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Productivity and institutions

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Abstract

Differences in productivity account for differences in output per capita between countries as well as changes in output and the standard of living for each country over long periods of time. During the first industrial revolution, one could already see the emergence of two groups of countries: the high- and the low-GDP per capita countries. The list of countries belonging to the high-productivity group has not changed much over the past century. Differences in institutions separate the two clubs. The high-productivity group is, amongst many other differences, characterized by less corruption, a better legal system, superior enforcement of contracts, a lower cost of starting a business and lower tariffs. Historical output series for Britain going back to the mid-19th century show that productivity has increased greatly and improved the standard of living.

Keywords: Productivity; institutions; growth; corporatism.

Introduction

The past couple of centuries have brought unparalleled riches to the Western world while leaving many poor countries behind. In economic models, the differences in living standards are captured neatly by the letter A in the production function denoting the level of productivity. As an example, when the Cobb-Douglas production function $Y=AK^{\alpha}N^{1-\alpha}$, where Y denotes output, K capital and N labor, is used to explain differences in output per capita between countries one finds that over half the difference is accounted for by differences in the unobserved variable A.[1] However, it is not clear why productivity differs from one country to another, nor is it clear how to improve produc-

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tivity in the poor countries. What is clear is that productivity reflects not only the level of technology but also the institutional environment and perhaps also culture.

The objective of this paper is to demonstrate the importance of productivity for both explaining differences in output per capita between countries as well as its growth over time. The first section of the paper has an overview of the literature on institutions and productivity growth. There follows an empirical analysis of the performance of a sample of countries since the late 19th century where clubs of rich and poor countries are identified,[2] their movements over time described and the movements of countries between the clubs of poor and rich nations explored. The relationship between productivity and economic institutions will then be examined before exploring the long-run performance of Britain, which has always belonged to the rich club, in terms of its productivity growth starting in the 19th century.

1. Institutions

Eggertsson (2007) describes how a society's institutions are chosen from a set of feasible institutions, defined by physical technology, our knowledge of social institutions, geography, climate, and past institutions. The choice of a set of institutions affects economic outcomes, as can be seen in the relative performance of divided countries such as East and West Germany and Taiwan and mainland China (see Olson 1986).Various factors can prevent a society from adopting the best set of institutions, such as the failure of collective action, the self-interest of ruling groups, the belief in the efficiency of different institutions, culture, and ethnic diversity.

A dictator, corrupt governments, and industries benefiting from rent-seeking may prefer a social infrastructure that generates lower national income (see DeLong; Shleifer 1993). Culture may also be important. For example, the societies of Scandinavia enjoy higher levels of trust than other European and American countries, which enables them to run an extensive welfare state aimed at promoting participation in the labor market, as was first proposed by Alva and Gunnar Myrdal (1934).[3] Ethnic homogeneity may also play a role in these countries. Geography may affect exposure to Western ideas and can affect trade and specialization as well (see Nunn & Puga 2007). Bloom and Sachs (1998) describe the disadvantages of the tropics for economic activity. An alternative explanation is proposed by Acemoglu, Johnson, and Robinson (2001, 2002), who describe the effect of the colonial-era disease environment on the willingness of Europeans to settle in countries where settlers' mortality rates were known to be high, thus impeding the introduction of institutions favorable to growth. In their place, the Europeans set up extractive economies, especially in densely populated areas with pre-existing institutions. In contrast, Europeans migrated to colonies where mortality rates were lower – such as Canada, Australia, and New Zealand – bringing institutions with them. Sokoloff and Engerman (2000) trace the superior performance of the United States and Canada in comparison to other American countries to differences in relative factor endowments that made inequality greater and political power more concentrated in South America and the Caribbean. Higher levels of inequality created institutions intended to protect

the interests of the few and limited the access of most of the population to economic opportunities. Acemoglu, Johnson, and Robinson (2002) claim that, in the UK and the Netherlands, trade with America emboldened a new mercantile class that demanded capitalist institutions, whereas in countries such as Spain and Portugal, Atlantic trade strengthened central control. A recent book by Acemoglu and Robinson (2012) continues this theme by distinguishing between extractive and productive institutions. A final factor determining the institutional setup – beliefs about the merits of different social systems – may also be important. Thus a Soviet-type planning economy was admired in the 1950s and into the 1960s, the German Wirthschaftswunder was widely acclaimed in the 1960s, Japan was supposed to be "Number one" in the 1980s, and currently, Chinese state capitalism is supposed to make China the most powerful nation in the world.

There are examples of positive changes in institutions, such as Britain in the 17th and 18th centuries[4] and Singapore in the 20th century. But there are also examples of institutions deteriorating, as discussed by Phelps (2013) and Olson (1982). Phelps's main worry is the gradual strengthening of corporatist institutions in many Western countries that are intended to prevent capitalism from harming the objects of traditional values by making competition in the market less important and replacing it with shared objectives for society. At the heart of corporatism is thus an intervention in what the economy produces and how income is distributed.[5] In Phelps and Zoega (2013), we show how corporatist institutions are inversely correlated with measures of economic performance across countries, in particular reported job satisfaction.[6] In his The Rise and Decline of Nations, Mancur Olson describes how stable societies with unchanged boundaries tend to accumulate more collusion and more organizations for collective action over time. Such groups reduce efficiency and economic growth and make political life more divisive. Distributional coalitions increase the volume of regulations and the role of government.

In what follows I will identify clubs of successful developed countries and less successful developing countries in order to explore how frequently countries move between the clubs and whether the distance between them has changed. The set of institutions that separate the two will also be briefly explored without formally analyzing causality, i.e. whether institutions cause growth or vice versa. We then go on to study productivity growth in one rich economy to explore whether there has been a productivity slowdown in recent decades in the club of rich nations.

2. Convergence clubs

The emergence of the West and its possible decline can best be studied by looking at long-run data on output. The evolution of the world income distribution in a cross-section of countries and the mobility of individual countries within the distribution can be described using kernel density estimation. Denote by y_i the GDP per capita in 1990 dollars for country i and transform the variable so that x_i denotes the country's per capita GDP relative to the average of GDP per capita across the countries:

$$x_i = y_i \Big/ \left(\sum_{i=1}^{n} y_i / n\right) \quad (1)$$

The transformation has a natural interpretation as the relative GDP per capita of the i^{th} country.[7] This normalization makes it easier to compare the densities between any two periods. The estimated distribution can then be used to assess whether the distribution is multimodal, which would show up in a distribution with two or more peaks.

Following Bianchi (1997), the density distribution $f(x_i)$ is estimated in order to identify the location of each country within the estimated distribution. There may be different groups of countries, such as low-income countries and high-income countries. In this case, the density distribution of the data is a mixture of distributions described by

$$f(x) = \sum_{j=0}^{m-1} p_j g_j(x; \mu_j, \sigma_j) \quad p_j \geq 0 \quad (2)$$

where p_j's are mixing proportions with

$$\sum_{j=0}^{m-1} p_j = 1 \quad (3)$$

and g_j are densities with first and second moments μ_j and σ_j. If the gap in the μ_j's is large relative to the σ_j's, the modes in the distribution are said to be well separated and $f(x)$ is multimodal, with m modes. If the gap is small relative to the variances, the mixture components in the density are not well separated.

The density can be estimated non-parametrically by the method of kernels. Given a sample of n independent and identically distributed observations,[8] a kernel density estimator of $f(x)$ is constructed as (see Silverman 1986)

$$\hat{f}_h(x) = (nh)^{-1} \sum_{i=1}^{n} K\left(\frac{x - x_i}{h}\right) = (nh)^{-1} \sum_{i=1}^{n} K(u) \quad (4)$$

where $h > 0$ is the bandwidth and $K(u) = 1/\sqrt{2\pi}\ exp(-1/2u^2)$ is the Gaussian kernel. In effect, the method sums up a set of n normal distribution, each centered on one of the observations in the sample (x_i).The bandwidth h determines the degree of smoothness of the density estimate, with larger values of h producing a smoother density estimate.[9] A critical bandwidth h_m is defined as the smallest possible h producing a density with, at most, m modes. The bandwidths proposed by Silverman (1986) fall between the critical bandwidths for one and two modes in the distribution.

Data from the Maddison Project includes GDP per capita back to 1820.[10] I begin by estimating the distribution of real GDP per capita for countries for which the Maddison data provide numbers in 1850,[11,12] and show the distribution for selected years in Figure 1 below. The estimated distributions show the gradual emergence of two groups of countries: the high-income (H) and low-income (L) countries. This trend was only interrupted by two world wars, which saw the higher mode of the income distribution

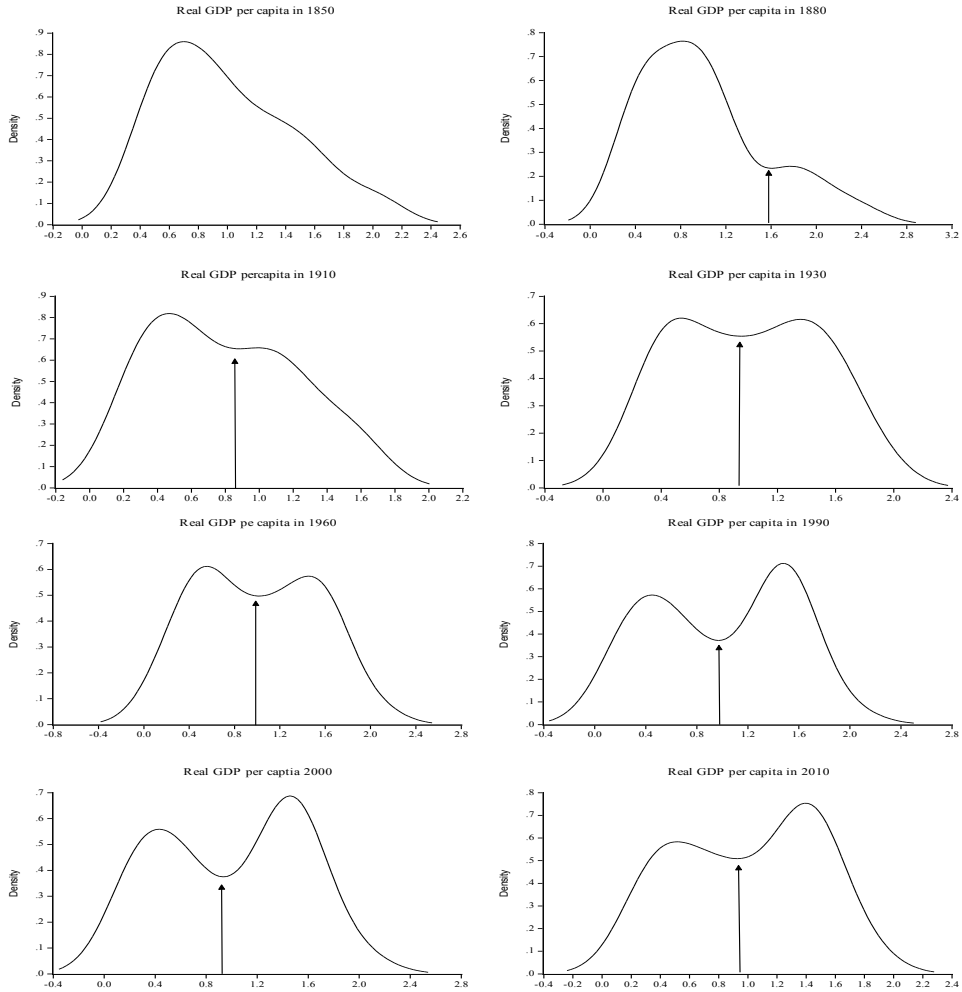
suppressed and the overall distribution become close to unimodal. In the figure, one can see the higher-income mode appearing in 1880 and becoming more pronounced in 1910 and 1930. What is happening over these years is the transition of countries from the group of *L* to the *H* group. The peak of the distribution for the *H* group has become taller in 1990 and remains so in 2000 and 2010. In fact, more countries are leaving the *L* group for the *H* group than are moving in the opposite direction.[13]

A table in the appendix (Table A1) lists the countries in the H and L groups in 1880, 1910, 1930, 1970, and 2010. The list of H countries in 1880 included only Britain, the US, the British colonies of Australia and New Zealand, and Belgium and the Netherlands. By 1910, this list had expanded considerably to include Canada, Denmark, Germany, Austria, and France, in addition to the agricultural economies of Argentina, Uruguay, and Chile. By 1930, four other countries had joined the H group: Sweden, Norway, Venezuela, and Czechoslovakia.

By 1970, Japan, Finland, and Italy had joined the *H* group, and Spain had done so by 2010. However, Argentina, Uruguay, Chile, and Czechoslovakia had moved back to the *L* group by 1970. Thus the list of countries belonging to the *H* group has not changed much over the past century. There are only a handful of new members – Sweden, Norway, Japan, Italy, and Spain – when one only includes those countries for which Madison had numbers in 1850.

While Figure 1 is informative in the sense of describing differences in living standards in the world, it does not describe differences in productivity. To do this, one needs to work with output per employed worker instead of output per capita. Furthermore, a decomposition of cross-country differences in output per employed worker would highlight the significance of differences in capital intensity and productivity. Using the Penn World Tables,[14] one can find output per employed worker (in 2005 dollars) and investment series for 124 countries, which enables us to decompose differences in output per employed worker into differences in capital intensity and productivity (*A*) using the methodology of Hall and Jones (1999). Hall and Jones in effect performed growth accounting where they assume that the share of capital in GDP is 1/3 and the share of labor 2/3 and find that more than half of the difference between the poorest and the richest countries (measured in GDP per capita) is left unexplained by differences in physical and human capital (schooling).[15]

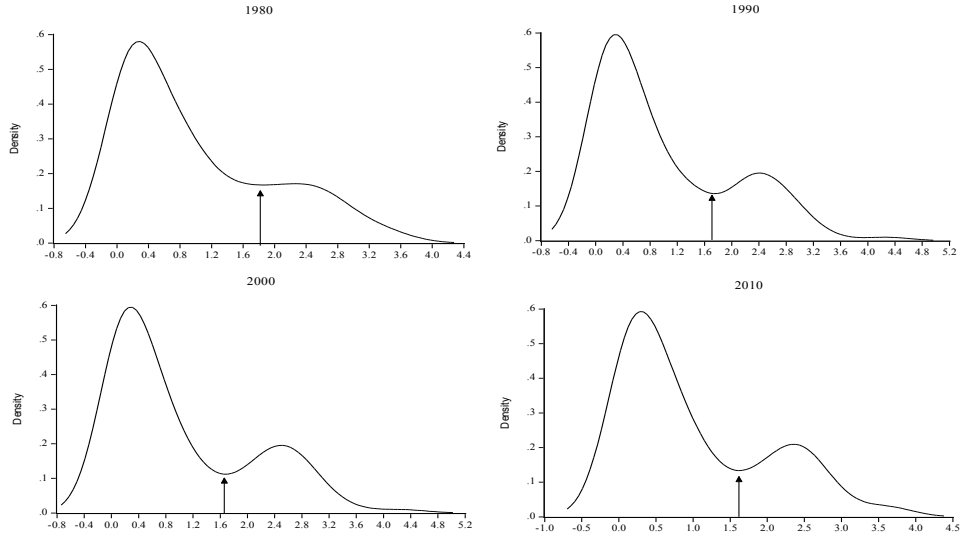
Figure 1. Distribution of real GDP per capita



Source: Maddison Project.

The figure below shows the distribution of output per employed worker for a group of 120 countries taken from Penn World data and estimated with the bandwidths proposed by Silverman (1986). Again, the same picture emerges of the existence of two groups of countries: the low-productivity and the high-productivity countries.

Figure 2. Distribution of real GDP per employed worker



Source: Penn World Tables.

The gap between the mean value in the two distributions widened in the 1990s but then fell in the 2000s, as is shown in the table below.

Table 1. Mean normalized output per employed worker

	1980	1990	2000	2010
Low-productivity	0.27	0.30	0.26	0.27
High-productivity	2.40	2.40	2.55	2.30
Difference	2.13	2.10	2.81	2.03

Note: The numbers show average normalized productivity in the two groups of countries after productivity in each country has been normalized by average productivity in the whole sample.

One feature of the data is the low frequency of transitions between the two groups. Table 2 documents transitions between states when each country is classified based on the distribution to which it belongs in each year. The top part of the figure includes industrial countries and the bottom part of the table includes economies based on natural resources. The distinction is made because the ascendance of the latter into the high-income group can be explained by changes in the volume of oil production and the price of oil in the case of the first three countries listed and changes in the number of tourists in the Seychelles.

Table 2. Transitions to the group of high-productivity (output per employed worker) countries

1980		1990		2000		2010	
Industrial economies							
		Hong Kong	2.11	Hong Kong	2.26	Hong Kong	2.69
		Singapore	2.2	Singapore	2.94	Singapore	3.68
				Malta	2.03	Malta	1.83
				Taiwan	2.12	Taiwan	2.43
						Czech R.	1.7
						South Korea	1.98
Natural resource economies							
Oman	2.17	Oman	2.17	Oman	1.99	Oman	1.87
		Saudi Arabia	2.38	Saudi Arabia	2.32	Saudi Arabia	2.11
		Seychelles	2.26	Seychelles	2.42	Seychelles	NA

Note: The numbers for each country give the normalized output per employed worker for each country.

Between 1980 and 2010, there are six countries that join the high output per employed worker group: Hong Kong and Singapore in 1990, Malta and Taiwan in 2000, and the Czech Republic and South Korea in 2010. In addition, the oil-producing countries and Oman and Saudi Arabia join in 1980 and 1990, and the Seychelles Islands, whose main industry is tourism, join in 1990. Only two countries leave the high-output club. These are Iran and Venezuela, which belong to the high-output club in 1970 but joined the low-output club in 1980 (not shown in Table 2).

It is noteworthy that, of the six countries that move from the low-output to the high output per employed worker group over these forty years, three are former British colonies: Hong Kong, Malta, and Singapore. The meteoric rise of Singapore is interesting. Singapore was a colony of Britain from 1826 until it gained independence in 1963.[16] Its subsequent leaders were educated in Britain, upheld the principle of property rights, fought corruption and promoted free trade, implemented polices to harness the global flow of ideas, and encouraged foreign direct investment. Malta, a British colony from 1802 to 1964, and Hong Kong, a colony from 1841 to 1997, also have a strong British heritage.[17]

The differences in output per employed worker reflect differences in capital intensity and productivity. The approach of Hall and Jones (1999) can be used to calculate the relative importance of productivity and capital in explaining differences in output per employed worker across countries and provinces. Starting with the Cobb-Douglas production function for the whole economy,

$$Y = K^{\alpha}(AN)^{1-\alpha} \tag{5}$$

where N denotes the number of employed workers and K is calculated from investment data,[18] and taking logs gives:

$$\log Y = \alpha \log K + (1-\alpha)\log A + (1-\alpha)\log N \qquad (6)$$

Finally, rearranging gives a solution for A that can be calculated by assuming that the share of capital in national income is 1/3 (as in Hall and Jones):

$$\log A = \log Y - \frac{1}{2}\log\frac{K}{Y} - \log N \qquad (7)$$

The distribution of the capital-output ratio is shown in Figure A1 in the appendix. It is unimodal in all years, which tells us that in terms of that variable there is only one group of countries. The bimodality instead shows up in the distribution of the productivity A calculated as in equation (7) and shown in Figure 3.

Figure 3. Productivity (A)

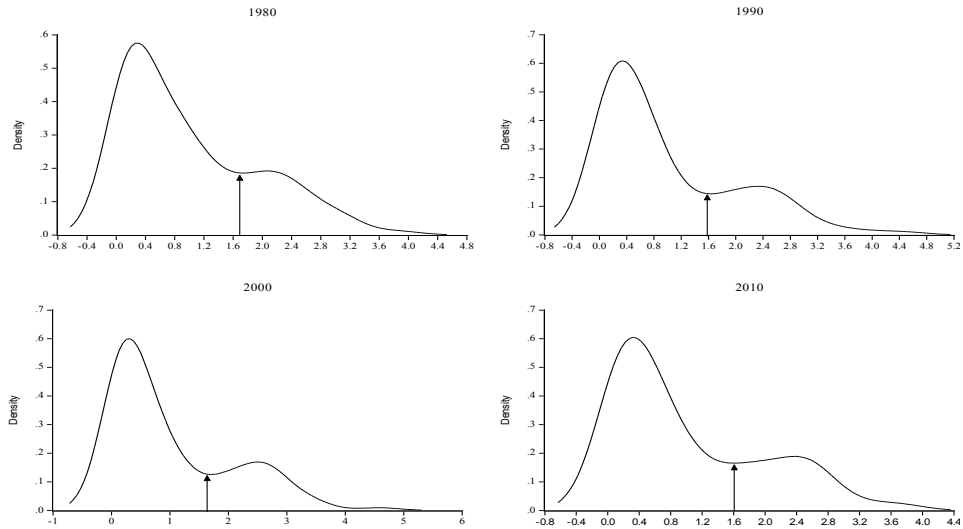


Table 3 shows the mean of the two distributions – one for low-productivity countries and the other for high-productivity countries – for each of the four years and the difference between the means. The gap between the two groups widened between 1980 and 1990 and again between 1990 and 2000 but has fallen somewhat since then, although it remains above its 1990 level.

Table 3. Mean normalized productivity

	1980	1990	2000	2010
Low-productivity	0.30	0.40	0.25	0.35
High-productivity	2.15	2.40	2.50	2.40
Difference	1.85	2.0	2.25	2.05

It follows that the existence of clubs of high and low output per capita countries in Figure 1 above can be traced to differences in the level of productivity A between the countries.

3. Institutions and convergence clubs

There are two groups of countries in our data with only infrequent transitions between the two. One can attempt to account for the groups by describing differences in institutions across the countries following the literature review in the first section of this paper. The theme of Eggertsson (2007), Acemoglu, Johnson, and Robinson (2001), Sokoloff and Engerman (2000) and Phelps (2013), amongst others, is that institutions affect economic performance as a causal factor.

It is beyond the scope of this paper to prove that institutions cause growth empirically. It is of course possible that good economic performance has an effect on institutions, for example by encouraging rulers and nations to adopt democracy. Barro (1996) finds that while democracy has growth-enhancing effects by maintaining the rule of law, free markets, small government consumption and high levels of human capital, it is also the case that improvements in the standard of living raise the probability that political freedoms will be increased. Helliwell (1994) uses data for 125 countries from 1960-1985 and finds that while higher income increases democracy, democracy has an insignificant direct effect on subsequent growth but does have a positive effect through education and investment. Tavares and Wacziarg (2001) find that democracy fosters growth through the accumulation of human capital and the lowering of income inequality but affects growth adversely by raising the ratio of government consumption to GDP. Doucouliagos and Ulubasoglu (2008) perform a quantitative assessment of the democracy-growth literature by applying meta-regression analysis to the population of 483 estimates derived from 84 studies on democracy and growth. They conclude that democracy has no direct impact on economic growth but a robust, significant and positive indirect effect through higher human capital, lower inflation, lower political instability and higher levels of economic freedom.

My starting point in exploring the relationship between productivity and economic freedom is Phelps (2013) and Phelps and Zoega (2013). The alternative to economic freedom in our work is corporatism, which consists of a set of institutions and interventions that impair the functioning of the capitalist system. These are intended to prevent capitalism from harming the objectives of traditional values, such as state, family, community and religion. Corporatist institutions reduce competition in the market place and

in its place come shared objectives that are supposed to serve the interest of society. In some of our previous work, we have explored the detrimental effect of corporatist institutions on growth, such as red tape, the degree of employer- and union coordination in the bargaining process, employment protection, the cost of setting up a business.[19]

There are two main empirical problems when exploring the relationship between institutions and productivity. First, there is correlation between different institutional measures across countries. It follows that omitting an important institutions that is correlated with those included in a regression makes the estimated effect of those included biased. This is the omitted variable bias. There is also the problem of multicollinearity caused by the included institutional variables being highly correlated, which makes it difficult to disentangle the effect of each institution, the estimated coefficients will have low levels of significance. Secondly, such a relationship does not prove causality in any way. The last problem has made Acemoglu, Johnson, and Robinson (2001) and Sokoloff and Engerman (2000) explore the colonial history of developing countries in order to find an exogenous effect of institutions on subsequent growth. The objective of the present analysis is, however, not to prove causality but only to explore the institutional differences between the clubs of rich and poor countries.

In Phelps and Zoega (2013) we explore the relationship between different corporatist institutions and economic performance, in particular job satisfaction. In essence the corporatist system aims at protecting vested interests – jobs, industries and businesses – while controlling the speed and direction of change. Following that paper the analysis below has institutions that affect the allocation of resources, on the one hand, and the distribution of income, on the other hand. In the first group we have the tax system, the regulatory framework, barriers to entry by new businesses and red tape or bureaucratic procedures. Amongst the institutions affecting income distribution we have unions and labor market regulations. In addition, businesses affect the state in a corporatist setting. Cronyism features prominently as well as corruption and lobbying.[20]

The present analysis aims at accounting for differences in productivity across countries by differences in a set of institutions. In particular, differences in measured productivity A from equation (7) can be related to a set of institutional variables as in Phelps and Zoega (2013), which we take from the Fraser Institute data base.[21] These variables measure economic freedom – or absence of corporatism – so that a higher value of each index is indicative of greater freedom. The variables fall into roughly four groups. First there is the size of government measured by the marginal income and payroll tax rate and a measure of transfers and subsidies. Second, we have measures of the quality of the legal system, its overall quality as well as judicial independence, the impartiality of the courts, the protection of property rights and the legal enforcement of contracts. Third there are tariffs on trade. Finally, there are measures of regulations. Starting with credit market regulations there is an overall measure as well as a measure of the private ownership of banks and private sector credit creation. There is a measure of labor market regulations and finally measures of goods market regulations that include red tape (bureaucracy costs), the costs of starting a business and bribes (favoritism). All variables

are measured so that a low value indicates corporatism and a high value economic freedom or the absence of corporatism.

In order to address the problem of multicollinearity between different institutional measures discussed above, as well as the possible problem of omitted variable bias, the principal components of a matrix of productivity and institutions are calculated. There are 82 countries in the analysis and 16 variables when productivity is included. Call this 16*82 matrix U. The principal components of the contemporaneous covariance matrix are calculated by first taking the standardized U matrix and constructing its variance–covariance (correlation) matrix $U'U$ and diagonalizing the matrix in the following way

$$A'U'UA = \Phi$$

where A is the matrix of orthogonal eigenvectors and Φ is the (82* 82) diagonal matrix of eigenvalues. We can then define $Z = UA$ as the 82*16 matrix of principal components where each column of matrix Z is a 82*1 vector of observations for one principal component. Each eigenvalue then gives the proportion of the total variance of matrix U explained by the relevant principal component.

The eigenvalues of the matrix show that the first principal component explains 48% of the variation in the matrix, the second explains 11% and the remaining ones all explain less than 10% of the variation in the matrix. The eigenvector of the first principal component is shown in the table below, giving, roughly speaking, the weight attached to each institution in generating the first principal component. Note that productivity has a positive loading alongside a number of institutional variables while the measures of top marginal taxes and transfers and subsidies have a negative loading. Moreover, the measure of private sector credit has a very small positive loading.

Table 4. Eigenvector of first principal component

Productivity	0.31	Low taxes on trade	0.18
Lower top marginal income and payroll taxes	-0.09	Absence of bribes and favoritism	0.34
Lower transfers and subsidies	-0.22	Absence of red tape (bureaucracy)	0.34
Legal system	0.31	Ease of starting a business	0.23
Impartiality of the courts	0.31	Absence of credit market restrictions	0.14
Judicial independence	0.32	Private ownership of banks	0.14
Legal enforcement of contracts	0.24	Private sector credit	0.03
Protection of property rights	0.33	Absence of labor market regulations	0.16

We have found that the first principal component explains almost half the variation in the matrix U that contains measures of productivity and 15 institutions for 82 countries. The positive and large loading for productivity, the overall quality of the legal system, the impartiality of the courts, judicial independence, the legal enforcement of contracts, the protection of property rights, low taxes on trade, the absence of bribes, low levels of red tape, the ease of starting a business and finally, with a lower loading, the absence of labor market restrictions suggests that that high productivity and these institutional

features are related across countries. However, the findings do not tell us anything about causality. There is one factor loading that does not fit our prior, which is the one for the transfer and subsidies variable – or rather low transfers and subsidies – which indicates that more transfers and subsidies go together with high productivity.

Moving beyond the principal component analysis to estimating regression equations opens up the problems of collinearity and omitted variable bias. Table A2 in the appendix has the correlation between the institutional variables shown in Table 4. We note that the impartiality of the courts, judicial independence and the protection of property rights are highly correlated as well as all being correlated with the overall quality of the legal system. Therefore, we include only a measure of the legal system as well as the enforcement of contracts in the regression and omit the impartiality of the courts and judicial independence. The next variable that we include is taxes on trade or tariffs. Thereafter, we include the absence of bribes and the ease of starting business as measures of product market regulation. There is a very high correlation across the countries between the absence of bribes and less bureaucracy and we omit the latter variable for that reason. Moreover, we omit the absence of credit market restrictions, the private ownership of banks, private sector credit and the absence of labor market regulations because of their low factor loadings in Table 4. Finally, the negative loading for lower transfers and subsidies can be explained by extensive transfers and subsidies in the developed countries that score higher on all other institutional measures. Thus this variable is negatively correlated with the other institutions as shown in Table A2 – indicating that a country scoring low on transfers (that is having extensive transfers) has a higher number for the other institutions (implying that there is greater economic freedom).

Table 5 has the results of a regression where productivity A – taken from equation (7) and measured in 2010 – is explained by the institutions measuring the extent of transfers and subsidies; bribes and favoritism; the quality of the legal system; the enforcement of contracts; the cost of starting a business; and taxes on trade.

Table 5. Productivity explained

Variables	Coefficient	Standard error
Constant	-1.79	0.76**
Low transfers and subsidies	-0.08	0.04**
Absence of bribes and favoritism	0.16	0.05**
Legal system	0.07	0.03**
Legal enforcement of contracts	0.08	0.05*
Ease of starting a business	0.08	0.04**
Low taxes on trade	0.16	0.05**
Observations	81	
R-squared	0.76	
Wald F	50.7	

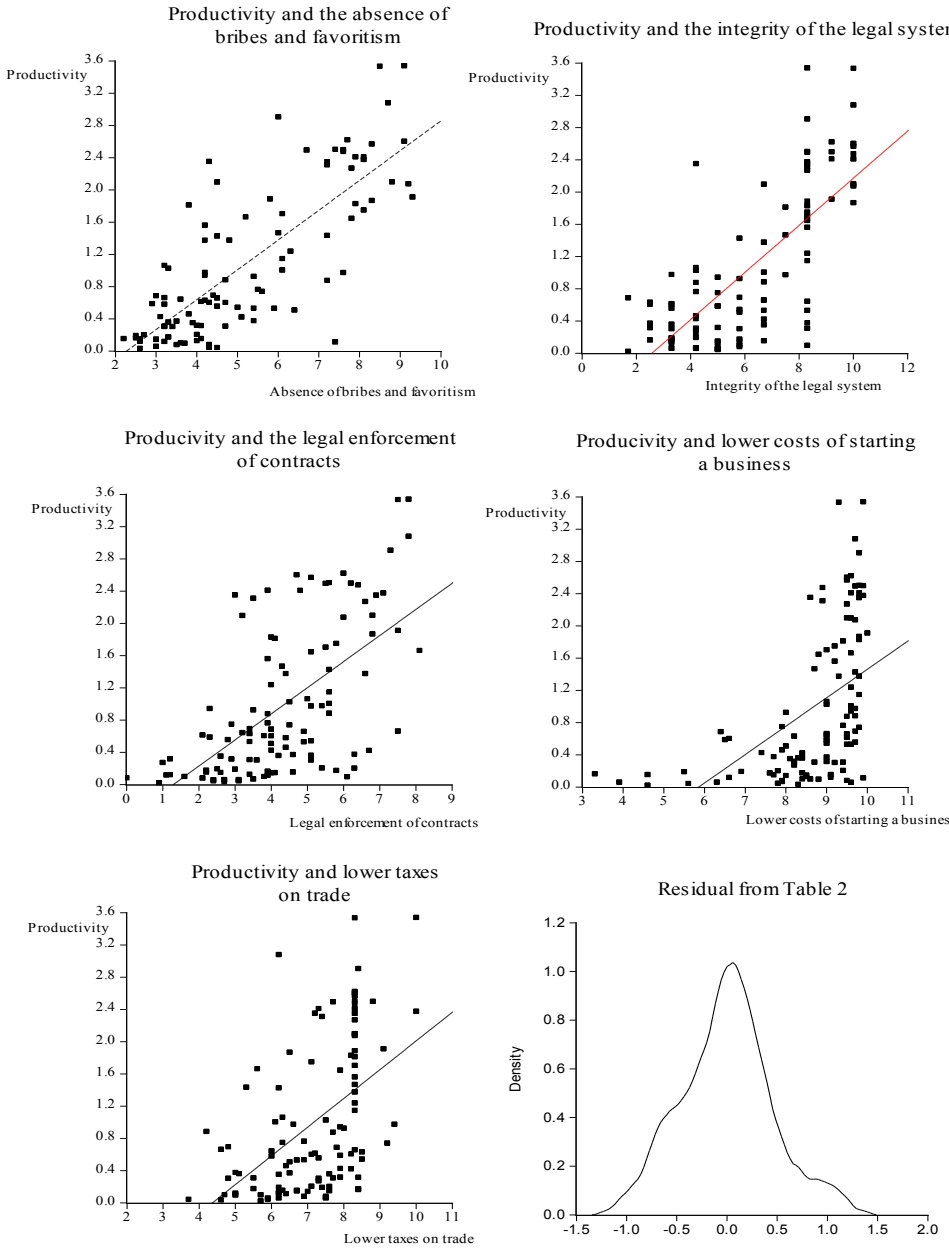
Oil exporting countries excluded although their inclusion does not change the results qualitatively. Standard errors in parentheses. ** denotes significance at 5% level, * significant at 10% level. The data are from year 2010.

There are five coefficients that are significantly different from zero at the 5% level of significance and one at the 10% level of significance. The coefficient of low transfers and subsidies is negative as in the factor loadings in Table 4. The signs of the remaining coefficients show that higher productivity is negatively associated with the prevalence of bribes and favoritism, the cost of starting a business, and taxes on trade and positively associated with the quality of the legal system and the enforcement of contracts. The scatter plots in Figure 4 show the relationship between each of the regressors and productivity. Together these variables explain 76% of the variation in the productivity data. Once controlled for the distribution of the productivity numbers becomes unimodal as shown in the right bottom panel of the figure.

Note that three variables included in Table 4 were omitted in Table 5 in order to address the problem of collinearity. It follows that we do not know whether it is bureaucracy (red tape) or the absence of bribes that is important for productivity, probably both, nor whether it is the impartiality of the courts or judicial independence that matters.

We conclude that a relatively small set of institutions can account for the differences between the group of high- and low productivity countries. However, causality has not been proven by running cross-sectional regressions. The choice of explanatory variables was, however, not random but based on previous work and the literature on institutions and growth surveyed above. We next turn to the country where significant economic growth first appeared in the 18th century due to the favorable effects of free trade, the protection of property rights and the rule of law. The objective is to show that while differences in productivity explain differences in output per capita across countries at a point in time, changes in productivity explain the growth of output per capita for each country. The importance of the level of productivity is thus paramount for the standard of living and may be affected by a country's institutions.

Figure 4. Institutions and total factor productivity



The first five figures show the relationship between productivity and institutions so that a higher value of the institutional variables fewer impediments to growth. The last figure plots the distribution of the residual from Table 4 using the Gaussian kernel.

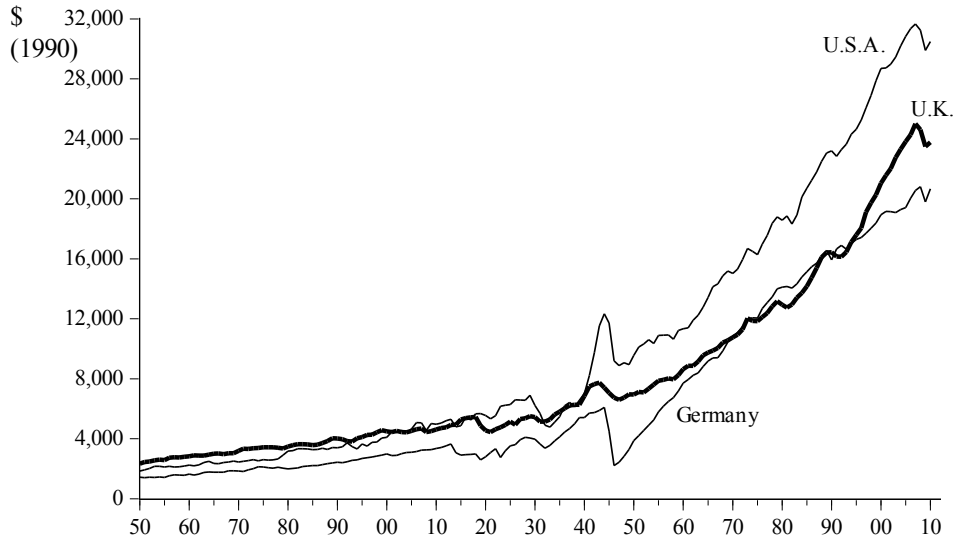
4. Productivity growth in the long run: the case of Britain

A large literature exists on the reasons why Britain was the birthplace of the first industrial revolution. This is the country where significant economic growth first appeared in the 18th century due to, amongst other factors, the favorable effects of free trade, the protection of property rights and the rule of law. Crafts (1998) describes some of the social capital that existed at the time in Britain and helped foster growth. [22] He accredits Britain's superior growth performance to its ability to learn, adapt, and improve upon technological discoveries made in other countries, an ability that is not easily captured by conventional measures of schooling.

According to Mokyr (1993), British engineers were in great demand in other European countries due to their superior abilities. At the time, a large number of associations designed to disseminate technological knowledge emerged in Britain. In an economy open to free trade, receptive to foreign ideas, and with well-established property rights and engineering expertise, Britain came to excel at importing and improving upon foreign technological discoveries, what Mokyr (1993) has called "micro-inventions".

The figure below shows data taken from Maddison[23] on real GDP per capita in Britain, the US, and Germany, starting in 1850. Britain had the highest level of real GDP per capita until 1905, when the US became the leader while Germany grew more rapidly than Britain in the decades after WWII.

Figure 5. Real GDP per capita in Germany, the UK, and the US



Source: Maddison (GDP per capita in 1990 Int. GK$).

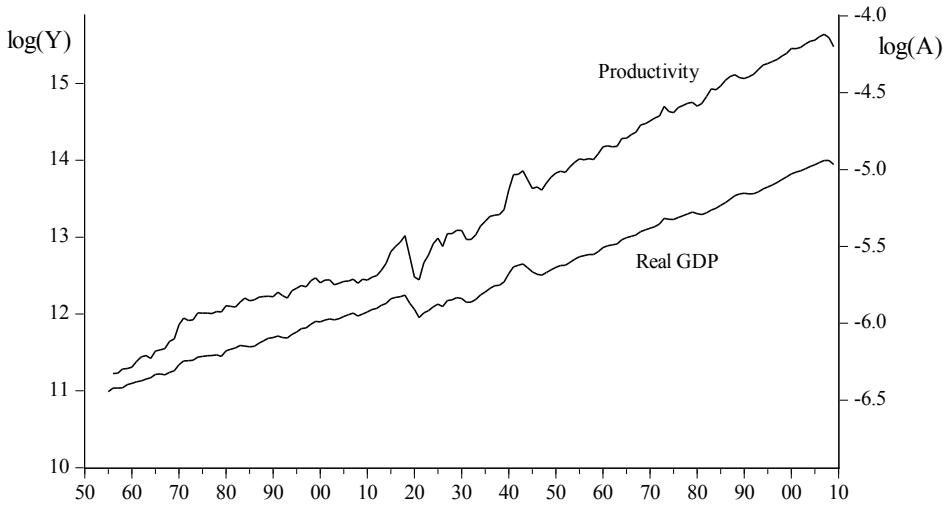
Strong productivity growth in Germany during the post-war period has been explained by delayed urbanization in Germany since Germany shifted resources out of agriculture and services later than Britain did. Thus Broadberry (1993, 1997) finds that labor

productivity in German manufacturing was already close to British levels in the late 19th century, while agriculture accounted for almost half of all employment in Germany in 1875 and less than a quarter in Britain in 1871. It follows that a significant part of Germany's catching up to Britain's overall productivity levels can possibly be attributed to urbanization and industrialization. Thus agriculture accounted for almost a quarter of employment in Germany in 1950, as opposed to just over 5% in Britain. Denison (1968) also concluded that urbanization abroad was the main cause of Britain's lagging behind some of its European neighbors in terms of productivity growth in the period 1950-1962. On the other hand, Bean and Crafts (1996) argue that Britain was also plagued by structural problems such as union behavior, which generated a hold-up problem in Britain, while others have mentioned the structure of British firms. Broadberry and Crafts (1992) blame both a bargaining environment that allowed workers to maintain restrictive practices and collusive agreements that limited the exit of inefficient firms.

It is also not undisputed that the higher productivity levels of the US in the early 20th century reflect Britain's failure to attain similar growth rates. Following Habakkuk (1962), many economists have found that different factor endowments in the US and Britain allowed different technologies to develop in the US which could not be easily adapted in Britain. According to this thesis, American technologies were too capital- and resource-intensive and too reliant on large markets for the European setting. This changed after WWII, when American technology became more transferable.

In the long run, the growth of output is driven primarily by productivity growth. The figure below shows both real GDP in Britain and productivity calculated from equation (7). [24, 25]

Figure 6. Real GDP and productivity in Britain in logs



Chained composite measure of GDP. Chained volume measure £mn, reference year 2006.
Productivity calculated from equation (7) using the total number of hours worked as a measure of input.

From the figure, one can spot several developments. First, there may have been a slight slowdown in productivity growth at the end of the 19th century. Second, trend growth of productivity is higher in the 20th century than in the 19th century. Third, productivity increased considerably during the two world wars. Fourth, there was a large drop in output, productivity, and hours of work at the end of WWI and a slighter one at the end of WWII.[26] Fifth, one can see a slight dip in productivity in 1926 due to the General Strike, following years of austerity in the run-up to the adoption of the gold standard, as well as slight falls in the recessions of the early 1980s and early 1990s and the recent recession, which reduced output in the financial sector. The decadal averages are shown below in Table 6 after adjusting for employment growth.

The following equation can be estimated to test for regime changes between periods of high and low productivity growth, where N denotes employment:

$$log(A_t) = log(A_{t-1}) + g_t + \alpha \Delta log(N_t) + \epsilon_t \quad (8)$$

We first estimate one value for g, average growth of productivity A, and test for its stability over time and then subdivide the period 1857-2007 into four periods and test for the equality of growth rates across periods. In column (1) of Table 6, the average annual rate of growth of productivity A over the period 1857-2007 is 1.4%. The estimated coefficient is stable over time since it is not possible to find structural breaks.[27] Column (2) has the estimated average growth rates for each decade. In spite of numerical differences between decades – and the large literature devoted to explaining episodes such as the apparent growth slowdown later in the 19th century – the differences between decadal growth rates are, again, not statistically significant.[28] When one replaces the decadal variables with dummy variables for the years 1850-1899, 1900-1949, 1950-1979, 1980-2007, one obtains the results shown in column (3) of the table. The first period is chosen as the Golden Age of Victorian growth. The period 1900-1948 is the period after technological leadership had been lost to the US, followed by the post-war decades of interventionist policies and the post-Thatcher market economy. Once again, there is not a statistically significant difference between the growth estimates for the different periods.[29]

Table 6. Productivity growth by decade

Variables	(1)	(2)	(3)	Variables	(2)	(3)
Constant	0.014** (5.11)					
Δ(log(N))	0.31** (2.79)	0.39** (2.88)	0.32** (2.74)	1910s	0.014 (0.80)	
Time dummies				1920s	0.021 (0.89)	0.013** (2.65)
1850s		0.010 (0.73)		1930s	0.008 (0.91)	
1860s		0.021** (2.59)		1940s	0.022 (1.25)	
1870s		0.018* (1.95)	0.013** (2.48)	1950s	0.015** (2.87)	
1880s		0.003 (0.37)		1960s	0.022 (3.22)	0.017** (2.76)
1890s		0.007 (1.06)		1970s	0.014* (1.89)	
1900s		-0.002 (0.39)		1980s	0.015 (1.55)	
				1990s	0.016** (4.13)	0.016** (2.10)
				2000s	0.013** (3.33)	
Obs. R-squared	151 0.05				153 0.10	153 0.04

t-ratios in parentheses. Significance at the 5% level indicated by ** and at the 10% level by *.

5. Conclusions

The level of productivity determines whether a country belongs to the club or poor or the club of rich nations while the growth of productivity explains the rise in living standards over long periods of time. There is a complex relationship between productivity and institutions. While the study of each country's economic history is needed in order to understand the evolution of institutions, a rather simple pattern emerges in the data on productivity and real GDP per capita. As early as the first industrial revolution, one can already see the emergence of two groups of countries, the high- and the low-GDP per capita countries. In 1910, this group included Britain, the US, the British colonies of Australia, New Zealand, and Canada, and Austria, Belgium, Denmark, France, Germany, and the Netherlands. This list of countries belonging to the high-productivity group has not changed much over the past century when only countries for which Madison had numbers for in 1850 are included. There are only a handful of new members: Sweden,

Norway, Japan, Italy, and Spain. Using a larger data set of 124 countries, one can add Hong Kong, Singapore, Malta, Taiwan, the Czech Republic, and South Korea to this list.

A set of five institutional variables is sufficient to make the distribution of productivity in a sample of 124 countries unimodal, hence eliminating the clear distinction between the two sets of groups. These are – perhaps not surprisingly – a measure of the absence bribes and favoritism, a measure of the quality of the legal system, a measure of the enforcement of contracts, a measure of how easy it is to start a business, and a measure on how low taxes on trade are. Three other variables are indistinguishable from some of these due to multicollinearity; the lack of bureaucracy, judicial independence and the impartiality of the courts. While this list is by no means exhaustive it shows some key institutional differences that may separate the poor from the advanced economies.

Although the empirical analysis does not prove causality from institutions to productivity, it is consistent with a large literature explaining such causality. It is also consistent with natural experiments where institutional changes clearly precede and cause growth such as the unification of Germany, observed differences in productivity between Taiwan and China and the very rapid growth in China in the past few decades following economic liberalization. As discussed by Eggertsson (2005), various factors can prevent a society from adopting the best set of institutions such as the failure of collective action, the self-interest of ruling groups, misplaced belief in the efficiency of institutions, culture and ethnic diversity. Clearly, one or more of these factors prevented economic liberalization in Eastern Europe from 1950-1990 and in China until the reforms initiated by Deng Xiaoping in the 1980s. A recent article by William Easterly describes the effect of economic liberalization in many African countries in recent years, which he contrasts with the futile policies of giving aid to these countries while supporting corrupt dictatorships.[30]

Productivity growth in Britain has increased living standards in that country from one decade to another as far as our data go, which is the 1850s. One is struck by the difficulty of finding statistically significant breaks in the growth of productivity. However, there is uncertainty about the effect of the new technologies on institutions in the West, in addition to the unavoidable uncertainty about the extent and nature of future technological discoveries.

Some observers of the latest technology innovations, which is the main driver of productivity growth in the long run, in the West have doubted both their significance and the durability of their effect on productivity growth once their effects on productivity in the production of IT equipment and the application of IT equipment to other industries have been exhausted.[31] Gordon (2012) claims that inventions since 2000 have mainly taken the form of much smarter entertainment and communications devices without having a major impact on productivity or living standards in the way that electric lights, cars, or indoor plumbing did.

The fact that Adam Smith apparently did not notice the beginning of what has been called the first industrial revolution should teach us humility in the prediction of future productivity and technological developments. Two types of uncertainties must be rec-

ognized. First, technological innovations take a long time to be implemented through a series of micro-inventions (see Mokyr 1993). Second, new technologies affect the evolution of institutions, as is described by Eggertsson (2007). The lag between the invention of new technology and its application may be long, owing to a long learning process and adjustment costs, the latter taking the form of reorganization of industry in terms of location and networks. It took about half a century of innovations and costly investment before electricity had made its full impact on productivity in the United States. Thus the replacement of water and steam power by electricity required the reorganization of the production process when each factory acquired its own electrical motors.[32] Crafts (2004) finds that steam had its peak impact about a hundred years after its invention.

Technology may gradually affect the institutions of the economy and the political system, but this may take quite a long time. Organizations for collective action, such as unions, take a long time to emerge and to change. The effect of the first industrial revolution on organizations and institutions was delayed and was much greater than could have been anticipated. The first modern trade union, the *Amalgamated Society of Engineers* in Great Britain, was founded in 1851, a century after the beginning of the Industrial Revolution. In the US, union membership grew fastest in the 1930s and 1940s, long after the industrialization of the country.[33]

In conclusion, the elusive variable productivity in the economics literature determines whether a country belongs to the club of low income or high income countries, changes in productivity can move a country between the groups and the growth of productivity over time is the reason why the standard of living can keep on growing. The distribution of productivity in our sample was correlated with various institutional measures, causality was not tested nor proven, but the examples cited of the split Germany before 1990, the two Koreas, the contrast between Taiwan and China, the very impressive growth of China in past decades, the difference between North and South America all indicate that institutions matter and that some countries may have imperfect institutions.

The author would like to thank Thrainn Eggertsson and Timothy Hatton for their useful comments on an earlier draft of this paper.

Notes

1 See, for example, Hall and Jones (1999).
2 See Quah (1996), amongst others.
3 See also Knack and Keefer (1997).
4 See Joel Mokyr (2005) on the role of journals and political fragmentation in the genesis of the first industrial revolution.
5 The intensity of resource allocation in the corporatist system can be measured by the size of tax revenue, the volume of recorded regulations, the size of the government sector, barriers to entry, red tape, and industrial policy.
6 In particular, job satisfaction – taken from the *World Values Survey* – is positively correlated with labor freedom, freedom from corruption, and measured protection of property rights, and is negatively correlated with an index of access to capital (implying that greater access to capital gives greater job satisfaction) and with the volume of regulation of credit, labor, and goods markets. Moreover, job satisfaction is negatively related to barriers to entrepreneurship and positively correlated with the number of listed companies and market capitalization.
7 This transformation was proposed by Canova and Marcet (1995) to correct for potential problems of cross-correlation for the countries, such as expansions and contractions of the world economy.
8 Since the observations are in an alphabetical order, independence implies that high income in country whose name starts with an "A", to take an example, does not provide information about whether the next country in the alphabet has high or low income per capita.
9 If the true underlying density has two modes, a large value of h_1 is expected because a considerable amount of smoothing is required to obtain a unimodal density estimate from a bimodal density. A large value of h_m would then indicate the presence of more than m modes. See Silverman (1981, 1983, and 1986).
10 This project continues the work of the late Professor Angus Maddison who assembled a data set on historical time series. See: http://www.ggdc.net/maddison/maddison-project/home.htm.
11 The countries are Austria, Belgium, Denmark, Finland, France, Germany, Italy (centre-north), Holland, Norway, Sweden, England/GB/UK, Greece, Portugal, Spain, Australia, New Zealand, Canada, the US, Czechoslovakia, Argentina, Brazil, Chile, Colombia, Mexico, Uruguay, Venezuela, Cuba, Jamaica, China, Indonesia (Java), Japan, Sri Lanka, and South Africa.
12 The numbers measure GDP per capita in 1990 Int. GK$. See Maddison Project, http://www.ggdc.net/maddison/maddison-project/home.htm.
13 The sample includes all the countries (except Ireland) that DeLong (1988) added to Baumol's (1986) sample in a study of income convergence.
14 The Penn World Table includes economic data from around the world where macroeconomic variables have been adjusted to account for differences in purchasing power parity making a comparison across countries possible. There are currently 152 countries and 29 variables in the data base. This includes, for example, output per capita in dollars at constant prices for the 152 countries once adjustment have been made for differences in purchasing power across the countries. See http://www.rug.nl/research/ggdc/data/pwt/.
15 In particular, they find that 1/6 of the gap between the richest and the poorest countries is explained by differenes in physical capital and less than ¼ by differences in schooling.
16 Singapore was a part of Malaysia from 1963 until 1965, when it became an independent country.
17 The Seychelles were also a British colony, then part of the Commonwealth, from 1794 until independence in 1976.
18 K is calculated by using data on gross capital formation in 1970, assuming that the rate of depreciation is 0.06 and calculating the rate of growth of output for the next ten years. Assuming that the K/Y ratio was stable, one can then calculate the level of K in 1970. Then, using data on investment and the assumed depreciation rate K, the series is extended until 2010.

19 See Phelps and Zoega (2001, 2004).
20 See Phelps and Zoega (2013), pages 36-40.
21 The Fraser Institute is a Canadian public policy think tank founded in 1974. Each year, the institute publishes a report titled *Economic Freedom of the World*, which has an index that ranks countries according to their degree of economic freedom. See http://www.freetheworld.com/.
22 Growth in 19th century Britain was quite modest by 20th–century standards. According to the numbers presented by Crafts, TFP growth in Britain between 1780 and1830 was similar to what Argentina experienced from 1960-1985, at 0.3% per year (as opposed to 0.2% in Argentina).
23 http://www.ggdc.net/maddison/maddison-project/home.htm.
24 Taken from www.bankofengland.co.uk/publications/.../threecenturiesofdata.xls.
25 Labor share: Mitchell (1988) and *Office for National Statistics*. Employment in heads: Feinstein (1972) and Office for National statistics. Average weekly hours: Mitchell(1988) and Office for National Statistics.
26 Broadberry (1990) explains the fall in hours at the end of WWI and (to a lesser extent) WWII by the wealth that accumulated during the war and increased the demand for leisure once the war was over. A similar effect could have reduced productivity.
27 Testing for structural breaks in years 1900, 1950, and 1980 gives $F = 0.07$ ($P=0.79$) for a break in 1900, $F=0.36$ ($P=0.55$) for a break in 1950, and $F=0.045$ ($P=0.83$) for a break in 1980, in all cases rejecting the hypothesis of a structural break in these years.
28 A Wald test gives $F=0.84$ ($P=0.62$).
29 The hypothesis that these four rates of growth are all equal cannot be rejected ($F= 0.14$ ($P=0.94$)).
30 See William Easterly, The West's aid illusion is betraying the world's poor, *Sunday Times*, 29 November, 2015.
31 See Gordon (2010) and Gordon (2012), among others.
32 See Eggertsson (2007), Devine (1983), and David (1990).
33 Both examples are taken from Mancur Olson (1982).

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Table A1. Convergence clubs

Real GDP per capita, 1859 sample								
1880		1910		1930		1970		2010	
Rich countries									
Austrlia	2,4	N. Zealand	1,62	USA	1,93	USA	1,93	USA	1,84
N. Zealand	2,1	Australia	1,58	Netherlands	1,74	Sweden	1,64	Norway	1,69
Britain	1,95	USA	1,51	Britain	1,69	Denmark	1,63	Australia	1,54
USA	1,79	Britain	1,4	Denmark	1,66	Canada	1,55	Sweden	1,52
Belgium	1,72	Canada ↑	1,24	Belgium	1,54	Australia	1,55	Canada	1,5
Netherlands	1,64	Belgium	1,24	N. Zealand	1,54	Netherlands	1,54	Netherlands	1,46
		Argentina ↑	1,16	Canada	1,49	France	1,47	Austia	1,45
		Netherlands	1,15	Australia	1,46	N. Zealand	1,44	Britain	1,43
		Denmark ↑	1,13	France	1,41	Germany	1,4	Belgium	1,42
		Germany ↑	1,02	Uruguay	1,33	Britain	1,39	Denmark	1,42
		Austria ↑	1	Sweden ↑	1,31	Venezuela	1,37	Finland	1,4
		Uruguay ↑	0,95	Argentina	1,27	Belgium	1,37	Japan	1,32
		Chile ↑	0,91	Germany	1,23	Norway	1,29	France	1,29
		France ↑	0,9	Norway ↑	1,12	Austria	1,25	Germany	1,24
				Austria	1,11	Japan ↑	1,25	N. Zealand	1,14
				Venezuela ↑	1,07	Finland ↑	1,23	Italy	1,12
				Czech. ↑	0,91	Italy ↑	1,21	Spain ↑	1,01
Threshold	1,6		0,85		0,9		1		0,9
Poor countries									
Denmark	1,22	Sweden	0,77	Finland	0,83	Agentina ↓	0,94	Greece	0,89
France	1,19	Norway	0,66	Italy	0,82	Czeh. ↓	0,83	Portugal	0,86
Uruguay	1,17	Italy	0,66	Spain	0,81	Spain	0,81	Chile ↓	0,84
Austria	1,17	Czech.	0,61	Greece	0,7	Greece	0,8	Czech.	0,78
Germany	1,12	Finland	0,58	Japan	0,57	Portugal	0,7	Uruguay ↓	0,69
Canada	1,02	Spain	0,58	Mexico	0,5	Chile ↓	0,67	Argentina ↓	0,62
Chile	0,98	Mexico	0,51	Portugal	0,49	Uruguay ↓	0,67	Venezuela	0,59
Spain	0,92	Greece	0,49	Colombia	0,46	Mexico	0,56	China	0,48
Argentina	0,9	Japan	0,4	S. Africa	0,44	S. Africa	0,52	Mexico	0,46
Italy	0,89	Portugal	0,37	Sri Lanka	0,39	Jamaica	0,5	Colombia	0,43
Norway	0,85	Sri Lanka	0,37	Indonesia	0,34	Colombia	0,4	Brazil	0,41
Sweden	0,93	S. Africa	0,35	Brazil	0,32	Brazil	0,39	Sri Lanka	0,32
South Africa	0,81	Venezuela	0,27			Cuba	0,25	S. Africa	0,31
Greece	0,71	Indonesia	0,25			Sri Lanka	0,19	Indonesia	0,28
Finland	0,65	Colombia	0,24			Indonesia	0,16	Jamaica	0,22
Cuba	0,62	Brazil	0,23			China	0,1		
Portugal	0,53								
Japan	0,48								
Sri Lanka	0,47								
Brazil	0,42								
Colombia	0,4								
Venezuela	0,38								
Inonesia	0,37								
Jamaica	0,3								

Source: Maddison Project, http://www.ggdc.net/maddison/maddison-project/home.htm.

Figure A1. Capital-output ratios

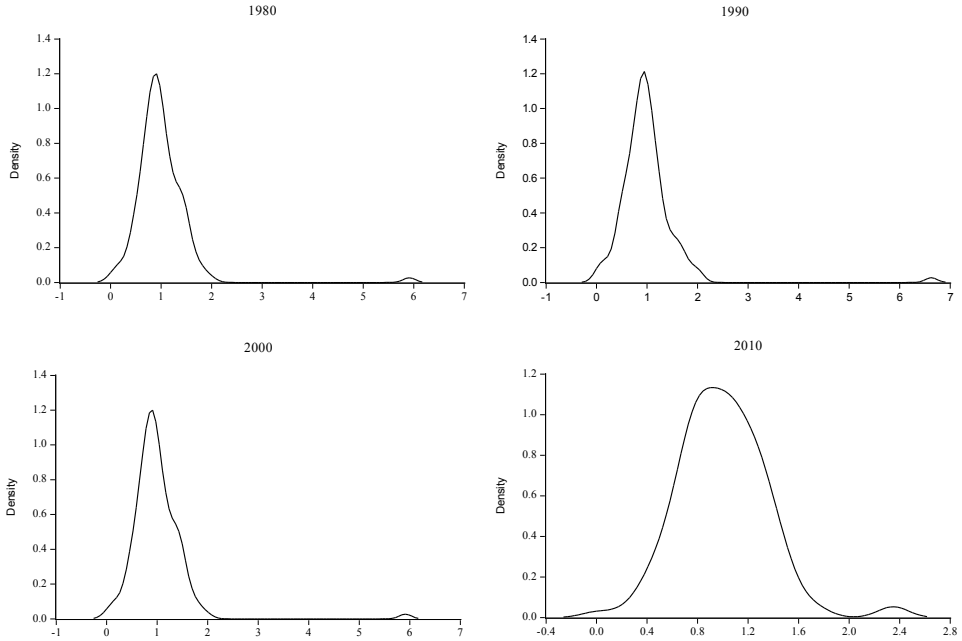

Table A2. Correlation matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Lower top marginal income and payroll taxes (1)	1.00	0.51	-0.24	0.06	-0.05	-0.05	-0.10	-0.05	-0.11	-0.10	-0.16	0.03	-0.13	0.01	0.09
Lower transfers and subsidies (2)	0.51	1.00	-0.59	-0.16	-0.35	-0.35	-0.35	-0.30	-0.42	-0.40	-0.35	-0.04	-0.12	-0.03	0.00
Legal system (3)	-0.24	-0.59	1.00	0.61	0.69	0.57	0.75	0.24	0.75	0.74	0.45	0.19	0.21	0.03	0.31
Impartiality of the courts (4)	0.06	-0.16	0.61	1.00	0.90	0.42	0.88	0.17	0.86	0.88	0.35	0.28	0.19	0.02	0.43
Judicial independence (5)	-0.05	-0.35	0.69	0.90	1.00	0.38	0.89	0.21	0.90	0.91	0.40	0.21	0.19	-0.01	0.42
Legal enforcement of contracts (6)	-0.05	-0.35	0.57	0.42	0.38	1.00	0.43	0.27	0.49	0.49	0.43	0.29	0.20	0.26	0.21
Protection of property rights (7)	-0.10	-0.35	0.75	0.88	0.89	0.43	1.00	0.28	0.90	0.90	0.50	0.27	0.22	-0.05	0.40
Low taxes on trade (8)	-0.05	-0.30	0.24	0.17	0.21	0.27	0.28	1.00	0.34	0.33	0.31	0.34	0.38	-0.01	0.23
Absence of bribes (9)	-0.11	-0.42	0.75	0.86	0.90	0.49	0.90	0.34	1.00	1.00	0.43	0.25	0.25	0.04	0.36
Absence of red tape (bureaucracy) (10)	-0.10	-0.40	0.74	0.88	0.91	0.49	0.90	0.33	1.00	1.00	0.43	0.25	0.25	0.04	0.38
Ease of starting business (11)	-0.16	-0.35	0.45	0.35	0.40	0.43	0.50	0.31	0.43	0.43	1.00	0.20	0.17	0.12	0.29
Absence of credit market restrictions (12)	0.03	-0.04	0.19	0.28	0.21	0.29	0.27	0.34	0.25	0.25	0.20	1.00	0.61	0.28	0.23
Private ownership of banks (13)	-0.13	-0.12	0.21	0.19	0.19	0.20	0.22	0.38	0.25	0.25	0.17	0.61	1.00	0.07	0.32
Private sector credit (14)	0.01	-0.03	0.03	0.02	-0.01	0.26	-0.05	-0.01	0.04	0.04	0.12	0.28	0.07	1.00	-0.01
Absence of labor market regulations (15)	0.09	0.00	0.31	0.43	0.42	0.21	0.40	0.23	0.36	0.38	0.29	0.23	0.32	-0.01	1.00