

**CEE DP 95**

**The Convergence of Compulsory Schooling  
In Western Europe: 1950-2000**

**Fabrice Murtin**

**Martina Viarengo**

CENTRE FOR THE  
ECONOMICS OF  
EDUCATION

**November 2008**

Published by  
Centre for the Economics of Education  
London School of Economics  
Houghton Street  
London WC2A 2AE

© Fabrice Murtin and Martina Viarengo, submitted November 2007  
November 2008

The Centre for the Economics of Education is an independent research centre funded by the Department for Children, Schools and Families. The views expressed in this work are those of the author and do not reflect the views of the DCSF. All errors and omissions remain the authors.

# **The Convergence of Compulsory Schooling In Western Europe: 1950-2000**

**Fabrice Murtin**

**Martina Viarengo**

<b>1.</b>	<b>Introduction</b>	<b>2</b>
<b>2.</b>	<b>Theories of compulsory years of schooling</b>	<b>3</b>
	Compulsory versus actual years of schooling	3
	The origin of compulsory schooling	4
	The convergence process	6
	The convergence process	10
<b>3.</b>	<b>The Data</b>	<b>14</b>
	Compulsory years of schooling	14
	Compulsory and actual years of schooling	16
	Convergence of compulsory years of schooling	17
	Other explanatory variables	18
<b>4.</b>	<b>Econometric Analysis</b>	<b>20</b>
	The model	20
	Results	22
<b>5.</b>	<b>Discussion</b>	<b>25</b>
<b>6.</b>	<b>Conclusions</b>	<b>26</b>
	<b>References</b>	<b>28</b>
	<b>Appendices</b>	<b>33</b>
	<b>Tables</b>	<b>34</b>
	<b>Figures</b>	<b>40</b>

## **Acknowledgments**

Fabrice Murtin is Mellon Post-Doctoral Scholar at the Stanford Center for the Study of Poverty and Inequality, Stanford University and a CEE Associate. Martina Viarengo is a Research Economist at the Center for Economic Performance, London School of Economics, a Post-Doctoral Fellow at Kennedy School of Government, Harvard University and a CEE Associate.

# 1 Introduction

The expansion of compulsory schooling after the Second World War represented an important reform common to the majority of European countries. Specifically, over the period 1950-2000, the fifteen Western European countries considered in this study have extended the school-leaving age by one year or longer. Interestingly, this change in legislation was undertaken by Nordic, Anglo-Saxon and Continental countries, which had different traditions and experiences in educational policy.

Many theories have been proposed in the sociology and political science literature to explain the expansion of education during this “period of extensive development of the educational and training system” (Diebolt (1999), p.30). But these country-level studies are too specific to allow any inference on the common factors that may have influenced education policies in a similar way. What is missing in the literature is a comparative analysis of the educational reforms undertaken at the European level. Comparative works by Diebolt and Fontevielle (2001) and Ringer (1979) represent an attractive start but are not sufficient to exhibit the factors driving the expansion of compulsory schooling in general.<sup>1</sup> Nor do they explain the timing and the magnitude of changes in compulsory years of schooling that occurred in most European countries after the war.

In contrast, this paper adopts a comparative approach using an original data set for fifteen European countries over the period 1950-2000, and undertakes a quantitative analysis of the determinants of changes in compulsory schooling laws. The major phenomenon we observe in the data is convergence: the lower mandatory schooling in 1950, the sooner and the larger the change in the legal age of compulsory schooling. We argue that economic forces promote convergence of educational systems for two simple reasons: first, the profitability

---

<sup>1</sup>The focus of these analyses is limited to a small number of countries: to France and Germany in the former and to France, Germany and the United Kingdom in the latter.

of education is decreasing at the margin, second, extending compulsory schooling has an increasing marginal cost because years of Secondary are more expensive than years of Primary. In other words, compulsory schooling has decreasing net aggregate returns that trigger convergence.

Next, we test whether convergence still holds when one controls for other determinants described in the literature. Some theories have emphasized respectively the effects of trade and technological progress, institutional aspects, and constraints set on a benevolent State. We do find conditional convergence as well as evidence supporting some aspects of these theories taken individually. However, the most robust secondary effect is openness: the more open a country, the higher compulsory years of schooling. Rising globalization and public investments into education therefore appear to be complementary phenomena in the postwar Western Europe.

The paper proceeds as follows. First, we explain why we focus on compulsory rather than actual years of schooling, and we review the origins of educational laws that have characterised the European experience after the war. We present the economic motives for convergence and analyse the other theories proposed by scholars to explain the expansion of education. Then, we describe the dataset, explain the methodology, and present the results of the empirical analysis. Last section concludes.

## **2 Theories of compulsory years of schooling**

### **2.1 Compulsory versus actual years of schooling**

In this paper we focus on compulsory rather than on actual years of schooling. Indeed, actual years of schooling depend on three major factors : the constraint of the law - mandatory schooling -, as well as costs and benefits of voluntary

education. A manifold of determinants affect costs and benefits of voluntary education: its observed return on the labour market, which eventually depends on heterogeneous unobserved factors, expectations of the latter return, credit constraints to the family, preferences, the rate of discounting with respect to intertemporal choices, and so on and so forth.

This paper does not envisage an exhaustive theory of the determinants of actual education, but rather focuses on one single component, which we believe an important one, the constraint of the law. Actual years of schooling of the population can indeed be related to lagged compulsory years of schooling, as this paper will demonstrate. In which extent this policy variable has been an effective mean of increasing average education in postwar Europe? A subsequent question arises naturally: what were the economic, political, demographic forces that underlied the extension of the school-leaving age? This question is addressed in details in the following.

## **2.2 The origin of compulsory schooling**

Following the definition provided by the OECD (1983, p.12), compulsory schooling is “the span of years during which every normal child must be receiving a formal education”. Compulsory schooling was introduced in most Western countries between the second half of the nineteenth century and the beginning of the twentieth century.<sup>2</sup> Economic historians have been interested in the topic of formal education to understand how institutions can create the conditions to promote economic development and growth, as in Cipolla (1969), Tortella (1990) or Sandberg (1982). Interestingly, compulsory schooling was introduced only at a relatively late stage of industrialization whereas basic human capital, measured by literacy rates, was already widespread. In fact, the basic skills of

---

<sup>2</sup>Maynes (1985, p.25). The exception is represented by Germany. In Prussia compulsory schooling was introduced in 1763 and extended to the German Empire in 1871.

reading, writing and arithmetic were provided by a variety of religious and non religious institutions in Western Europe at this time.

Why was compulsory schooling not institutionalized before the nineteenth century and only after the beginning of the industrialization process in most European countries? Mitch (1983) argued that an earlier introduction of compulsory schooling would have been socially desirable but not economically necessary as there was a lack of demand for educated workers. In fact, literate workers did not benefit from any wage premium with respect to their illiterate counterparts. The shift in demand was probably generated by the greater complexity of the productive activity, in other words by the acceleration of technological progress as strongly emphasized by Galor (2006). This would suggest that schooling became compulsory first in more industrialized countries where the demand for education was already high. Accordingly to Landes and Solmon (1972), this is what happened in the United States where the institutionalization of schooling may be seen as the formalization of a social change that was taking place in the American society. Scholars have not reached such a conclusion for Europe, although enrolments in primary school were already high when compulsion was established (see Craig (1981) as well as Morrisson-Murtin (2008) for quantitative evidence).

In many aspects, the introduction of compulsory schooling in Europe was a revolutionary policy change, often associated to the process of nation building as emphasized by Cipolla (1969). It is however important to acknowledge that the number of years of schooling that was initially made compulsory was very low, especially in Southern Europe. Moreover attendance was low, especially in the countryside at harvest time, and the power of the state to enforce it was limited due to budget constraints. Moreover, the economic depression that followed the Great War and the slow recovery during the interwar period im-



posed important constraints on government expenditure for social services such as public education. In fact, even if governmental intervention increased after 1918, the important increase in public expenditure as a share of GDP between 1913 and 1937 was largely due to the depression rather than a real increase in public spending for social services (e.g. Tanzi and Schuknecht (2000)).

After 1945, with the end of the war, things changed dramatically. Countries started experiencing unprecedented growth rates and the recovery was faster than the more optimistic could have expected (Eichengreen, 1996). Moreover, the new economic and socio-political conditions created the pressure for governments to modernize the education system. The expansion of compulsory schooling was an institutional reconfiguration of the schooling system undertaken in countries at odds with each other, with dissimilar economic conditions and different cultural and educational traditions. In addition to the expansion of education, many countries reshaped their educational system. For instance the 1970 reform in Spain was the first since the Moyano Act of 1857 to reshape the entire educational system (EURYDICE, 2005).

In the following paragraphs we will argue that the extension of compulsory schooling after 1950 was mainly characterized by convergence. We will also analyse the alternative theories proposed by sociologists and political scientists, and describe the variables used to compare their relative explanatory power.

### **2.3 The convergence process**

The intuition on which we have based our main argument is very simple: if education has decreasing aggregate returns, it is relatively more profitable for a benevolent State to increase compulsory schooling when its current level is lower. As a result, countries with a low mandatory years of schooling should catch-up with others everything else equal.

At the macroeconomic level, the returns to input factors are usually assumed to be smaller than one. However, the elasticity of human capital could possibly be augmented by the so-called externality of education, possibly leaving room for increasing returns to human capital. This externality could stem from technological spillovers, increased social capital such as crime reduction, or better institutions in general. However, only small externalities of education have been found in the literature (see for instance Acemoglu-Angrist (2000), Ciccone (2005) or Soto (2006)). So it is likely that education has decreasing returns on the aggregate.

Also, it is clear that providing education has a cost that is a convex function of the number of years of schooling. Statistics from the OECD (2002) show that in 1999 the average spending on a pupil in primary is 4229 dollars, versus 5174 dollars in secondary and 11422 dollars in higher education. That is, the expenditure per student at tertiary level was, in 1999, 2.3 times greater than at primary level (OECD, 2002, p.145). The reason for a convex cost of schooling has to do with the production function of knowledge in general. It takes more and more resources - time, money, and human capital - to achieve a marginal increase in productive knowledge.

As a sum, the marginal gains from schooling are decreasing and the marginal cost is increasing with educational development, leading to decreasing net returns to schooling. A simple model, inspired by Skidmore et al. (2004), rationalizes this. Notice  $G_t$  governmental spending in education and  $h_t$  human capital derived from compulsory years of schooling that affects the current generation of children. Let  $N$  be the population aged between 0 and 20 and  $L$  that aged between 20 and 60. Both are assumed to be constant over time for simplicity. Saying that the cost of schooling is convex is equivalent to say that compulsory units of human capital are a concave function of financial resources per head<sup>3</sup>,

---

<sup>3</sup>Normally, only the fraction of pupils under the compulsory age of schooling should enter

namely that

$$h_t = \left( \frac{G_t}{N} \right)^\gamma, \quad \gamma < 1 \quad (1)$$

Then, compulsory schooling has a positive impact on total output  $Y_t$ , but is subject to decreasing marginal returns. Importantly, reforms conducted on the current generation of pupils will have a lagged impact, only to manifest when this generation enters the labour market. Hence,

$$Y_{t+1} = AL(h_t)^\alpha, \quad \alpha < 1 \quad (2)$$

In the latter equation,  $A$  is a technological parameter<sup>4</sup> possibly country-specific and time-varying. Full participation of the labour force is assumed.

A budget constraint sets the final stage. Government spending are given by

$$G_t = \tau Y_t \quad (3)$$

where  $\tau$  is the tax rate, which can vary across countries and across time<sup>5</sup>. Then, equations (1-3) bring together

$$h_{t+1} = \left( \frac{\tau AL(h_t)^\alpha}{N} \right)^\gamma \quad (4)$$

---

equation (1). But as the State also subsidises non-compulsory schooling, the fraction of young people below 20 is a more realistic denominator. It captures the fact that only a fraction of total educational expenditures is devoted to compulsory schooling.

<sup>4</sup>Human capital could enter the above equation through the technological parameter as in the Schumpeterian theory. This would complicate the exposure but not necessarily alter the result. Indeed, if the growth rate of technology was a function of human capital, then  $A$  would depend on all past stocks of human capital. This does not preclude convergence, but simply introduces a degree of time dependence strictly larger than one.

<sup>5</sup>Barro (1990) gives a theoretical justification for the fact that the tax rate does not depend on the stage of development and should remain constant over time. A vast and unconvincing literature examines the empirical validity of the latter assumption, assessing whether government spending increases or remains a constant share of GDP in the course of economic development.

Taking logs leads to

$$\log h_{t+1} = \gamma \log \left( \frac{\tau AL}{N} \right) + \gamma \alpha \log(h_t) \quad (5)$$

Hence both decreasing marginal returns ( $\alpha < 1$ ) and convex cost of schooling ( $\gamma < 1$ ) generate convergence in compulsory human capital.

Last, the compulsory stock of human capital can be related to compulsory years of schooling using the usual Mincerian transformation. Assuming for simplicity a constant return to schooling over time  $h_t = \exp(rS_t)$  where  $r$  is the return to schooling and  $S_t$  compulsory years of schooling, we obtain

$$S_{t+1} = \frac{\gamma}{r} \log \left( \frac{\tau AL}{N} \right) + \gamma \alpha S_t \quad (6)$$

This equation is the basic one that will be tested empirically in a following section<sup>6</sup>. Admittedly, this model is simplistic as it rules out various institutional features such as the balance of power between different classes of policy makers - for instance in the model  $\tau$  is kept exogenous. However, it has the virtue of offering a comprehensive framework to understand the two main motives of educational systems convergence, namely the decreasing marginal gains from schooling and its convex cost. Also, it sheds light upon some other major mechanisms that might interfere: for instance, the technology  $A$ , the tax rate  $\tau$  and the demographic structure captured by  $L/N$  might vary across time and across countries. Last, considering what will come out from the empirical analysis, this model appears to be completely sufficient on its own. In the next subsection, we

---

<sup>6</sup>Possibly the return to compulsory years of schooling differs from the Mincer return to schooling, as many non-linearities are associated to certain degrees as demonstrated by Heckman et al. (2005). We rule out this problem for the sake of simplicity. Also, the Mincer return to schooling  $r$  can vary over time. Consequently the autoregressive coefficient  $\gamma\alpha$  should rather be equal to  $\gamma\alpha r_{t-1}/r_t$ . The magnitude of the ratio of returns should however be very close to one in contemporary European countries as we will consider time spans of 5 or 10 years later on.

describe the three latter economic, political and demographic forces that might affect compulsory schooling in addition to the convergence effect.

## **2.4 Other determinants**

We review hereafter the various factors that could have had an impact on the implementation of compulsory schooling. We have classified them into three different categories: technological and trade factors, political ones, and those relative to the budget constraint of the state.

### **2.4.1 Technological factors**

According to this theory, technological advance and greater complexity of the organization of production creates the demand for a more educated labour force. According to Collins (1971), this happens when the proportion of jobs requiring more educated workers increases. This mechanism certainly makes sense on the long-term. For instance, Galor (2006) suggests that fierce economic competition between England and its continental challengers Prussia and France led the British government to provision universal education for the first time in the Educational Act of 1870 in order to increase its industrial productivity. In the “race between education and technological progress”, states can indeed increase the number of years of compulsory schooling in order to facilitate the adoption of new technologies.

This phenomenon is certainly reinforced by trade and globalization. Heckscher-Ohlin theory states that openness should have a Ricardian effect on the economies, which should invest in the sector that defines their comparative advantage. Because it augments the demand for technology-intensive products in industrial Western European countries, a rising globalization can reinforce the incentive to educate the workforce in order to deal with fast technological progress. So

openness should have a positive effect on education in industrial countries where the former complementarity between education and technology is crucial to the economy.

#### **2.4.2 Political economy mechanisms**

This theory has been developed in order to address the unanswered questions left by the latter theory, in particular that the expansion of education goes beyond the experience of rich and developed countries. In the context of the European expansion of compulsory schooling, countries at different stages of development, with dissimilar levels of GDP per capita and technology, have enacted the school-leaving age laws and increased compulsory education.

The common history of European countries is characterized by important socio-political factors that may have been influential for the expansion of compulsory schooling after the 1950s. Among these, the process of European integration may have played a central role. Because harmonization of the legal systems across countries may affect the dynamics of convergence, we expect the membership to the European Union<sup>7</sup> to interfere with convergence. Similarly, the expectation of becoming a member of the EU may have led countries to modernize the educational system in order to catch-up with the educational leaders<sup>8</sup>.

Another factor that may have affected the expansion of compulsory schooling is democracy. The majority of European countries already had democratic institutions at the beginning of the study period, 1950. However, the West-

---

<sup>7</sup>In the following we will refer to the European Union as the EU even if historically the Union has changed of name.

<sup>8</sup>Indeed, there was a consistent lag between the year of application and when new members joined the European Union. Ireland for instance, applied in 1961 and joined the European Union in 1971 whereas Portugal and Spain were admitted in 1986 after applying in 1977. During these time periods both Ireland and Portugal enacted school-leaving age laws. In Greece, the application was submitted when the democratic regime was restored in 1975. Many educational reforms that had been invalidated during the regime were re-established (see Kurian (1988)) and the country could become member of the European Union in 1981.

ern European countries that experienced the greatest expansion of compulsory schooling did not have a democratic regime before.<sup>9</sup> Lindert (2004) has argued that the spread of democracy increased enrolments at primary and secondary levels rather than the opposite<sup>10</sup>

Last political variable worth analyzing is the tax rate in equation (6), and more generally inequality. In general, Sokoloff-Engerman (2000) or Galor et al. (2006) argue that the degree of implementation of education reforms is an outcome of the balance of power in society; the latter authors provide indeed historical evidence in support of the inverse relationship between land inequality and investments in human capital. In that context, higher inequality should entail lower compulsory schooling. However, in the context of democracies with well-functioning and pro-growth institutions, inequality might well have the opposite effect. Indeed, benevolent governments might well be keen on reducing the gap between the most and least educated workers, especially in the context of a rising globalization and skill-bias technological change. Rising inequality across educational groups could then entail increasing compulsory schooling.

### **2.4.3 The budget constraint of the government**

In this framework the timing of the enactment of laws on school-leaving age is not considered as a result of post-war economic and socio-political conditions, but rather as a function of the state's capacity to support the expansion of education. Consequently, strong states that emerged at the end of the Second World

---

<sup>9</sup>This is the case of Italy, Greece, Spain and Portugal. In 1974 "the Regime of the Colonels" ended in Greece and the Carnation Revolution put an end to Salazar's regime in Portugal. On the other hand, in 1975, the authoritarian regime ended in Spain with Franco's death. In Italy for instance, radical school reforms were undertaken as a result of the fall of fascism and in Greece as well, when the military dictatorship ended, many schooling policy changes were undertaken.

<sup>10</sup>The direction of causality between democracy and human capital is nevertheless much debated in the literature, see Acemoglu and Robinson (2006) and Glaeser et al. (2006). But it is true that the idea of some visionary dictators boosting education in postwar Europe is clearly counter-factual to the experiences of Greece, Portugal and Spain.

War had the possibility to devote resources to education and to expand the level of compulsory schooling with the belief that “sustained economic growth needed an increasingly skilled manpower” as quoted from Demeulemeester and Diebolt (2005).

One important factor of the strength of the state is its capacity to reform, which depends on its budget. Expanding education imposes a high cost on the government budget, which will be easier to bear during periods of fast growth. Following this reasoning it seems plausible to assume that growth of GDP per capita will be a determinant of compulsory schooling. For instance, from the aftermath of the Second World War until the end of the Golden Age, there has been a positive correlation between GDP growth and expenditure on education as Tanzi and Schuknecht (2000) have illustrated.<sup>11</sup>

Reciprocally, the share of illiterate people in the population gives an indication of the burden faced by governments.<sup>12</sup> It proxies the importance of dropouts and enforcement difficulties. A further factor affecting the cost of public education derives from the demographic composition of the labour force, and is determined by the demographic ratio of active population (aged 15-64) divided by young population (aged 0-14). This is central to the “population ecology hypothesis” from Craig (1981). It is related to the ability of countries to support the expansion of education when the share of the active labour force grows faster than the schooling-age population. This factor arises naturally from equation (6) via the ratio  $L/N$ . A last factor should be considered. Urbanization is expected to have a positive impact on the expansion of compulsory schooling as it enables countries to realize economies of scale. Also, the greater

---

<sup>11</sup>The reason for not having chosen a variable more strictly related to education such as expenditure on education as a percentage of GDP is that this variable would depend on the business cycle and would be contaminated by any other mechanisms affecting GDP such as the post-oil shock long term economic slowdown.

<sup>12</sup>For Portugal and Italy who displayed respectively 3 and 5 years of compulsory years in 1950, there is a risk of reverse causality: a low level of mandatory schooling could have created illiterate people in the early 50s.



complexity of the economic activity in urban areas is likely to create the demand for more educated workers.

### **3 The data**

In this section we describe extensively the dependent variable, mandatory years of schooling, and we exhibit its relationships with actual years of schooling. We find a significant and robust relationship that justifies why it is relevant to consider it as a public policy variable. Then we illustrate the convergence process associated to it, and we depict the explanatory variables mentioned above.

#### **3.1 Compulsory years of schooling**

Table 1 describes the occurrence of the reform in Europe after World War II. Two groups of countries can be identified according to the starting level of compulsory schooling at the end of the Second World War. Austria, Belgium, France, Switzerland, Ireland, the United Kingdom and the Nordic countries started with high levels of compulsory schooling, varying from 7 to 9 years. On the other hand, Southern European countries had lower initial levels of compulsory schooling, from 3 years for Portugal to 5 for Italy and 6 for Greece. This distinction was reflected in the actual levels of schooling achieved by the population.

Southern European countries have increased the number of years of compulsory schooling more than the other countries since 1945. They achieved a significant catch-up. Spain and Italy increased compulsory schooling twice and the overall change consisted of 3 and 4 additional years of compulsory schooling. Portugal is the European country that has had the largest increase of compulsory schooling since 1945. According to Alves and Canário (2002, p.656), since

the end of the war “schooling has become the primary focus”.

On the other hand, Nordic countries and other countries that started with higher levels of compulsory schooling increased the school-leaving age by a year or two. The experience of the United Kingdom is an exception. A education act was already passed by Parliament in 1939 to raise the school-leaving age by one year. However, the law was suspended because of the outbreak of the Second World War (see Kurian (1988)). A plan to increase compulsory schooling was included in the 1944 Butler Act but did not become effective until 1947 (Dent, 1954). The case of the Netherlands deserves a comment. In fact, after the first legislation making education compulsory was passed in 1900, the Act was amended several times but a new legislation replacing it was provided only in 1950 and after in 1971 with the implementation of the “Leerplichtwet”, the Compulsory Education Act. For many countries this change was the result of a reconfiguration of the education system that was perceived as necessary by governments during the postwar period. In Austria, for example, after the Second World War “educational reform became one of the major issues facing the new republic” as quoted from Kurian (1988, p.8). However, the school-leaving age law did not pass until 1962 because of the divergent education policies between the Austrian Socialist Party and the Austrian People’s Party, the two largest parties. Also, in France there was a great need for reforms after the war and the policy change in compulsory schooling was undertaken under the Plevin government. In Spain the need for reform was not addressed under Franco’s authoritarian regime before 1970 when the Ley General de Educación was enacted (Marlow-Ferguson, 2002, p.1272).

### 3.2 Compulsory and actual years of schooling

Hereafter we present the relationships between compulsory and actual years of schooling. From an empirical perspective, it would be useful to track the evolution of education by age cohort following the implementation of new laws and the extension of the school-leaving age. It would reveal in which extent was the constraint binding for the relevant cohorts of age. Unfortunately, there does not exist such data on education by cohort of age. However, it is possible to relate actual and lagged compulsory schooling among the whole population. Table 2 displays a fixed-effects panel data estimation conducted on our sample of 15 Western European countries, with average years of Primary and Secondary schooling in the population older than 15 as a dependent variable, and lagged compulsory years of schooling as explanatory variables. Data on actual years of Primary and Secondary schooling are adapted from Cohen-Soto (2007)<sup>13</sup>.

We consider the population older than 15 and retain a sizeable time interval between actual and compulsory schooling, which is however limited to 40 years because of data availability. As compulsory schooling evolves slowly over time, introducing all past lags may cause multicollinearity problems. Also, favouring long-distant lags over more recent ones is likely to improve the exogeneity of regressors - admittedly, finding an instrument for compulsory years of schooling is out of the scope of this paper, but we do control for fixed-effects. So in all regressions we exclude the first lag, as well as the third one in some regressions in order to diminish the correlation between regressors. Time dummies are also introduced in order to control for modifications of the age structure and the overall extension of life expectancy that affects the average stock of years of schooling.

---

<sup>13</sup>In order to deal with different durations of Primary and Secondary across countries, the latter were redefined as respectively the first six years of school and the following 6 years. For instance, the last year of Secondary in Italy, which has a total of 13 years of Primary and Secondary schooling, is reclassified as Higher Education and is not taken into account.

With three time periods (1990, 2000, 2010) in columns I and IV, all the lags are always significant. With only two time periods (1990 and 2000) in columns II and V, only the fourth lag is always significant. So changes in actual education between 1990 and 2010 are consistently correlated with changes in compulsory schooling between 1950 and 1970. As the median age in European countries was roughly comprised between 30 and 40 in 2000, focusing on a 40 years lag makes perfectly sense. Interestingly, had compulsory schooling followed rather than entailed the rise in schooling enrolment, then more recent lags and even contemporary compulsory schooling would most likely correlate with actual schooling. However, this is not the case as shown by columns III and VI.

So the increase in compulsory schooling 40 years ago is a robust determinant of current changes in actual average schooling in the population. This confers a true public policy dimension to the former variable. We are now ready to investigate the following issues: why did Southern European countries catch-up with the rest of Europe in terms of compulsory schooling? what were the other factors that promoted or undermined convergence?

### **3.3 Convergence of compulsory years of schooling**

In order to adopt a general perspective on the data, we now treat the sample as a whole. Figure 1 depicts all occurrences of a schooling reform regardless of the country. It makes visible that overall the pace of reforms has been more intense during the period 1951-1975, with 16 reforms versus 9 afterwards<sup>14</sup>. Both mix economically advanced countries and less developed countries such as Greece, Portugal, Spain and Italy. Seven countries have had multiple increases (Ireland, Italy, Greece, the Netherlands, Portugal, Spain and Norway), spaced in time

---

<sup>14</sup>For Portugal the men and women reforms taking place in respectively 1956 and 1960 have been counted as a single reform taking place in 1956.

from 20 years in most cases, with three notable exceptions (Greece in 1964, 1967 and 1976, the Netherlands in 1971-1975 and Portugal in 1956-1964).

Figure 2 is the core of the paper. It shows the variation in the number of mandatory years of schooling over the period 1950-2000 with respect to initial mandatory years. There is a clear negative correlation: the lower the initial compulsory years, the larger the increase in compulsory schooling. This convergence process, also called the “beta-convergence” in Barro and Sala-I-Martin (1995), depicts the impact of the initial value on the growth rate of mandatory years of schooling. It is not necessarily linked to the convergence of the distribution of mandatory years of schooling towards a common mean, the “sigma-convergence”. Stationarity of unobserved factors is required for the first type of convergence to imply the second.

Figure 3 depicts the standard error of the distribution of mandatory years of schooling over the period 1950-2000 with respect to its annual average (there are 21 points as 21 years of reforms). It is clear that the dispersion of this variable has decreased with the overall increase of compulsory schooling. Hence we do validate the “sigma-convergence” hypothesis as well.

### 3.4 Other explanatory variables

We now detail and describe succinctly the other explanatory variables associated to the above theories<sup>15</sup>. Table 3 presents their averages and standard errors over the whole period and the two sub-periods.

The first set of variables is relative to technology and trade: we first consider *technology per capita* measured as the number of patents granted to residents and non-residents divided by the population, smoothed with the help of a moving average filter over the past 10 years (over the past 5 years for the period 1951-

---

<sup>15</sup>please refer to the appendix for the discussion of the construction of two variables, technology and democracy.

1955); one expects to find a positive coefficient for this variable as the higher the level of technology the greater would be the complementarity between technology and schooling. Second, *openness*, calculated as the sum of exports and imports divided by GDP. As the considered countries were relatively advanced industrial ones by international standards, we expect openness to have a positive effect as it might increase the price of technology-intensive products. In that regard, human capital would be a key factor of production. It turns out that technology per capita has increased by 25% across the two sub-periods and openness by a dramatic 73%, these increases being two characteristics of the globalization era.

The second set of regressors concerns the political economy mechanisms. Interestingly, the index for *democracy* is greater in the second period - see details on the construction of the variable in annex. As previously suggested countries like Greece, Portugal and Spain did not have a “strongly democratic regime” in the years following the end of the Second World War. Further on, the Gini coefficient has decreased by nearly 7 percent since 1975. The *Gini* was retained to capture the effect of inequality and the balance of power within the society. Statistics show a large decrease of inequality in the second half of the period. As shown by Morrisson-Murtin (2005), market income inequality has been reduced among a majority of European countries between 1970 and the mid-80s, while increased redistributive fiscality has partly compensated the increasing market inequality after the mid-80s.

Among the variables taken from the third theory, *growth in GDP per capita* was significantly greater before 1975, this decrease being clearly due to the slowdown that followed the Golden Age. The *demographic ratio* reflects the population ageing effect following the Baby-boom of the 1950s. That is, after 1975, the ratio increases and this is revealing of the growth in the working age

population with respect to the schooling age one. *Urbanization* increases by 15 percent and this is due to the economic expansion of cities. Also, socio-economic trends, cultural traditions and constraints as the attractiveness of urban areas and the application of planning policies have fostered the development of urban areas (see for instance European Environment Agency (2006), p.7, and Lever (1999) p.234). *Illiteracy* has been cut by 2 to reach 2.7% in the second sub-period.

## 4 Econometric analysis

### 4.1 The model

First, we discuss the statistical model. There are two approaches: one is to model explicitly the lapse of time between two reforms, the other is to model the intensity of the reform, namely the number of mandatory years that have been passed in the new law. The first strategy uses duration analysis, the second one relies on a classical linear analysis. We explain briefly why we chose the second approach.

Duration analysis models the timing of a given event.<sup>16</sup> In our case, changes can occur many times and the duration since last change, as well as the total number of changes in the past, have clearly an influence on the likelihood of a current change, in other words, there is some time-dependency. A logit-probit approach cannot capture it, because it would assume independence between various occurrences conditionally on covariates. The use of a duration model

---

<sup>16</sup>For instance, Fishback and Kantor (1998; 2000) used this methodology in order to study the passage of the Workers' Compensation Laws in the United States. Also, Box-Steffensmeier and Zorn (1998) used the Cox parametric approach in order to study the pattern of retirement among the justices of the U.S. Supreme Court over the period 1789-1993. Alternatively, if one were interested in modelling the date a law is passed rather than the duration until this law has been passed, a logit-probit approach could also be adopted. For instance, Chen (2001) used a discrete-time logit model in order to study the determinants of the passage of the State Fair Employment Legislation in the American states over the period 1945-64.

with multiple-spells can account for this problem since it explicitly models the lapse of time between the successive changes of the law. However, this framework has a major drawback: it neglects the intensity of the change. As described above, more than half of the reforms entail an increase of 2, 3 and even 4 years, which must be taken into account. Consequently, we run a classical linear analysis where the actual mandatory years of schooling is the dependent variable.<sup>17</sup>

In the former section we have heavily stressed the convergence process occurring over the period. The natural framework is consequently a dynamic linear panel model with an autoregressive component of order one, which can be estimated either with Arellano-Bond (1991) or Blundell-Bond (1998) procedures. Formally, the model for a country  $i$  at date  $t$  is

$$y_{i,t} = \mu + \delta_t + b_i + \rho y_{i,t-T} + Z_{i,t}\beta + u_{i,t} \quad (7)$$

where  $\mu$  is a grand mean,  $\delta_t$  period dummies,  $b_i$  country dummies,  $Z$  a matrix of potentially endogeneous regressors,  $u_{i,t}$  *iid* residuals,  $T$  the delay between the two considered periods. In this general framework, convergence is captured by the autoregressive term  $\rho y_{i,t-T}$ .<sup>18</sup> Covariates  $Z_{i,t}$  reflect the influence of other factors such as technology, openness, democracy and so forth.

Two econometric problems are likely to arise. First, measurement errors may affect some of the regressors, biasing their coefficient towards 0. For this reason, we have smoothed some erratic variables - technology per capita and

---

<sup>17</sup>The use of such a model raises the issue of the interpretation of the dependent variable: one should rather talk about a *score* in mandatory schooling, since in the model the dependent variable takes continuous values but is discrete in reality. For the sake of simplicity we make the approximation that both variables are equal and keep on using the mandatory years of schooling as the dependent variable.

<sup>18</sup> $\rho$  measures the degree of autocorrelation of the process: the lower it is, the faster the return to the “mean”. Importantly, accounting for other variables, including unobserved ones, can have a dramatic effect on estimates of the speed of convergence if those variables are correlated with the lagged dependent variable. In particular, controlling for unobserved heterogeneity removes any omitted variables bias that could affect estimates of  $\rho$



growth of GDP per capita - by using a moving average procedure with two different time spans, 5 and 10 years. We also examine convergence with those two different time spans. Second, there has been a controversy in the convergence literature on the use of Arellano-Bond (1991) and Blundell-Bond (1998) estimators, which are respectively called “DIF-GMM” and “SYS-GMM”. This econometric problem is linked to the quality of instruments (some lags of the dependant variable) used in the procedure DIF-GMM. If those instruments are weakly correlated with the regressors, estimates may be biased towards 0. In the case of the convergence estimates, this turns out to overestimate the speed of convergence. On the other hand, SYS-GMM makes another assumption, namely stationnarity of the initial variable. For this reason, we have to investigate the results given by both DIF-GMM and SYS-GMM.

## 4.2 Results

Table 3 reports estimates from a simple dynamic panel model with fixed-effects using the two time spans and the two estimators described above. We used the `xtabond2` Stata version of the latter estimators provided by Roodman (2006). We applied the two-steps procedures that correct for a non-trivial covariance matrix, using the Windmeijer (2005) correction of downward biased standard errors in finite samples.

We report the coefficient of lagged mandatory years of schooling, as well as the implied annual convergence rate in order to ease comparisons across time spans. This rate  $\lambda$  follows from the dynamics of convergence<sup>19</sup> and is simply defined as:

$$\lambda = -\frac{1}{T} \log(\hat{\rho})$$

where  $\hat{\rho}$  is the estimated autoregressive coefficient. We find that the annual

<sup>19</sup>If  $y_t$  is the dependent variable, then convergence states that  $\Delta y_t = -\lambda y_t$  or equivalently that  $y_{t+T} = y_t \exp(-\lambda T) = \rho y_t$ .

convergence rates are respectively equal to 14.9% and 3.7% for DIF-GMM and SYS-GMM with a 5 years time span, and respectively equal to 9.2% and 2.5% with a 10 years time span<sup>20</sup>. In tune with the convergence literature, SYS-GMM delivers much smaller convergence rates: presumably, lagged levels of the dependent variable are weak instruments of its first differences when the process is close to an unit root, biasing the estimates of  $\rho$  towards zero in DIF-GMM.

Besides, we report in each case the Arellano-Bond autocorrelation tests and the Hansen J test of over-identifying restrictions. The latter is robust to heteroskedasticity and autocorrelation of residuals, contrary to the usual Sargan test. However, it can be weakened when there are too many instruments. For this reason, we restricted the set of instruments to the single second lag of the dependent variable, sticking to the practical rule of thumb of having less instruments than countries. As expected, in any case the first-order autocorrelation test conducted on first-differenced residuals rejects the null hypothesis of no autocorrelation, and accepts it at the second-order. Those two results jointly indicate the absence of autocorrelation in the levels of residuals. Then, all the Hansen tests accept the null hypothesis of exogeneous regressors as a group, with p-values avoiding the suspicious subsets of either too low or too high values.

As a result, we find that SYS-GMM provide more trustworthy estimates, with comparable estimates across the two time spans. The lower p-value of the Hansen J-test with a 10 rather than a 5 years time span, together with the idea of maximizing the number of observations, lead us to choose SYS-GMM with a 5 years time span as a benchmark procedure.

In table 5 we test for conditional convergence conditionally on each of the three sets of variables. As before we used the two-steps SYS-GMM with ro-

---

<sup>20</sup>Implied annual rates of convergence should be compared across estimators but not across different different time spans as the latter entail a non-linear mapping between  $\rho$  and  $\lambda$ .

bust standard errors, a 5 years time-span, and the second lags of the dependent variable (both in level and in difference) as a single instrument. All regressions passed the specifications tests. The results show that the effect of convergence is significant and positive in each case. Openness is positive and significant, showing the positive impact of globalization. In the political economy framework only the democracy index is significant at 10% level. It certainly captures the negative impact of dictatorships on education in Southern European countries such as Portugal, Spain and Greece. Surprisingly, the membership of the European Union, or the expectation of becoming a member, has no effect on the speed of convergence. We find the same absence of effect when introducing simple dummies for membership or application to the Union rather than the interaction between those dummies and the lagged variable. This might be explained by the relative homogeneity of the sample in the postwar period. Also, the Gini coefficient was negative and almost significant at a 10% level, but still above this confidence level. In contrast with the literature on the introduction of compulsory schooling towards the end of the 19th century in Europe, inequality does not have a significant impact on the increase in school-leaving age after the war. In the government's budget set of variables, the urbanization rate is significant with the expected sign. Surprisingly, the demographic ratio did to come out as a significant determinant of compulsory schooling.

The last regression<sup>21</sup> shows the results of testing convergence while including all of the former significant variables. This aims at determining which factors remain significant when different theories are tested altogether. It turns out that only two variables remain significant: the convergence effect, and openness. A clearer picture emerges: in the immediate postwar period, there has been a catch-up process from the less advanced countries. In the meantime, globaliza-

---

<sup>21</sup>Due to small sample size, it was not possible to conduct further analysis on various sub-samples or sub-periods.

tion forces have gained strength and increasingly fostered public investments into education. More open countries were more likely to enhance compulsory schooling. It is indeed striking that the two countries the most endowed with compulsory years of schooling in 2000, Belgium and Netherlands, were the most open countries in Europe at the same date, together with Ireland which reformed its system in 2000.

The link between globalization and education has received some attention in the literature (see for instance Bloom (2004) or Green (2000)), but little quantification as achieved in this paper. Admittedly, the motives behind the political will of increasing compulsory schooling in open countries remain somewhat obscure: policy makers might aim at strengthening the skills of the overall workforce in a global market; alternatively, they may be keen on reducing tensions linked to inequality by raising the educational level of the least educated; they could seek both goals simultaneously. This question is left aside for future research. However, the convergence effect might certainly leave less and less room for public intervention as compulsory years of schooling in Western Europe have already reached high levels of compulsory schooling by international and historical standards.

## 5 Discussion

We acknowledge the following comments received from discussants and referees. Our results show that the major driver of the convergence of compulsory schooling over the period examined has been the existence of aggregate decreasing returns to education. We also acknowledge in an earlier section the existence of other factors, like political and institutional changes that have led some countries to increase the school-leaving age (section 2.4.2, p.11).

We understand that by setting a mandatory number of years of schooling

governments prevent children from choosing whether to go to school or not. Enforcement in this case is based on the assumption that up to a certain age children should not work and they cannot fully understand the consequences of their choices. However, by allowing children to choose after a given age governments recognize the basic freedom of adult individuals. This does not imply that governments do not see the benefits resulting from additional years of schooling.

In our analysis, we only attempt to provide an explanation for why compulsory schooling has converged in Western Europe since the end of the Second World War without arguing that the number of years of schooling reached by the majority of countries examined coincides with a social optimum. The analysis of the level of compulsory schooling that equals the social optimum goes beyond the purpose of this study.

## **6 Conclusion**

This paper has analysed the determinants of the number of years of compulsory schooling in fifteen Western European countries since 1950, whereas previous analyses have mainly focused on single country experiences. Also, we have used an analytical approach rather than the descriptive approach of the majority of the existing studies. In order to examine the factors that led to the expansion of compulsory schooling, we have proposed and validated an explanation based on convergence forces inherent to decreasing aggregate returns to schooling, and tested the explanatory power of other explanations extracted from the sociology and political science literatures. Empirically, we have assembled a dataset by using a variety of national and international sources.

Some robust evidence supports the view that convergence has been the major phenomenon characterizing the evolution of compulsory schooling after 1950.

Because education has decreasing returns, it has been relatively more valuable for countries with a low educational level to extend compulsory schooling and to catch-up with more advanced ones. This is still true when one controls for the various explanations that have been provided in the literature. Hence both absolute and conditional convergence holds. A second robust explanatory variable is openness. Rising globalization has fostered the enhancement of compulsory schooling, as the latter both increases the competitiveness of the workforce in a global market and reduces inequality between the most and least educated within a society. Regarding future work, the extension of the analysis to the whole twentieth century is a promising direction. Statistical robustness will be increased, and the validity of the latter effects will be examined since the introduction of universal education.

## References

- [1] Acemoglu, D. and J. Angrist (2000). How Large are Human Capital Externalities? Evidence from Compulsory Schooling Laws. .
- [2] Acemoglu, D. and J. Robinson (2006). Economic Origins of Dictatorship and Democracy. New York: Cambridge University Press.
- [3] Alves N. and Canário R. (2002), “The New Magistry of Influence: changing governance of education in Portugal”, European Educational Research Journal, Vol. 1, No. 1, pp. 656-66.
- [4] Arellano M. and Bond S. R. (1991), “Some Specification Tests for Panel Data: Monte Carlo Evidence and an Application to Employment Equations”, Review of Economic Studies, Vol. 58, pp. 277-98.
- [5] Barro R. and Sala-i-Martin X. (1995), Economic Growth, Boston: Mc Graw Hill.
- [6] Bloom, D.E. (2004). Globalization and Education. Chapter from Globalization Culture and Education in the New Millenium, eds. M Suarez-Orozco and D. Quin-Hilliard.
- [7] Blundell R. and Bond S. R. (1998), “Initial Conditions and Moment Restrictions in Dynamic Panel Data Models”, Journal of Econometrics, Vol. 87, pp. 115-43.
- [8] Box-Steffensmeier J. M. and Zorn C. J. W. (1998), “Duration Models and Proportional Hazards in Political Science”, Paper prepared for the presentation at the Annual Meeting of the Midwest Political Science Association, April 23-25 1998.

- [9] Chen T. (2001), “The Passage of State Fair Employment Legislation, 1945-1964: An Event-History Analysis with Time-Varying and Time-Constant Covariates”, Berkeley, Industrial Relations Working Paper No. 1016.
- [10] Ciccone, A. and G. Peri (2005). “Identifying human capital externalities: Theory and applications. Forthcoming in Review of Economic Studies.
- [11] Cipolla C. M. (1969), “Literacy and development in the West”, Harmondsworth: Penguin.
- [12] Cohen D. and Soto M. (2001), “Growth and Human Capital: Good data, good results”, OECD Development Centre Tehnical Paper No. 179.
- [13] Collins R. (1971), “Functional and Conflict Theories of Educational Stratification”, American Sociological Review, Vol. 36, No. 6, pp. 1002-19.
- [14] Craig J. E. (1981), “The Expansion of Education”, Review of Research in Education, Vol. 9, pp. 151-213.
- [15] Demeulemeester J. L. and Diebolt C. (2005), “The Economics of Education: Unkept Promises?”, Association Francaise de Cliometrie Working Paper No. 8.
- [16] Dent H. C. (1954), “Growth in English Education, 1946-1952”, London: Routledge & Kegan Paul Ltd, p. 46.
- [17] Diebolt C. (1999), “Government Expenditure on Education and Economic Cycles in the Niteenth and Twentieth Centuries. The Case of Spain with special reference to France and Germany”, Historical Social Research, Vol. 24, No. 1, pp. 3-31.
- [18] Diebolt C. and Fontevielle L. (2001), “Dynamic forces in Educational Development: A Long-Run Comparative View of France and Germany in the 19th and 20th Centuries”, Compare, Vol. 31, No. 3, pp. 295-309.



- [19] Eichengreen B. (1996), "Institutions and Economic Growth: Europe after World War II" in N. F. R. Crafts and G. Toniolo (eds.), *Economic Growth in Europe since 1945*, Cambridge: Cambridge University Press, pp. 38-65.
- [20] European Environment Agency (EEA) (2006), "Urban sprawl in Europe. The ignored challenge", Report No. 10/2006, Luxembourg: EEA Publication.
- [21] EURYDICE Database, "Report on schooling system of European countries", (Various years).
- [22] Fishback P. V. and Kantor S. (1998), "The Adoption of Workers' Compensation in the United States, 1900-1930", *Journal of Law and Economics*, Vol. 41, No. 2, pp. 305-42.
- [23] Galor O. (2006), "From Stagnation to Growth: Unified Growth Theory" in P. Aghion and S. Durlauf (eds.), *Handbook of Economic Growth*, Amsterdam: North-Holland.
- [24] Galor O., Moav O. and Vollrath D. (2006), "Inequality in Land Ownership, the Emergence of Human Capital Promoting Institutions, and the Great Divergence", Brown University Economics Working Paper No. 06-14.
- [25] Glaeser, E.L., La Porta, R., Lopez-de-Silanes F. and Schleifer A. (2004). Do Institutions Cause Growth?. *Journal of Economic Growth*, Vol. 9, No. 3, pp. 271-303.
- [26] Green, A. (1999). Education and globalization in Europe and East Asia: convergent and divergent trends. *Journal of Education Policy*, v.14 p.55-71
- [27] Heckman, J., Lochner L. and P. E. Todd (2005). Earnings Functions, Rates of Returns and Treatment Effects: the Mincer Equation and Beyond. IZA DP 1700.

- [28] Kurian T. (1988), "World Education Encyclopedia", New York: Facts on File.
- [29] Landes W. M. and Solmon L. C. (1972), "Compulsory Schooling Legislation: An Economic Analysis of Law and Social Change in the Nineteenth Century", *Journal of Economic History*, Vol. 32, No. 1, pp. 54-91.
- [30] Lever W. (1999), "Welfare States" in M. S. Schulze (ed.), *Western Europe: Economic and Social Change since 1945*, London: Longman, pp. 234-252.
- [31] Lindert P. (2004), "Growing public. Social Spending and Economic Growth since the Eighteenth Century", Vol. I and II, Cambridge: Cambridge University Press.
- [32] Marlow-Ferguson R. (ed.), (2002), "World Education Encyclopaedia. A Survey of Educational Systems Worldwide", Farmington Hills, MI: Gale Group.
- [33] Maynes M. J. (1985), "Schooling in Western Europe. A Social History", Albany, NY: State of New York Press.
- [34] Mitch D. (1983), "The Spread of Literacy in Nineteenth-Century England", *Journal of Economic History*, Vol. 43, No. 1, pp. 287-8.
- [35] Morrison C. and Murtin F. (2005), "History and Prospects of Inequality Among Europeans", mimeo.
- [36] Morrison C. and Murtin F. (2007), "Education Inequalities and the Kuznets Curves: A Global Perspective Since 1870", mimeo.
- [37] OECD (1983), "Compulsory schooling in a changing world", Paris: OECD.
- [38] OECD (2002), "Education at a Glance. OECD Indicators. Education and Skills", Paris: OECD.

- [39] Ringer F. K. (1979), “Education and society in modern Europe”, Bloomington: Indiana University Press.
- [40] Roodman, D. (2006). How to Do xtabond2: An Introduction to “Difference” and “System” GMM in Stata. Working Paper 103. Center for Global Development, Washington.
- [41] Sandberg L. G. (1982), “Ignorance, Poverty and Economic Backwardness in the Early Stages of European Industrialization: Variations on Alexander Gerschenkron’s Grand Theme”, *Journal of European Economic History*, Vol. 11, p. 675-97.
- [42] Sokoloff, Kenneth L., and Stanley L. Engerman (2000). History Lessons: Institutions, Factor Endowments, and Paths of Development in the New World, *Journal of Economic Perspectives*, 14, 217-232.
- [43] Soto, M. (2006). The Causal Effect of Education on Aggregate Income. IIEI wp. 0605.
- [44] Skidmore, M., Toya H. and D. Merriman (2004), “Convergence in Government Spending: Theory and Cross-Country Evidence ”, *Kyklos*, Vol.57, p.587-620.
- [45] Tanzi V. and Schuknecht L. (2000), “Public Spending in the 20th Century. A Global Perspective”, Cambridge: Cambridge University Press.
- [46] Tortella G. (1990), “Education and Economic Development since the Industrial Revolution”, Valencia: Generalitat Valenciana.
- [47] Windmeijer, F. (2005). A Finite Sample Correction for the Variance of Linear Efficient Two-step GMM Estimators. *Journal of Econometrics* 126, p. 25-51.

## Appendix

### A Variables

- *Technology per capita*:<sup>22</sup> has been constructed as the number of patents granted to residents and non-residents at a given year. The choice of this variable to measure technology is motivated by the state-of-the-art literature. In fact, many scholars such as Griliches (1986, 1990), Evenson (1984) and Eaton and Kortum (1996; 1998) have shown both advantages and disadvantages in the use of this indicators as a proxy for technology. These authors have also shown that other measures such as the level of scientific publication, R&D expenditure and performance in the high-technology industrial sector do not seem to work better. Patents remain, as Stern et al. (2000, p.18) say, “the most concrete and comparable measure [of overall technological performance] across countries and time”. The choice of patents granted to both residents and non-residents is motivated by data availability. Data for residents only are not available for the whole period 1950-2000. To take into account a possible bias that could arise by considering patents granted to non-residents and therefore introducing a correlation between this variable and openness we have run the regression with the number of patents granted to residents only for 1970-2000. There is virtually no difference in running the regression with the two measures of technology. This may be motivated by the fact that the fifteen European countries under study do not have a very high share of patents granted to foreigners. Therefore, it seems reasonable to extend the use of this measure to the entire period.
- *Democracy*: It is an index that measures the level of democracy by considering characteristics such as the existence of competitive and open elections, human rights protection, limitations on power holders. It has been taken from Marshall and Jaggers (2000) and Meyer and Schofer (2005a) from whom we have received these data. It can take a value from -10 (“strongly autocratic regime”) to +10 (“strongly democratic regime”). It seems to be a better indicator than the dummy variable that is commonly used in the literature and that takes the value of “1” if there is a democratic regime and “0” otherwise. For it allows the analysis of the more subtle differences that characterize different democratic regimes.

---

<sup>22</sup>This variable has been smoothed by using 5-year moving average.

## B Tables

Table 1 - The Extension of Compulsory Schooling in Europe 1938-2000<sup>1</sup>

Country	Years in 1938	Date of Reform	Years After	Starting Age	Change
Austria	8	1962	9	6	+1
Belgium <sup>2</sup>	8	1983	12	6	+4
Denmark	7	1971	9	7	+2
Finland <sup>3</sup>	6	1977	9	7	+3
France	8	1967	10	6	+2
Greece	6	1964	9	6	+3
		1967	6		-3
		1976	9		+3
Ireland	8	1972	9	6	+1
		2000	10		+1
Italy <sup>4</sup>	5	1963	8	6	+3
		1999	9		+1
Netherlands <sup>5</sup>	6	1950	8	7	+2
		1971	9		+1
		1975	10		+1
		1985	12	5	+1.5 (on avg)
Norway	7	1969	9	6	+2
		1997	10		+1
Portugal	3	1956 (men)	4	6	+1
		1960 (women)	4		
		1964 (all)	6		+2
		1986 (all)	9		+3
Spain	7	1970	8	6	+1
		1990	10		+2
Sweden <sup>6</sup>	8	1962	9	7	+1
Switzerland <sup>7</sup>	8	1970	9	5 or 6	+1
United Kingdom <sup>8</sup>	9	1947	10	5	+1
		1973	11		+1

*Notes on Table 1:*

<sup>1</sup> The dates considered refer to the enactment of the school-leaving age law, that is to say when compulsory schooling was increased, enforcement was effective and education was provided at virtually no private cost

<sup>2</sup>The reform was adopted in the three Communities. Compulsory schooling is full-time until 15 (at 16 only if the student is 15 and has not been enrolled in the first two years of secondary school), after it is part-time until 18

<sup>3</sup>For countries where the reform was implemented more gradually the date of change considered is the year when the compulsory schooling law started being implemented. These countries are Finland, Sweden (see note below) and Switzerland

<sup>4</sup>Information have been extracted from Shavit and Westerbeek (1998) and Brandolini and Cipollone (2002)

<sup>5</sup>The 1985 reform has led to a change in the school starting age. School starts the first month after children turn 5 and full-time education is compulsory until students have attended 12 complete years of schooling, in any case until the end of the school year when they turn 16; then students are required to take one year part-time courses. Therefore, on average, the 1985 change implied a 1.5 increase. Before this reform students started school at the beginning of the academic year when they turned 7. Information on the Dutch reforms has been kindly provided by Pr Oosterbeek, Universiteit van Amsterdam, Dr Webbink, Centraal Planbureau and Eurydice (2005)

<sup>6</sup>It is acknowledged that in some municipalities compulsory schooling lasted 7 years before the change. This policy change is known as the "1950 Education Reform" was gradually implemented across municipalities over 1949-62 and the legislation passed in 1962. Here, the starting point is 1950 as the reform was implemented in the second half of 1949 and only 1.3% of the municipalities had adopted the change in 1949 (Meghir and Palme, 2005, table 1)

<sup>7</sup>This reform corresponds to the first implementation of the policy change undertaken in the country. Differences exist across Cantons

<sup>8</sup>The first reform was implemented in England and Wales in 1947, in Scotland in 1946 and in Northern Ireland in 1957

Source: Arnet (2000), Eurydice Database on Education (2006), Flora et al. (1987), Marlow-Ferguson (2002)

Table 2 - Actual with Respect to Lagged Compulsory Years of Schooling in Europe 1950-2010

	1990-2010	1990-2000	1990-2000	1990-2010	1990-2000	1990-2000	1990-2010	1990-2000	1990-2010
Compulsory Years of Schooling	-	-	0.17 (0.21)	-	-	-	-	-	0.19 (0.18)
Compulsory Years of Schooling (20 years lag)	0.10** (0.04)	0.10 (0.08)	0.09 (0.08)	0.08* (0.04)	0.06 (0.06)	0.08 (0.06)	0.06 (0.06)	0.06 (0.06)	0.08 (0.06)
Compulsory Years of Schooling (30 years lag)	0.11* (0.05)	0.06 (0.10)	0.02 (0.11)	-	-	-	-	-	-
Compulsory Years of Schooling (40 years lag)	0.18*** (0.06)	0.62* (0.30)	0.70** (0.32)	0.15** (0.06)	0.66** (0.28)	0.72** (0.28)	0.66** (0.28)	0.66** (0.28)	0.72** (0.28)
N	45	30	30	45	30	30	45	30	30
Fixed-Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 3 - Descriptive Statistics

	1950-2000	1950-1975	1976-2000
<b>Technological Theory</b>			
Technology per capita	0.68 (0.57)	0.60 (0.53)	0.75 (0.59)
Openness	49.83 (27.27)	36.52 (18.55)	63.13 (28.12)
Share of population in agriculture	15.12 (12.14)	21.48 (13.29)	8.76 (6.14)
Share of population in industry	33.73 (6.82)	36.82 (7.08)	30.65 (4.89)
<b>Political Economy Theory</b>			
Democracy index	8.17 (4.82)	6.80 (6.31)	9.53 (1.71)
Gini	32.99 (6.81)	34.19 (7.43)	31.80 (5.90)
<b>Role of the State Theory</b>			
Growth of GDP per capita	0.03 (0.02)	0.04 (0.01)	0.02 (0.01)
Demographic ratio	2.89 (0.65)	2.43 (0.35)	3.35 (0.55)
Urbanization rate	65.10 (16.32)	60.51 (17.17)	69.68 (14.01)
Illiteracy rate	4.32 (7.28)	5.97 (9.34)	2.67 (3.67)



Table 4 - Absolute Convergence of Mandatory Years of Schooling in Europe  
1950-2000

	DIF-GMM		SYS-GMM	
	5 years span	10 years span	5 years span	10 years span
$\rho$	0.50 <sup>***</sup> (0.16)	0.45 <sup>***</sup> (0.13)	0.83 <sup>***</sup> (0.07)	0.78 <sup>**</sup> (0.07)
Implied $\lambda$ (in percents)	14.9	9.2	3.7	2.5
Nb of instruments	9	7	16	11
AB AR(1) p-value	0.02	0.01	0.01	0.01
AB AR(2) p-value	0.40	0.84	0.50	0.68
Hansen J-Test p-value	0.33	0.17	0.55	0.21

note: AB AR(i) stands for Arellano-Bond test of serial correlation of order i for first-differenced residuals.

Table 5 - The Determinants of Mandatory Years of Schooling in Europe 1950-2000 (SYS-GMM Estimator)

	<b>Technological Theory</b>	<b>Political Economy Theory</b>	<b>Role of the State Theory</b>	<b>All</b>
Lagged Mandatory Years	0.64*** (0.11)	0.42*** (0.12)	0.49*** (0.11)	0.46*** (0.08)
Technology per capita	0.25 (0.29)			
Openness	0.02** (0.01)			0.03*** (0.00)
EU convergence effect		0.09 (0.08)		
Application to EU effect		-0.08 (0.10)		
Democracy index		0.16* (0.09)		0.11 (0.07)
Gini		-0.03 (0.02)		
Growth of GDP per capita			20.4 (21.9)	
Demographic ratio			-1.11 (1.54)	
Urbanization rate			0.05** (0.02)	0.00 (0.03)
Illiteracy rate			-0.02 (0.04)	
Nb of instruments	16	16	16	16
AB AR(1) p-value	0.01	0.08	0.02	0.02
AB AR(2) p-value	0.42	0.41	0.98	0.36
Hansen J-Test p-value	0.65	0.36	0.59	0.83

## C Figures

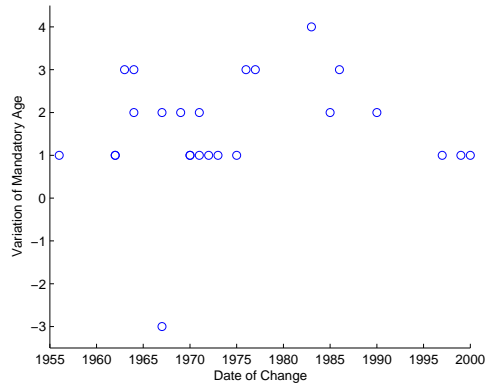


Figure 1: Variations of Mandatory Years of Schooling in Europe 1950-2000

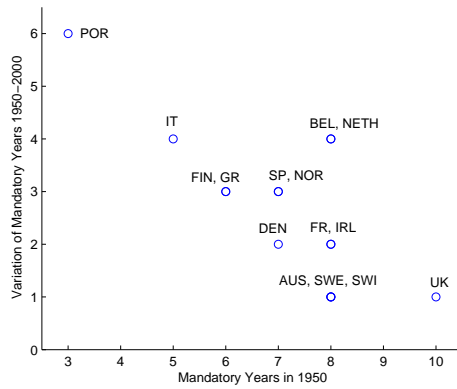


Figure 2: Beta-Convergence in the Mandatory Years of Schooling in Europe 1950-2000

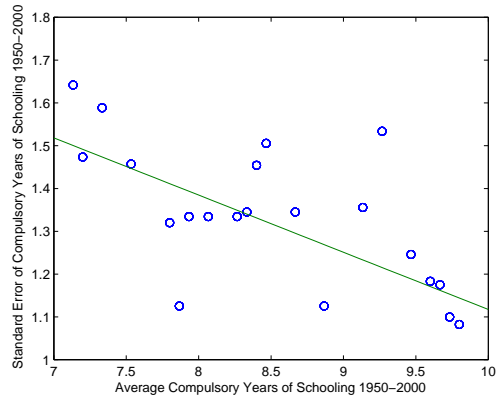


Figure 3: Sigma-Convergence in the Mandatory Years of Schooling in Europe 1950-2000