external demand with respect to price is assumed to be -2.5.

Note: In each model the rate of growth of capital has been corrected to take into account the weight of land on capital. Thus, in model (1) rents of land represent 25% of the estimated rents of capital. In model (2) rents of land represent 11% of the estimated rents of capital. In models (3) and (4) the rate of growth of capital has not been corrected because land is already included in the model.

6. Conclusions

The current era of globalisation has witnessed a rising premium paid to skilled workers resulting in increasing wage inequality in most OECD countries. This pattern differs from that observed during the past globalisation period (1880-1913), in which wage inequality decreased in most of the Old World countries. The present debate over wage inequality focuses on the implications of globalisation, technological change, the role of labour market institutions and education. Similar factors took place in the past globalisation process.
During the past globalisation, the UK experienced a decrease in wage inequality. We have shown that this was a general pattern in other European countries. In order to disentangle the main factors that contribute to explaining wage inequality, we calibrate a general equilibrium model for the UK economy in 1913. To achieve this, we have made a great effort to compile and elaborate data so as to be able to construct a social accounting matrix. A general equilibrium approach is first used in this historical context to explain the wage inequality change. Thus, we intend to corroborate some hypotheses proposed by previous research based on the use of reduced-form and CGE models to enrich the analysis by considering a higher disaggregation of the main variables implied, such as migration, education, capital and skilled and unskilled labour endowments.

One primary result is that the globalisation factors (trade and emigration) had a significant effect on wage inequality when considered separately. However, other factors such as education and technological change also had an impact on the wage premium. Numerical simulations show that a trade shock, in the terms of trade, and a technology shock biased against unskilled labour are compatible with the observed decrease in the ratio between skilled and unskilled labour wages during the 1880-1913 globalisation period. For this to be possible, there must have been other off-setting factors such as education and emigration.

Other of our purposes was to categorise the importance of all the shocks that affected wage inequality in the UK. In order to accomplish this, we have presented three types of effects. First, we have calculated the individual effect of each shock, showing that the total impact of emigration, education and capital growth reducing the wage premium offsets the impact of trade and technology increasing wage inequality. Technology change also played an important role, increasing wage inequality, thus
supporting the hypothesis that technological change in the Second Industrial Revolution favoured skilled workers. These results are somewhat sensitive to the elasticity of substitution between skilled and unskilled workers, reducing the magnitude of all the effects, and to the elasticity of substitution between imports and domestic production, reducing the impact of trade and increasing the impact of technology. However, the main results are robust to parameter checking.

Secondly, we present the simulated elasticity of wage dispersion to a change in each individual factor in order to illustrate that, once we homogenise by the size of the shock, emigration and education had the higher effect. In a reduced-form estimation these results would be translated to the parameters of the main offsetting factors (emigration and education) to be the most important.

Thirdly, we calculate the opportunity cost of each of the shocks that occurred in the past, concluding that the technology change was the most important in this sense, as wage inequality would have improved the most had this factor been absent. The main difference with respect to the first set of results is the fact that interaction effects are considered. In a reduced-form estimation, these results would be roughly similar to multiplying the coefficient by the actual change in the explanatory variable.

Working with different modeling strategies does not alter too much the sign of the effects of the shocks on wage inequality, the main exception being the impact of capital accumulation when land is considered as a specific factor in the model. A reduction in the size of the impact of trade in inequality is detected as we go from the base model to an alternative model including services, land and external price dependence of domestic conditions.

What can we learn from the past? Our results indicates that in the past globalisation process, as in most of the research on wage inequality for the present,
technology change played an important role against a reduction in wage inequality. The most important difference between past and present being the existence of offsetting factors (especially migration, education and perhaps trade unions) that had a significant influence in the past and do not seem to be acting in the present. These factors could explain why wage differentials decreased in the past in some countries, but increased in the last decade of the twentieth century. Nevertheless, this paper is based on data from only one country. Further research is needed to elucidate whether the above results can be generalised to other countries.

References


Appendix 1: Parameters, variables and equations

Table A1: Parameters of the model

| Scale parameters: | \( \alpha_1 = 1.74 \), \( \alpha_2 = 1.91 \), \( \alpha_3 = 2.00 \), \( \alpha_4 = 1.86 \), \( \alpha_5 = 1.87 \), \( \alpha_6 = 1.92 \) |
| Shift parameters: | \( \delta_1 = 0.84 \), \( \delta_2 = 0.29 \), \( \delta_3 = 0.55 \), \( \delta_4 = 0.75 \), \( \delta_5 = 0.25 \), \( \delta_6 = 0.57 \) |

Elasticity of substitution \( \eta \): \( \nu^s = \nu^u = \nu^p = -1 \), \( \nu^c = 0.8 \) where \( \nu = 1 - 1/\eta \)

Skilled biased technology parameter: \( \beta^s = 1 \)

Unskilled biased technology parameter: \( \beta^u = 1 \)

Table A2: Exogenous variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \overline{P}_{E1} )</td>
<td>World price for the export good</td>
</tr>
<tr>
<td>( \overline{P}_{M2} )</td>
<td>World price for the import good</td>
</tr>
<tr>
<td>( \overline{K} )</td>
<td>Total capital endowment</td>
</tr>
<tr>
<td>( \overline{S} )</td>
<td>Skilled labour endowment</td>
</tr>
<tr>
<td>( \overline{U} )</td>
<td>Unskilled labour endowment</td>
</tr>
<tr>
<td>( \overline{CTD} )</td>
<td>Current trade deficit</td>
</tr>
</tbody>
</table>

Table A3: Endogenous variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>( X_1 )</td>
<td>Production index for the skill intensive sector</td>
</tr>
<tr>
<td>( X_2 )</td>
<td>Production index for the unskilled intensive sector</td>
</tr>
<tr>
<td>( L_1 )</td>
<td>Labour composite in sector 1</td>
</tr>
<tr>
<td>( L_2 )</td>
<td>Labour composite in sector 2</td>
</tr>
<tr>
<td>( W )</td>
<td>Welfare index</td>
</tr>
<tr>
<td>( Y )</td>
<td>Armington composite</td>
</tr>
<tr>
<td>( M_2 )</td>
<td>Imports of good 2</td>
</tr>
<tr>
<td>( E_1 )</td>
<td>Exports of good 1</td>
</tr>
<tr>
<td>( P_1 )</td>
<td>Price for the good in the skilled intensive sector</td>
</tr>
<tr>
<td>( P_2 )</td>
<td>Price for the good in the unskilled intensive sector</td>
</tr>
<tr>
<td>( P_{L1} )</td>
<td>Price for the labour composite in the skilled intensive sector</td>
</tr>
<tr>
<td>( P_{L2} )</td>
<td>Price for the labour composite in the unskilled intensive sector</td>
</tr>
<tr>
<td>( W_s )</td>
<td>Skilled labour wage</td>
</tr>
<tr>
<td>( W_u )</td>
<td>Unskilled labour wage</td>
</tr>
<tr>
<td>( P_{w} )</td>
<td>Welfare price index</td>
</tr>
<tr>
<td>( P_y )</td>
<td>Price for Armington composite</td>
</tr>
<tr>
<td>( P_{F2} )</td>
<td>Price for the imported unskilled good</td>
</tr>
<tr>
<td>( P_{EX} )</td>
<td>Exchange rate</td>
</tr>
<tr>
<td>( I )</td>
<td>Total income for the representative consumer</td>
</tr>
</tbody>
</table>
A1.1 Production functions

Each sector produces using capital and a composite of skilled and unskilled labour:

\[ X_j = \alpha_j \left[ \delta_j^s K_j^v + (1 - \delta_j^s) L_j^v \right]^{\gamma_j} \]

where \( j = 1, 2 \) stands for the skilled (1) and unskilled (2) sector. The composite of labour for each sector takes the form:

\[ L_j = \alpha \left[ \delta^s (\beta^s S_j)^{\gamma_j} + (1 - \delta^s) (\beta^s U_j)^{\gamma_j} \right]^{\frac{1}{\gamma_j}} \]

There is a utility function defined over domestic and imported goods:

\[ W = \alpha^w \left[ \delta^w X_1^{\gamma_w} + (1 - \delta^w) Y^{\gamma_w} \right]^{\frac{1}{\gamma_w}} \]

where \( Y \) is a composite of the domestic produced unskilled good and an equivalent imported good (Armington assumption):

\[ Y = \alpha^y \left[ \delta^y X_2^{\gamma_y} + (1 - \delta^y) M_2^{\gamma_y} \right]^{\frac{1}{\gamma_y}} \]

The model is composed of the following equations determined by zero profit conditions, market clearing conditions, income balance and the macroeconomic closure rule.

A1.2 Zero profit conditions

Perfect competition and free entry imply that firms do not have extraordinary profits.

\[ P_j = (\alpha^s)^{-1} \left[ (\delta^s)^{\gamma_s} \left( \frac{1 - \delta^s}{\beta^s} \right)^{\gamma_s} + (1 - \delta^s) \right] \]

\[ P_{L_j} = (\alpha^s)^{-1} \left[ (\delta^s)^{\gamma_s} \left( \frac{W_j}{\beta^s} \right)^{\gamma_s} + (1 - \delta^s) \right] \]

\[ P_w = (\alpha^w)^{-1} \left[ (\delta^w)^{\gamma_w} \left( \frac{1 - \delta^w}{\beta^w} \right)^{\gamma_w} + (1 - \delta^w) \right] \]

\[ P_y = (\alpha^y)^{-1} \left[ (\delta^y)^{\gamma_y} \left( \frac{1 - \delta^y}{\beta^y} \right)^{\gamma_y} + (1 - \delta^y) \right] \]

\[ P_1 = \frac{P_{E_1}}{P_{E_1}^{FX}} \]

\[ P_{E_2} = \frac{P_{E_2}}{P_{E_2}^{FX}} \]

Where unitary revenue is on the left hand side of the equations and unitary cost on the right.

A1.3 Market clearing conditions

These conditions imply that demand equals supply for each good and factor.

\[ X_1 - E_1 = (\alpha^s)^{-1} \left[ (\delta^s) + (1 - \delta^s) \left( \frac{\delta^w P_1}{(1 - \delta^w) P_1} \right)^{\gamma_s} \right]^{\gamma_s} \]

\[ W \]
\[
Y = (\alpha^u)^{-1} \left[ \delta^u \left( \frac{(1 - \delta^u)P_1}{\delta^u P_P} \right)^{\cdot \eta} \right] W
\]

\[
X_2 = (\alpha^v)^{-1} \left[ \delta^v + (1 - \delta^v) \left( \frac{\delta^v P_{P_2}}{(1 - \delta^v) P_2} \right)^{\cdot \eta} \right] Y
\]

\[
M_2 = (\alpha^s)^{-1} \left[ \delta^s \left( \frac{(1 - \delta^s)P_2}{\delta^s P_{P_2}} \right)^{\cdot \eta} \right] Y
\]

\[
W = \frac{I}{P_w}
\]

\[
\bar{K} = \sum_{j=1}^{2} \left( \alpha_j^{\cdot} \right)^{-1} \left[ \delta_j^{\cdot} + (1 - \delta_j^{\cdot}) \left( \frac{\delta_j^{\cdot} P_{P_j}}{(1 - \delta_j^{\cdot}) P_k} \right)^{\cdot \eta_j} \right] X_j
\]

\[
L_1 + L_2 = \sum_{j=1}^{2} \left( \alpha_j^{\cdot} \right)^{-1} \left[ \delta_j^{\cdot} \left( \frac{(1 - \delta_j^{\cdot})P_k}{\delta_j^{\cdot} P_{P_j}} \right)^{\cdot \eta_j} \right] X_j
\]

\[
\bar{U} = \sum_{j=1}^{2} \left( \alpha_j^{\cdot} \right)^{-1} \left( \frac{1}{\beta^u} \right) \left[ \delta_j^{\cdot} \left( \frac{(1 - \delta_j^{\cdot})\beta^u W_s}{\delta_j^{\cdot} \beta^u W_{s}} \right)^{\cdot \eta_j} \right] L_j
\]

\[
\bar{S} = \sum_{j=1}^{2} \left( \alpha_j^{\cdot} \right)^{-1} \left( \frac{1}{\beta^s} \right) \left[ \delta_j^{\cdot} \left( \frac{(1 - \delta_j^{\cdot})\beta^s W}{(1 - \delta_j^{\cdot}) \beta^s W_s} \right)^{\cdot \eta_j} \right] L_j
\]

Supply is on the left hand side while the right captures demand. The equation \( W = I/P_w \) represents the budget constraint, \( P_w \) being the minimum cost at a given commodity prices of buying one unit of utility (the expenditure function) and \( I \) the total income of the representative household (see definition in the below equation).

**A1.4 Income balance**

The following equation defines total income as revenues from total capital endowment, skilled and unskilled labour endowments and current trade deficit.

\[
I = P_k \overline{K} + W_s \overline{S} + W_u \overline{U} + P_{P_x} \overline{CTD}
\]
A1.5 Macro closure rule
This rule reflects the fact that the current trade deficit is constant.

\[ P_1 E_1 - P_{F_2} M_2 = P_{F2} \overline{CTD} \]

Equations (from A2.2) to (A2.5) determine a model with 19 equations that is solved for 19 endogenous variables (see Table A3 above).

A1.6 Calibration with added restrictions
Up to what degree match the model solution other data than wage premium? To answer this question two changes in calibration are included with respect to exact calibration in which only information for the wage premium is considered. First, we allow for Hicks neutral technology change in sector X2 as captured by \( \Delta \alpha_x \) in addition to the unskilled biased technological change (\( \Delta \beta^u \)) used in the exact calibration procedure. Second, we choose \( \beta^u \) and \( \alpha_x \) for 1880 in order to minimise a criterion function. In particular we choose the sum of squared deviation of model-predicted wage and production ratios (with a hat in the expression below) with respect to the actual values in 1880 (the variables without hat):

\[
\min_{\beta^u, \alpha_x} \left\{ \Omega \left( \frac{W_{1880}^c}{W_{1880}^s} \frac{\hat{W}_{1880}^s}{\hat{W}_{1880}^s} \right)^2 + (1 - \Omega) \left( \frac{X_{1880}^c}{X_{1880}^s} \frac{\hat{X}_{1880}^s}{\hat{X}_{1880}^s} \right)^2 \right\}
\]

where \( \Omega = 0.5 \). This particular form implies the same weight for the wage premium and production deviations. Thus, the exact calibration procedure can be consider a special case where both \( \Omega = 1 \) (in this case we reply exactly the wage premium variation) or \( \Omega = 0 \) in which case we would replicate exactly variation in production ratios. We solve the above optimization problem numerically creating a grid of values for \( \beta^u \) and \( \alpha_x \), and solve the model for all the possible combinations of values of \( \beta^u \) and \( \alpha_x \), taking the combination that minimize the objective function.

According to our results the minimum value for this function is 0.004 that is reached for a value of \( \beta^u_{1880} = 0.600 \) and \( \alpha_x^{1880} = 1.230 \).

Appendix 2:

Data for wage inequality in the past
For France, the UK, Italy and Spain see Betrán and Pons (2004). For Sweden, we have calculated from Bagge, G., Lundberg, E. and Svennilson, I. (1933).

Data for UK

A2.1 Employment
Skilled workers: skilled manual workers.


Sectors: Industry (Manufacturing, Building, Gas, Electricity and Water, Mining and Quarrying) and Agriculture. We have not considered the service sector.

Years: 1911 (census year).

We have used employment of manual workers by industry elaborated by Routh, G. (1980): Occupation and Pay in Great Britain 1906-1979, London, MacMillan. These data are elaborated from the Census of Population to obtain a homogeneous classification. As we need data by industry for skilled, semi-skilled and unskilled manual workers and the data elaborated by Routh, G. (1980) only refer to 1951, we have calculated the proportions of skilled manual workers, semi-skilled and unskilled manual workers and non-manual workers in the labour force for each industry in 1951 and we have considered that these proportions are the same as in 1911.

We have also used the proportion of skilled on semi-skilled and unskilled manual workers to classify industries in skilled and unskilled sectors. The skilled industries are those that display an above average proportion and the unskilled industries a below average proportion.

Classification of sectors in decreasing order:


A2.2 Production

We have obtained the data of production for the different industries for 1924. We have taken the production data from Gross Domestic product at factor cost (million pounds) for 1924 elaborated by Feinstein, Ch. (1972): National income, expenditure and output of the UK, 1855-1965, Table 9, p. T26 and the share of value added in manufacturing for 1924 in Mathews, Feinstein and Odling-Sme (1982): “Output, Inputs, and Productivity by Sector” in British Economic Growth, 1856-1973, Oxford, OUP, Chapter 4, p. 239. To obtain the data for the year 1913 we have used the index of production of each industry and agriculture, forestry and fishing elaborated by Feinstein, Ch. (1972).

We have used the above classification of skilled and unskilled sectors to obtain the skilled and unskilled production for the skilled and unskilled sectors.
A2.3 Capital

The rents of capital are estimated for each sector as a residual obtained from the difference between the value of the production and the income from labour.

A2.4 Trade


Imports (£m): Mitchell (1990, p.475-476)


Terms of trade: Prices of Exports on Prices of Imports in percentages.


A2.5 Average wage

We have calculated an annual average wage for the year 1913 (in pounds), weighted by the participation of each group of workers in the total number of manual workers. We have used the data from Routh (1980, p.99) for 1911 and for obtaining the data for 1913 we use the Index of Money Wages from Bowley, A.L. (1937): *Wages and income in the UK since 1860*, Cambridge.

A2.6 Education:


A2.7 Other variables:

Migration: To calculate the impact of emigration in the labour market, we consider that emigration reduced the unskilled labour force by 16% in 1911 following O’Rourke, Williamson and Hatton (1994, p. 208).

**Labour force**: We have used the data for the labour force in 1913 elaborated by Routh (1980) which is homogenous with the data of 1951 Census. To calculate the labour force in 1880 we have used the increase in the labour force in the considered sectors from 1880 to 1913 from Mitchell (1998, p. 104)

**The growth rate of capital stock**: We have considered the growth of the total gross stock of capital at 1900 prices between 1880-1913 from Mitchell (1990, p.864). As in our model, capital involves land and capital, in order to identify productive capital and land accumulation separately we use the percentage which represents the rents of land on GDP in 1841 (from Harley and Crafts, 2000) and extrapolate to the year 1913 using the rate of growth of the rents of land and buildings calculated by Feinstein (1972). According to our estimation the rents of land represented 15% of the production of agriculture (A) and industry (I) in 1913. As the participation of the total rents of capital on GDP (A+I) according to the social accounting matrix was 58.2%, we use the ratio (58.2-15)/58.2 to correct the shock in capital of Table 3.