Educational policies in a long run perspective[†]

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ABSTRACT

In this paper we study the effects of educational reforms on school attainment. We construct a dataset of relevant reforms occurred at the national level over the last century, and match individual information from 24 European countries to the most likely set-up faced when individual educational choices were undertaken. Our identification strategy relies on temporal and geographical variations in the institutional arrangements, controlling for time/country fixed effects, as well as for country specific time trend. By characterising each group of reforms for their impact on mean years of education, educational inequality and intergenerational persistence, we show an ideal policy menu which has been available to policy makers. We distinguish between groups of policies that are either "inclusive" or "selective", depending on diminishing or augmenting impact on inequality and persistence. Finally we correlate these reform measures to political coalitions prevailing in parliament, finding support to the idea that left wing parties support reforms that are inclusive, while right wing parties prefer selective ones.

Keywords: Education, institutions, reform, family background
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1. INTRODUCTION

Over the last century, all European countries experienced a general increase in the average level of schooling, and a contemporaneous reduction in the dispersion of educational attainments across their populations. Nevertheless, education still remains unequally distributed and highly correlated with family background. Inequality in the distribution of educational attainments contributes to shaping income inequality (see the contributions in Dolton et al. 2009). The extensive literature on intergenerational mobility has highlighted a strong and persistent link between parents and children educational attainment (see Black and Devereux, 2010, for a review), suggesting that opportunities remain unevenly spread across the population and life-chances of individuals reflect factors for which they are not responsible.

The average level of schooling, the dispersion of educational levels and the extent to which individual educational attainment depends on parental background vary extensively across countries and over time, possibly in response to the specific institutional setting in which the educational systems operate. Schools have a central role in shaping the ways educational inequalities are generated and perpetuated. Different characteristics of education systems may help reducing (reinforcing) to various extents the advantage of pupils from high socio-economic background, thus decreasing (increasing) educational inequality. Patterns of provision of pre-primary education, duration of compulsory school, school tracking, school choice, school accountability and autonomy, academic selection, are all features that may affect both the mean and the distribution of educational attainments, thus shaping efficiency and equity of each schooling system. Understanding how and to what extent these institutional features affect countries' accumulation of human capital is crucial from a policy perspective, under the (maintained) assumption of beneficial effects of education to individuals and societies.[1]

The aim of this paper is to study the impact of educational reforms on the distribution of educational attainments in Europe, using an original dataset collecting information on various reforms that affected the school design over the 1929-2000 period for 24 countries. By school design we mean the institutional set-up that characterizes compulsory and post–compulsory education, starting from pre-primary and ending with tertiary education. Previous literature investigating the role of school institutions on educational attainment has mainly focused on either country-specific episodes, or cross-country evidence, but mostly restricting to single dimensions. In the former approach, the effects of institutional features are identified exploiting the variation of educational policies across regions within a state, or using reforms in the school system and adopting a before-after approach, sometimes also exploiting a gradual introduction that makes the timing of the reform different across areas. The limit of these case studies is that results are hardly generalisable since it is impossible to disentangle the impact of the educational reform from the whole institutional setting of a specific country. Moreover, since most of the variation in the institutional features of schooling systems occurs between countries rather than over time, the identification of the impact of school design is difficult when using national data only (see the discussion in Hanushek and Woessmann, 2010). In principle, a cross-country approach seems to be more effective in this perspective, but most of the existing cross-country studies are based on cross-sectional data only (see for example, Woessmann, 2003; Schuetz *et al.*, 2008) making the identification of the effect of school design problematic, given that country-specific unobservable factors are likely to bias the results. In the present paper, we exploit variations of the institutional setting across countries *and* over time. This allows us controlling for time-invariant country-specific factors that are possibly correlated with educational attainment and inequality. In addition, we expand the set of institutional dimensions in several directions, from pre-primary education to university access.

While most of the existing cross-country literature has investigated the impact of schools' institutional features on pupils' *competences*, using data from international testing surveys, the available datasets do not go backward

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[1] From the individual point of view, more educated people are not only more likely to have better labour market outcomes in terms of employability and wages (see the surveys by Card, 1999 and Harmon et al., 2003), but they also experience better health, fertility, well-being, lower probability of engaging in crime and other non-monetary outcomes (see Grossman 2006 and Oreopulos and Salvanes 2011 for a survey on non pecuniary returns). Moreover, education has wide spill over effects, generating not only *private*, but also *public* benefits. Increasing education is positively associated to economic growth, social cohesion, citizenship, and political participation (see, for example, Hanushek and Kimko, 2000; Krueger and Lindhal, 2001; Dee, 2004; Milligan et al., 2004; Lochner and Moretti 2004). Conversely, we ignore the issue of over-education, which may suggest that education is not always achieved up to an efficient threshold.

beyond two decades, thus preventing the study of earlier reforms. For this reason we measure *educational attainment in terms of completed years of school achieved*, which allows us to consider the effect of school reforms for individuals of different age groups without restricting ourselves to specific and (recent) cohorts for which data on competences are available.

Our main finding is that reforms are effective in shaping the entire distribution of educational attainments. By studying the impact at the mean and at the various deciles, as well as on synthetic measures of inequality (Atkinson index) and persistence (the intergenerational elasticity in education), we provide a complete picture of what a politician may learn from past experience on the equality/efficiency impact of each reform area. Reforms extending pre-primary schooling and/or expanding the access to education (via raise in leaving age for compulsory education or in tracking age, removing barriers to university admissions) and/or increasing student support to college exhibit positive correlation with average years of education in the population and negative association with inequality and intergenerational persistence. We label these reforms as *inclusive*. Reforms increasing school autonomy and accountability are also positively correlated with mean educational attainment, but also with inequality and persistence. We identify these reforms as *selective*. Politicians may have different preferences in the trade-off between mean achievement and its dispersion, and we highlight that political orientation of ruling parties is associated to prevailing policy stance with respect to the design of the educational system: left-wing oriented parliaments prefer inclusive policies, that raise the mean and reduce the variance of educational attainments, whereas right-wing oriented parliaments favour selective policies, that augment the mean as well as the variance.

Our work extends the existing literature in different directions. First, covering over 70 years of reforms our database expands the time span of most of previous studies, going backward as to 1930. Second, while most of the previous empirical works focus on one specific reform (duration of compulsory school, school tracking, accountability, to cite the main ones), this paper considers 18 dimensions of reform which are then grouped according to the intervention area of the underlying educational production function, constructing 6 summary measures of the reforming activity of governments in the following areas: pre-primary schooling, expansion of access, teacher qualification, school autonomy and accountability, university autonomy and student support. Third, we use our summary indices of reforms to characterise the menu of policy options available to policymakers, and we propose a taxonomy of reforms (*inclusive* vs. *selective*) based on their impact on mean and dispersion of educational attainments in the population affected by the reform. Fourth we investigate the correlation between the reform activities and the prevailing political orientations of parliaments and/or governments.

The paper is organized as follows. In section 2 we provide a brief review of the existing literature on school institutions and we discuss their expected effect on school attainment. In Section 3 we present the data, while section 4 illustrates the empirical strategy. Results are presented in section 5, while policy issues are discussed in section 6. The final section 7 summarises the main findings and suggests policy implications.

2.EDUCATIONAL INSTITUTIONS AND SCHOOLING OUTCOMES: PREVIOUS LITERATURE AND THEORETICAL EXPECTATIONS

This section reviews the economic literature on the impact of educational institutions on educational achievement, largely focussing on cross-country studies. The surveyed papers are grouped according to the specific institutional feature that we will investigate in ensuing parts of the paper. Our selection criterion is the availability of information over a longer time span and sufficient country coverage at European level. For this reason, we classify the institutional characteristics of school systems in six groups: pre-primary education; expansion of compulsory education and comprehensiveness; teacher qualification; school autonomy and accountability; university autonomy and selectivity; student funding. We borrow part of this classification from Krueger and Lindhal (2009) (for a general discussion see also OECD 2010). For each of these characteristics of the school system, we shall discuss their expected impact on educational attainment and on educational inequality, thus highlighting possible trade-offs between equity and efficiency (see also the related discussion in Woessmann, 2008). We summarise the main

findings of the literature in the text, leaving a more extended discussion into boxes in the Web Appendix B for the interested readers.

2.1 Pre-primary schooling

The economic literature seems to agree on the positive effects of pre-school education on both efficiency and equity of the education system. The basic idea is that of recursive productivity, since learning at one stage makes more productive the learning at the subsequent stages (*education begets education*). This implies that investments in early education are more cost-effective than those at later stages (see Cunha et al., 2006; Cunha and Heckman, 2007, 2008 and 2009). Given a higher expected return on investing in the education of disadvantaged children, improving the access to pre-primary schooling is expected to raise the average educational attainment in a country, because children will tend to stay in school longer at later stages.

The empirical literature, mainly based on US studies, confirms that interventions in early childhood are generally efficient, especially when targeted at disadvantaged children, and that the positive effects are persistent over time (see the thorough surveys in Currie, 2001 and Carneiro and Heckman, 2003). Results for other countries are fewer but tend to reach similar conclusions (see for example Leuven et al., 2010 and Berlinski et al., 2009).

2.2 Expansion of compulsory education and comprehensiveness

The empirical literature is almost unanimous in recognising that changes in the legislation regarding the number of years of compulsory education affect individual educational choices, because the majority of the population tends to comply with the requirements of the legislation (see Murtin and Viarengo, 2011). If the ultimate goal of the policy is the expansion of school attendance at later stages, this may conflict with some institutional designs where students are channelled into separate tracks, some of which prevents further advances into later stages of education. In this respect the literature suggests that postponing the allocation of students to tracks and/or the conversion of tracked secondary school systems into comprehensive ones yields positive effects on average educational attainments, benefitting once more students from poorer backgrounds. The impact of de-tracking policies onto the distribution of educational attainments is potentially mixed, since students in academic tracks tend to stay in school longer, while those in vocational tracks stay shorter but drop-out less. However, the empirical evidence suggests that early tracking entails some costs in terms of equity (see for example Brunello and Checchi, 2007; Hanushek and Woessmann, 2006). In fact, when students are allocated to separate schools according to their ability, more able pupils will benefit from being with each other, while low ability pupils loose from not having an adequate peer group around them (see Manning and Pischke, 2006, for a discussion). If different school types are hierarchically structured by performance, the learning of disadvantaged students allocated to lower tracks may be hampered by poorer educational quality and the lack of benefits from peer group (OECD, 2007). Early tracking is thus likely to affect educational inequality, since it reinforces the ability gaps between pupils coming from different family backgrounds

2.3 Teacher qualifications

Measuring teaching quality is complicated because the most common observable teachers' characteristics (such as gender, age, qualifications or experience) appear to be relatively uncorrelated to (unobservable) teachers' quality as estimated from students' testing scores, once family and school effects are taken into account (Krueger, 1999; Rivkin, Hanushek and Kain, 2005). There is a large literature that investigates the role of teacher quality and teacher incentives in improving educational outcomes, considering test scores as outcome of interest (Hanushek and Rivkin, 2006).

The possibility of attracting better applicants into the profession, combined with stimulating their effort through appropriate wage policies, explains the correlation between teachers' pay and students' performance observed in a cross-country perspective (Dolton and Marcenaro-Gutierrez, 2011). Most of the recent policy recommendations to improve educational systems point to attracting, motivating and retaining good teachers. However, there are significant differences in country practices with respect to admission to the profession (national exams, university certification, on the job training), to mentoring at the beginning of the career and to improving professional development throughout the career (OECD, 2005).

Better selected and more motivated teachers should increase the quality of education they provide, thus inducing an increase in the (mean) educational investment due to the rise in the expected return of human capital in the labour market.

2.4. School accountability and autonomy

There are various instruments to increase school accountability. Among them, the most studied is the presence of central examination, because it allows for cross-school comparisons and enhances the degree of school choice for students and their families. Some countries have also associated teacher incentives scheme to the results of students' assessments, but their effects are more controversial. Overall the literature on student competences recognises a positive association between measures of accountability and students achievements, because of the higher incentives provided by the public visibility of students' and schools' exams (Bishop 1997; Jürges et al. 2005; Woessmann, 2003, 2005). However, despite this evidence showing that the introduction of test-based accountability increases average student achievement, different studies have found a negative impact on equality, since schools may become more selective in order to improve their scores, not necessarily changing the quality of the teaching (Hanushek and Raymond, 2004; Ladd and Walsh, 2002)

School autonomy (intended as decentralisation of decision making power) is typically associated to increased mean performance as well as increased dispersion (see for example Hanushek et al., 2011). The ability to better adapt existing resources to local needs explains the superior performance of successful schools and teachers. However there are schools and/or classes falling behind, which are responsible for the potential worsening of the bottom tail of the distribution. Few studies highlight the potential complementarity between autonomy and accountability, since the latter represents a check to the opportunistic behaviours offered by the latter.

While school autonomy may induce adapting teaching techniques and content to the social environment thus lowering costs of attendance, it has ambiguous effect on quality, especially in the absence of centralised control. On the contrary, accountability by its very nature leads to a more efficient use of resources, raising the quality of education for given resources but this may favour only those parents who are aware of quality issues and interested in greater school choice.

2.5. University autonomy and selectivity

Tertiary educational systems are more differentiated across countries compared to primary and secondary school levels. Focussing on universities (ISCED 5-A and 6), most of the comparative literature discusses the relationship between universities autonomy and competition. While continental Europe is characterised by centralised and homogenous systems, Anglo-Saxon countries have more heterogeneous systems, with best universities competing for top positions in international rankings and large disparity in college quality. Allowing more autonomy to universities implies greater differentiation in admission criteria, resource availability, and attractiveness for best researchers. While all these ingredients are positively associated with research performance and scientific productivity (Aghion et al., 2010), the aggregate effects on individual incentives to acquire education are less clear.

Raising the signalling value of college degrees may represent a stronger incentive for the "happy few" in the expectation of higher earnings, but it may also discourage potential students from disadvantaged backgrounds.

2.6. Financial support to students

Several studies have suggested that liquidity constraints may prevent children of poorer households from proceeding in their educational career up to secondary and tertiary levels (Carneiro and Heckman, 2002; for a recent review of the literature see Lochner and Monge-Naranjo, 2011). The empirical difficulty in assessing the extent of constrainedness is related to disentangling the contribution of other factors (either biological and/or cultural) to generating intergenerational dependence of children choices from parental conditions.

Without a clear understanding of how financial constraints work in limiting the choice set (through heterogeneity in risk aversion correlated with wealth possession? through debt aversion? through financial market imperfections? through lack of collaterals? through imperfect information about future potential gains?), it is difficult to assess which are the most effective policies to increase the equality of opportunities. Chapman (2006) reviews the main arguments in support of public interventions to reduce financial constraints and/or the risk associated to the educational investment. He argues that (almost full) subsidisation of tertiary education (through low or nil tuitions fees, as prevalent in many European countries) is fiscally regressive and not equitable from a social point of view. On the other extreme, full cost charged onto individual students, with publicly guaranteed loans to students, may reduce college attendance, disproportionately among poorer backgrounds. In his view both extremes can be avoided by resorting to income contingent loans (often indicated in policy debate as *graduate tax*). Olivera et al. (2007) review the existing student loan situation in most OECD countries, showing that when available, loan systems are designed not only to limit individual financial risks but also to provide a direct subsidy (through interest rate subsidisation, high income thresholds for repayment and long amortisation period). Despite this, in many countries the take-up rate remains low, students preferring part-time work as alternative source of funding. The alternative of student grants with universal coverage is available only in a limited number of countries (US, Scandinavia, Netherlands).

In principle a lower cost of attendance and/or a reduction of the risk associated to higher education should produce a positive mean impact because more students in higher education (mostly from financially constrained families) should apply to colleges. Depending on the fraction of students which is spontaneously attending colleges, the impact on the dispersion of educational attainment may be positive or negative.

2.7. Discussion and summary

We summarise the main findings of the previously reviewed literature in table 1. If we consider a standard model of optimal educational choice (Card 1999), rational agents choose to stay in school up to the point when the marginal cost equates the marginal benefit, conditional on not being financially constrained. Different educational reforms affect this optimality condition through four possible channels:

1) compelling students to school (which is typically enforced when there are no outside options)
2) lowering costs of attendance (both monetary and/or psychological ones)
3) relaxing financial constraints (mostly relevant for tertiary education)
4) increasing marginal return of education (through an improvement of the quality of schooling).

If these effects are heterogeneous in the population, then the reforms also have an impact on the distribution of educational attainments.

Table 1: Educational reforms and expected impact on educational attainment

area of reform	affecting investment in education	expected impact
pre-primary education	enhances productivity of later school stages, inducing lower costs of subsequent attendance	student stay in school longer (more in the case of poor backgrounds)
expansion of compulsory education and de-tracking	reduces drop-out (for compliers), reduces school stratification and avoids students being trapped in closed (vocational) tracks	student stay in school longer (effects being concentrated in the case of poor backgrounds) and drop-out less
teacher qualification	increases quality of education and raises the expectations with respect to future schooling career	positive effect on mean educational attainment – richer backgrounds may take advantage, because of better access to information
school autonomy and accountability	more efficient use of resources improves the quality of education - adapting teaching contents to the social environment lowers costs of attendance	uneven effects at mean, but increased variance, due to possible screening and/or sorting of students
university autonomy and selectivity	raises the signalling value of tertiary education	uneven effects (stronger competition to access better universities may translate in discouragement in the bottom tail)
student financial aid	lower cost of attendance and/or reduced risk associated to higher education	positive mean impact – uncertain effect on variance (depending on initial conditions)

There are other important institutional dimensions of the school system that we would have liked to include[2], but we were unable to collect information with sufficiently long time span and/or country coverage. Even if one could account for actual practices inferred from current data, it is impossible to go backward for more than two decades.

On the contrary, we make use of representative samples of the entire population to obtain the whole distribution of years of education across country and age cohorts. This has at least two advantages. When compared to interpolation of census years through permanent inventory methods (as done in Barro and Lee 2010) we gain more detailed information about intermediate degrees, which may also have changed overtime (in terms of length of curricula and admission). Given the available information, we also take into account failed attempts and/or early drop out events, which typically remain hidden when using the maximal educational attainment as unique source of information. The other advantage is that we obtain information on educational attainment going back to the beginning of previous century. When survival rates are correlated with education, this may constitute an overestimate of the educational attainment of the entire population, which can be partially offset by top-censoring our data on age (which however do not change results significantly).

The main drawback is that we take into account only the quantity dimension of human capital, while we would have liked studying the evolving distribution of actual competences across the age cohorts. The only existing surveys on adults' competences (IALS and ALL) have too few observations per cell when we disaggregate by age, gender and educational attainment. As many scholars in the field, we are looking forward to repeat our analysis when PIACC data will be made available in 2013[3].

3. DATA AND DESCRIPTIVE STATISTICS

Our analysis combines microdata drawn from four international surveys (see section 3.2) with a newly created dataset collecting information on several institutional reforms of school systems over the last 70 years. Our sample includes 24 European countries/regions (Austria, Belgium (Flanders), Belgium (French), Czech Republic, Denmark, Estonia, Finland, France, Germany, Great Britain, Greece, Hungary, Ireland, Italy, Latvia, Netherlands, Northern Ireland, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden) observed over the 1929-2000 period. In the following two sub-sections we describe our original dataset on school institutions (section 3.1) and the microdata on individual educational attainment used for the analysis (section 3.2).

3.1 A dataset on educational reforms

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[2] For example school competition, instructional time, grade repetition, class composition, class size and resource availability.
[3] However, a potential problem when using these datasets to measure competences for different birth cohorts is that competences and skills – opposite to formal education - change over the life course, making it difficult to separate the cohort effect and the age effect. Banks and Mazzonna 2012 show that formal education contributes (in causal sense) to the level of competences, using compulsory reform of education as instrumental variable in the case of UK.

In institutional comparative analysis it is always difficult to provide a thorough and concise description of the salient features of a (national) system, and the same trouble concerns the analysis of educational systems. In addition, if institutional aspects have to be correlated with outcome dimensions (like educational attainment, employment probability, wage or health), they need to be measured on a quantitative scale, either ordinal or cardinal. A well-established methodology consists of identifying the salient features of an institutional practice, assigning a subjective score to each aspect and aggregating them into a single index.[4] An alternative strategy is counting the reform events, signing the intended direction of the reform (Bertola and Ichino 1995). If we exclude Oliveira et al. (2007), at the best of our knowledge we are not aware of other attempts to build summary indices capable to account for salient features of national educational systems.[5] Despite a wide information available for each country in recent years (think of *Education at a Glance*, which is yearly published by OECD since 1996), it is not easy to aggregate single measures, especially when input, process and output variables are all mixed.

In the present paper we pursue a different strategy. We abandon the idea of being able to *fully* characterise a (national) educational system by means of level indicators. While everyone may be convinced that 10 years of compulsory education is better than 8 years, it is almost impossible to ascertain whether one country is requiring more teacher qualification than another.[6] Conversely everyone agrees on the fact that introducing (or raising) teacher required qualification should improve the quality of the education provision. Thus we combine level measures (such as beginning/leaving age and duration of compulsory education, tracking age) with temporal variations associated to the occurrence of school reforms in a specific country/year. In the regression analysis, the level dimension is anyhow absorbed by country fixed effect, while cohort effects and time trends are also absorbed by birth year fixed effect and country specific time trend. The remaining variations (along a longitudinal dimension) should identify the impact of each institutional dimension of the educational system, from kindergarten to university.

Information on the historical development of each national education system is drawn from different sources. Our primary source is *Eurybase*, the Eurydice database (www.eurydice.org) that provides detailed information on European education systems and policies. In particular, we use country-specific descriptions of national education systems[7] and thematic studies on specific institutional features (see APPENDIX A for a description of the reforms included in the analysis and the related sources). We integrate this information using other international sources, such as the United Nations Educational, Scientific and Cultural Organization (*UNESCO*) country reports, or OECD Education at a Glance, and using country specific documents and direct contact with national experts.

The resulting original dataset contains yearly observations over the 1929-2000 period for 24 countries on 18 institutional features of countries' school systems. The specific types of institutional features and reforms considered in the paper are summarised in Table 2, which also specifies the age that we assume individuals be initially affected by the reform (fourth column). Data are grouped by area of intervention (first column). In the final column we have grouped the reforms according to their broad aim as reforms pursuing universalism, selectivity, accountability, autonomy or quality.

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[4] This is for example the methodology adopted by the OECD in measuring the supply of tertiary education (Oliveira et al. 2007), the employment protection legislation (OECD 2004a), the degree of wage coordination (OECD 2004b) and the product market regulation (Nicoletti et al. 2000).

[5] On the contrary this is a common practice in the sociological literature, where however educational systems are characterised by indices obtained by aggregating individual behaviour, thus exposed to the objection of endogeneity. See for example Shavit et al. 2009 or Bol and vanWerfhorst 2011.

[6] The World Bank is currently promoting a project intended to reinforce the comparability and the benchmarking of national educational systems (project SABER). It is based on assigning different dimension of teacher practices to an ordinal scale, based on interviewing national experts.

[7] National Education System Descriptions are highly detailed reports on education systems covered by the Eurydice Network and updated annually by the National Units in the Network. Each country description is structured into 10 subject-based chapters: 1. Political, social and economic background and trends; 2.General organisation of the education system and administration of education; 3. Pre-primary education; 4. Primary education; 5. Secondary and post-secondary non-tertiary education; 5. Tertiary education; 6. Continuing education and training for young school leavers and adults; 7. Teachers and education staff; 8. Evaluation of educational institutions and the education system; 9. Special education support; 10. The European and international dimension in education. The reports also contain a summary of relevant legislation, a list of institutions, a glossary and a bibliography round off the description of each education system.

Table 2: Institutional Features of education systems: list and description

AREA	REFORM	DESCRIPTION	TARGET POPULATION	REFORM ASPIRATION
PREPRIMARY SCHOOL	Pre-primary expansion	Fees reduction; construction of new pre-primary schools; laws obliging to make pre-primary school available to all citizens; incorporation of pre-school into schooling systems	age 3	Universalism
	Beginning age of compulsory education	Entry age into compulsory formal education	age 6	Universalism
EDUCATION EXPANSION	Duration compulsory education	Number of years of compulsory school	age 10	Universalism
	Tracking age	Age at first tracking	age 10	universalism/ selectivity
	Standardised test (for career advancement)	Presence of national standardised tests for taking decisions about the school career of pupils	age 6	universalism/ selectivity
	Expansion of university access	Open access from vocational high schools; geographical expansion of universities; creation of polytechnic institutions providing non-university vocational higher education	age 15	Universalism
SCHOOL TEACHER QUALIFICATION	Pre-primary school teacher qualification	Increase educational requirement to be employed as a pre-primary school teacher	age 3	quality assurance
	Primary school teacher qualification	Increase educational requirement to be employed as a primary school teacher	age 6	quality assurance
	Secondary school teacher qualification	Increase educational requirement to be employed as a secondary school teacher	age 10	quality assurance
SCHOOL AUTONOMY AND ACCOUNTABILITY	Standardised test (for other purposes)	Presence of national standardised test for other purposes(e.g. measuring performance of schools)	age 6	Accountability
	School evaluation	Creation of structures for the steering and evaluation of its education system; carrying out of independent external inspections and evaluations; legislations strengthening the importance of school evaluation; measurement of school performance through the testing of samples of students	age 6	Accountability
	School autonomy	Reforms increasing autonomy in school management and decision-making processes	age 6	Autonomy
	Teacher autonomy	Increase degree of autonomy for teacher in primary and secondary education	age 6	Autonomy
UNIVERSITY FINANCIAL SUPPORT	Increase grant size	Increase financial support at tertiary level through grant	age 15	Universalism
	Loan component to grant component	Dimension of the loan component to the grant component for financial support at tertiary level	age 15	universalism/ selectivity
	Interest rate	Interest rate charged to loans for tertiary education	age 15	universalism/ selectivity
UNIVERSITY AUTONOMY AND SELECTIVITY	Selectivity in university access	Introduction of admission tests; introduction of national exam for entry to higher education; entrance to higher education based on candidates' marks at exit of secondary school	age 15	Selectivity
	Index of university autonomy	Autonomy at tertiary level in the following dimensions: budget, recruitment, organization, logistic, courses organization, self - evaluation and development plans	age 15	selectivity / autonomy

Table 3 reports some summary statistics of the reform variables and it also indicates whether a variable is measured in levels (beginning/leaving age and duration of compulsory education, tracking age) or as an index (taking a value of zero in the absence of a specific aspect and a value of one when it is present). When legislators have repeatedly reformed a specific dimension over the sample period, we created step dummies, which are then summed over the years, with a final normalisation yielding a unitary range of variation.[8] The variable "Index of university autonomy" is the average of indices characterising seven separate dimensions (budget, recruitment,

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[8] To make an example, take the case of "Pre-primary expansion" in Finland: we find record of significant reforms over this dimension in 1973, in 1985 and in 1999. We therefore construct a variable, which is zero before 1973, 1/3 between 1973 and 1984, 2/3 between 1985 and 1998 and 1 afterward. We then match this variable to individuals born 3 years earlier (since the reform is assumed to affect students when 3 year old): those born earlier than 1970 will get a 0 value for this reform, and so on.

organization, logistic, courses organization, self-evaluation and development plans), which are then rescaled in order to retain unitary variation. Plots of each reform variable are shown in figures B1 to B6 in Web Appendix B.

Using as a starting point the review of the literature presented in Section 2, we classified the available reforms of the school system into six groups according to their aim and target population and we created six "add-on" summary indices. In particular, the six dimensions are: 1) expansion of the pre–primary education, 2) expansion of the school system *latu sensu*, 3) requirements in terms of teacher qualifications, 4) school autonomy and accountability, 5) autonomy and selectivity of tertiary education, 6) financial support to university students.

In order to construct the indices, we first normalised between countries all the variables in a 0–1 interval and then we created the "add-on index" as the average of the single components.[9] These indices affect three main dimensions of the educational process. Some are intended to improve inputs quality (pre-primary childcare, teachers' qualification), others are aimed at boosting the educational output (expansion, student financial aid) and the remaining indices possibly enhance the efficiency of the organisation (school autonomy, university autonomy). In our view, this classification allows to identify basic dimensions which well characterise modern educational systems.

For some variables related to university access we lack information for 7 newly entrants in the European community (Czech Republic, Estonia, Hungary, Latvia, Poland, Slovak Republic, Slovenia). The decomposition of the standard deviation into the "between" and the "within" components indicates that there is sufficient variation within countries. In Table 3 we report the pair-wise correlation matrix for the synthetic indices. Since all indices are upward trended (by construction), they exhibit positive correlation.

Table 3: Descriptive Statistics of the variables describing national school systems – 1929-2000

	Mean	Std. Dev. (overall)	Std. Dev. (between)	Std. Dev. (within)	Min	Max	Obs.	N. of countries
Pre-primary expansion	0.403	0.450	0.221	0.395	0	1	1728	24
Beginning age compulsory education (year)	6.376	0.761	0.705	0.320	4	9	1728	24
Pre-primary summary index (normalised sum)	*0.464*	*0.233*	*0.105*	*0.209*	*0*	*1*	*1728*	*24*
Duration compulsory school (years)	8.146	1.871	1.100	1.530	3	13	1728	24
Tracking age (year)	13.119	2.268	1.687	1.555	6	16	1728	24
Standardised tests (for career advise)	0.120	0.316	0.203	0.246	0	1	1728	24
Expansion university access	0.321	0.422	0.153	0.394	0	1	1728	24
Expansion summary index (normalised sum)	*0.749*	*0.114*	*0.067*	*0.094*	*0.433*	*1*	*1728*	*24*
Pre-primary teacher qualification	0.275	0.402	0.211	0.345	0	1	1728	24
Primary teacher qualification	0.382	0.425	0.192	0.381	0	1	1728	24
Secondary teacher qualification	0.419	0.446	0.237	0.381	0	1	1728	24
Teacher summary index (normalised sum)	*0.359*	*0.353*	*0.135*	*0.328*	*0*	*1*	*1728*	*24*
School autonomy	0.181	0.383	0.167	0.347	0	1	1728	24
Teacher autonomy	0.245	0.430	0.310	0.305	0	1	1728	24
Standardised tests (for school accountability)	0.104	0.305	0.157	0.263	0	1	1728	24
School evaluation	0.121	0.323	0.100	0.307	0	1	1728	24
School autonomy summary index (normalised sum)	*0.163*	*0.262*	*0.135*	*0.227*	*0*	*1*	*1728*	*24*
Selective university access	0.371	0.469	0.361	0.311	0	1	1224	17
Index of university autonomy (mean over 7 dimension)	0.157	0.274	0.090	0.259	0	0.857	1296	18
University autonomy summary index (normalised sum)	*0.287*	*0.353*	*0.230*	*0.274*	*0*	*1*	*1224*	*17*
Increase grant size	0.475	0.485	0.342	0.353	0	1	1224	17
Increase loan to grant component	0.383	0.484	0.431	0.244	0	1	1224	17
Increase interest rate on student loans	0.226	0.398	0.346	0.213	0	1	1224	17
Student financing summary index (normalised sum)	*0.622*	*0.252*	*0.217*	*0.138*	*0*	*1*	*1224*	*17*

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[9] In case of continuous variables (like "beginning age of compulsory education", "compulsory education", tracking age") the original variables are initially normalised to reduce their range of variation between 0 and 1 (according to the following transformation $y = \frac{x - \min(x)}{\max(x) - \min(x)}$) and then averaged with the other indices. When a variable is negatively correlated with the educational choice (like "beginning age compulsory education", "loan to grant component", "interest rate"), the variable has been ridefined as $(1 - x)$.

Table 4: Pair-wise correlation between reform summary indices – 24 countries – 1929-2000

	Pre-primary summary index	Expansion summary index	Teacher summary index	School autonomy summary index	University autonomy summary index †	Student financing summary index †
Pre-primary summary index (normalised sum)	1					
Expansion summary index (normalised sum)	0.5714*	1				
Teacher summary index (normalised sum)	0.6033*	0.5979*	1			
School autonomy summary index (normalised sum)	0.3756*	0.3222*	0.4418*	1		
University autonomy summary index (normalised sum) †	0.3221*	0.3545*	0.4716*	0.3268*	1	
Student financing summary index (normalised sum) †	0.0592*	0.0337	0.1516*	-0.0384	0.0028	1

Note: * indicates statistically significant at 5%

3.2 Microdata on educational attainment

Data on individual school attainment and background characteristics come from four international surveys: the European Social Survey (ESS)[10], European Union Statistics on Income and Living Conditions (EUSILC)[11], International Adult Literacy Survey (IALS)[12], and International Social Survey Programme (ISSP)[13]. Not all countries are covered in all the four surveys; for a list of the specific countries included in every survey, see table B1 in Web Appendix B.

For each survey we use all the available waves containing information on individuals' education and background characteristics, such as gender, age, parents' education[14] and country of birth. To quantify educational attainment, we use an indicator of the duration of formal schooling, measured by the number of actual (full-time equivalent) years of education completed[15]. The main advantage of this variable is that years of schooling can be easily computed and compared across countries, unlike other measures capturing the qualifications achieved that depend on the specific institutional structure of the different educational systems and are therefore hardly comparable in a cross-country setting. Moreover, the number of years of completed education is a continuous-like variable that allows generating inequality indices and investigating the shape of its distribution.

In order to maximise the number of observations available per year of birth, we pool all surveys' waves together[16] and we create a pseudo panel where the time dimension is given by birth cohorts. We augment individual level data with the variables on school systems that we have constructed by matching each individual to the institutional environment that her cohort faced when attending each school grade (see column 4 in table 2).Presumably, investment in education ends when adulthood is reached and thereafter formal education remains unchanged over the life cycle of every individual. We can therefore exploit the variation in educational outcomes of different cohorts across countries to identify the effect of the characteristics of the school design. Assuming that formal educational attainment does not change after age 25 we restrict the sample to individuals aged at least 25 at the date of the survey, in order to minimise the number of people who did not complete their study when interviewed (see also Brunello, Fort and Weber, 2009). As a result, the oldest cohort of individuals included in our sample was born in

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[10] ESS is biennial survey covering over 30 mostly European countries and providing detailed information on individual attitudes, beliefs, and behaviour collected from nationally representative population samples. It consists of repeated cross-sections initiated in 2002/2003 (1st round) and then carried on in 2004/2005 (2nd round), 2006/2007 (3rd round) and 2008/2009 (4th round). The survey mainly focuses on people's attitudes and values, but it also contains several variables capturing the social background of respondents as well as their partners and parents. For more information, see http://www.europeansocialsurvey.org)

[11] EUSILC is a collection of comparable multidimensional microdata covering EU countries plus Iceland and Norway. EUSILC is a project developed by EUROSTAT, run yearly since 2004 and including both cross-section and longitudinal surveys. For more information, see http://epp.eurostat.ec.europa.eu/portal/page/portal/microdata/eu_silc

[12] IALS is a survey collecting information on adult literacy in representative samples for some OECD countries. It was implemented in different years - 1994, 1996, 1998 - for different countries using a common questionnaire. The central element of the survey is the direct assessment of the literacy skills of respondents, but the background questionnaire also includes detailed information on individual socio-demographic characteristics. For more information, see http://www.statcan.gc.ca/dli-ild/data-donnees/ftp/ials-eiaa-eng.htm)

[13] ISSP is a continuing annual programme of cross-national collaboration on surveys covering a wide range of topics. Data collection is annual, ranging from 1985 to 2010, covering 26 countries, most of which are surveyed only in a subset of years. For more information, see http://www.issp.org/index.php

[14] Note that information on parental background, in almost all the surveys, is recorded as a discrete variable indicating the highest level of schooling completed and not as years of full time education.

[15] The relevant question in the surveys is "During your life time how many years of formal education have you completed, beginning with grade 1 and not counting repeated years at the same level".

[16] More specifically, for ESS we pooled all the four waves; for ISSP we pooled the 1991, 1992, 1993 and 1999 waves that are the only waves containing information on parental background. For EUSILC information on parental background was only available in a special 2005 module, which forced us to use this wave only. For IALS, we only have one wave available.

1926,[17] while the youngest one includes individuals born in 1985. We also drop individuals reporting an amount of education exceeding 25 years of schooling, assuming that this is the highest reasonable duration of a complete educational career, starting at age 5 or 6 and ending with a Ph.D.; incidental additional years of education do not reflect real improvements but either misreported data or repeated years. Finally, for each country we only keep individuals who live in their country of birth, thus excluding foreign born people[18]: in this way, we minimize the risk of assigning to individuals a false educational system. Table 5 reports summary statistics of the individual variables included in the analysis and it can be noticed that the four datasets are rather consistent.

Table 5: Descriptive statistics – ESS, EUSILC, IALS, and ISSP

	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max
	ESS					**EUSILC**				
Birth year	109415	1955	14.83	1926	1985	159895	1960	11.14	1939	1980
Age	109299	49.90	14.77	25	84	159895	45	11.14	25	66
Female	109415	0.53	0.50	0	1	159895	0.52	0.50	0	1
Years of education	109415	12	4	0	25	159895	12.51	4.46	0	25
Highest qualification achieved										
Primary education or below	109097	0.15	0.36	0	1	159786	0.15	0.36	0	1
Lower secondary education	109097	0.19	0.39	0	1	159786	0.14	0.35	0	1
Upper secondary education	109097	0.38	0.49	0	1	159786	0.45	0.50	0	1
Tertiary education	109097	0.28	0.45	0	1	159786	0.25	0.44	0	1
Parental highest qualification achieved										
Primary education or below	109415	0.35	0.48	0	1	159895	0.48	0.50	0	1
Lower secondary education	109415	0.22	0.41	0	1	159895	0.17	0.38	0	1
Upper secondary education	109415	0.28	0.45	0	1	159895	0.24	0.43	0	1
Tertiary education	109415	0.15	0.36	0	1	159895	0.11	0.31	0	1
	IALS					**ISSP**				
Birth year	31592	1953	11	1926	1973	28200	1949	13	1926	1974
Age	31592	43	11	25	68	28200	45	13	25	73
Female	31592	0.54	0.50	0	1	28200	0.52	0.50	0	1
Years of education	31592	12.04	3.49	0	25	28200	11.28	3.91	0	25
Highest qualification achieved										
Primary education or below	31308	0.11	0.31	0	1	21543	0.06	0.24	0	1
Lower secondary education	31308	0.29	0.46	0	1	21543	0.48	0.50	0	1
Upper secondary education	31308	0.35	0.48	0	1	21543	0.32	0.47	0	1
Tertiary education	31308	0.25	0.43	0	1	21543	0.14	0.34	0	1
Parental highest qualification achieved										
Primary education or below	31592	0.33	0.47	0	1	28200	0.20	0.40	0	1
Lower secondary education	31592	0.35	0.48	0	1	28200	0.59	0.49	0	1
Upper secondary education	31592	0.22	0.41	0	1	28200	0.15	0.35	0	1
Tertiary education	31592	0.11	0.32	0	1	28200	0.07	0.25	0	1

In order to characterise the distribution of the educational attainment, we have calculated measures of dispersion of educational attainment (measured in terms of years of education) by countries and birth-cohorts. More specifically we compute two inequality indices: the Gini concentration index (see Thomas *et al.*, 2001; Checchi, 2004; Morrison and Murtin 2010; Földvári and Van Leeuwen 2011; see also Meschi and Scervini, 2010 for other applications of inequality measures to the educational context) and Atkinson indices with inequality aversion characterised by $\varepsilon = 2$. The temporal evolution of our dependent variables is reported in figure B.7 in Web Appendix B.

Figure 1 shows the average level of the two inequality indices by country. Central Europe (Austria, Germany, Czech and Slovak Republic) is the least unequal area (possibly a long run consequence of the early introduction of compulsory education in the Prussian empire)[19], while the Mediterranean area (Portugal, Spain, Greece and Italy) is
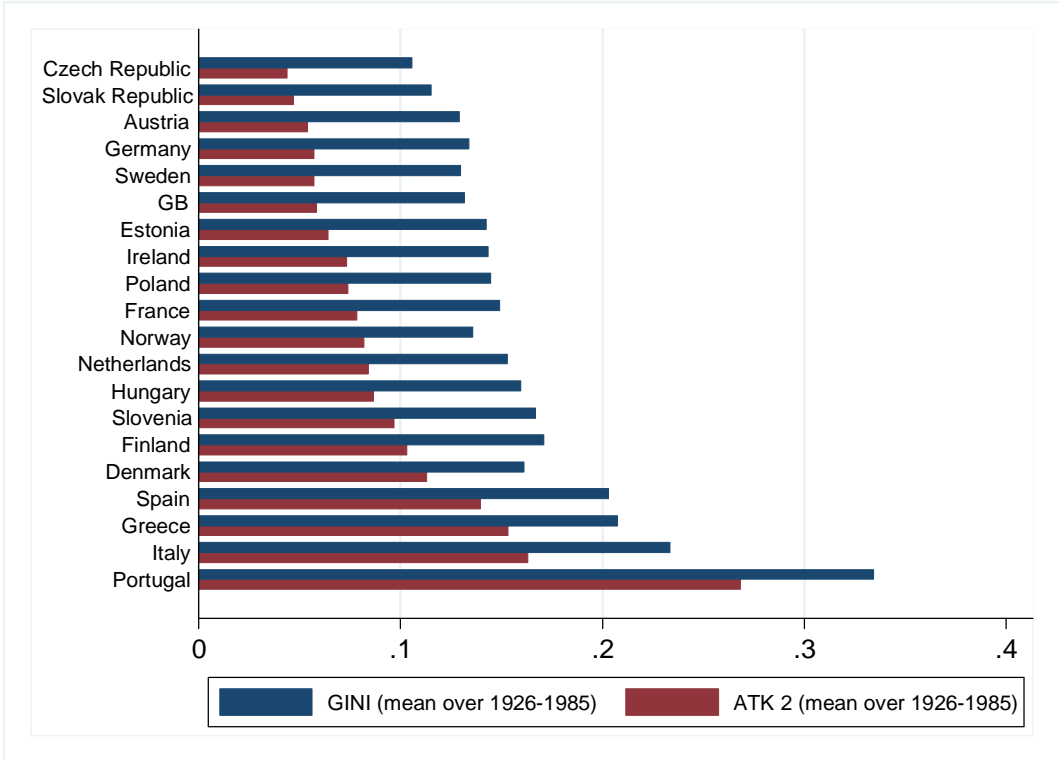
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[17] Since our institutional measures start in 1929, the first individual aged 3 facing pre-primary education has to be born as earliest as 1926. The match with reforms affecting tertiary education could concern people born in 1914 and aged 15 in 1929 (and we have few of them in our dataset). However consistency would have required selecting only individuals staying in school beyond compulsory education, thus distorting the sample even further (the first distortion occurring because of different life expectancies by educational attainment).

[18] Foreign born people are about seven percent of the total in ESS, six percent in EUSILC and five percent in IALS.

[19] The first introduction of compulsory education is attributed to Fredrick the Great, who introduced it in Prussia in 1763, followed ten years later by the Austrian Queen Mary Theresa.

the most unequal one (a possible legacy of the Spaniard domination). Within the list it is impossible to rank the countries, because the confidence intervals overlap. Also notice that the Gini index is often unable to discriminate between different situations, since it assigns more weight to the centre of the frequency distribution. On the contrary, the Atkinson index (with the aversion parameter $\varepsilon = 2$) gives relatively more weight on the lower tail of the distribution, the illiterates, and less weight at the top, the graduates. Using this index a clear and well defined ranking of countries emerges. For this reason, we prefer to use Atkinson index in the following empirical analysis.

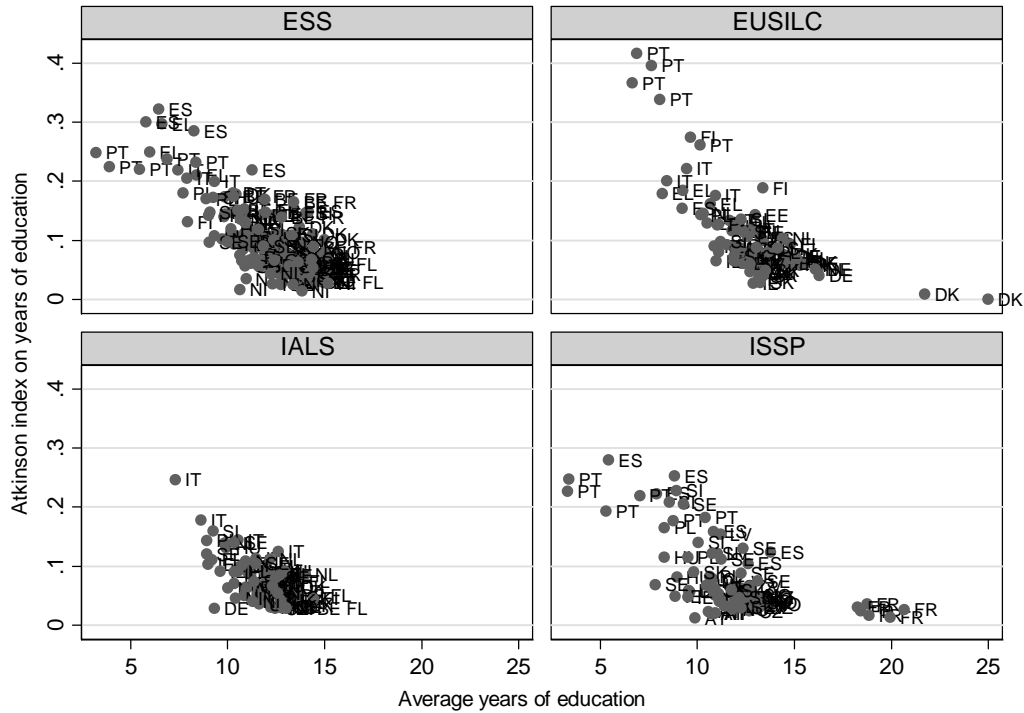**Figure 1: GINI and Atkinson index (ε=2) by country**

Note: Atkinson and GINI indices computed on cells containing at least 100 observations

Figure 2 scatter plots the relationship between average years of education and the Atkinson index[20] calculated on the distribution of the same variable for each country, decennial age cohort and survey. Some stylised facts emerge from the observation of this figure. First, we observe a remarkable variation in educational outcomes across countries, both in terms of levels and dispersion. Second, we notice a negative relationship between average years of education and education inequality, suggesting that the increase in school attainment occurred over the last century has been generally associated with a decline in inequality (Breen and Jonsson 2007). However, also the extent of this relationship varies across nations, possibly due to the difference in their institutional setting. Countries of late schooling (like Portugal, Italy and Spain) are characterised by the highest levels of educational inequality, while eastern countries benefited by free access to education in the communist era which translates in lower inequality. Eventually, by comparing the four survey datasets, we notice that they provide different snapshots of the national distribution, depending on the period when each survey was conducted.

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[20] Both Gini and Atkinson indices are not strictly applicable to the distribution of years of education, since such an endowment cannot be redistributed interpersonally. However their use as descriptive statistics indicator is widespread and we will follow common practice.

Figure 2: Mean years of education and Atkinson inequality index, by country and 10-years cohorts

4. THE EMPIRICAL STRATEGY

Our aim is to estimate the effect of implementing alternative educational policies on the educational attainment of the affected population, proposing a possible interpretation of these associations as a causal mechanism. We conduct our analysis using data for 24 countries over 70 years and we identify the effect of reforms exploiting the cross-country heterogeneity in the timing of their implementation. More specifically, we correlate changes in educational attainment of subsequent cohorts in each country with possibly occurred policy changes.

The intuition behind our identification strategy is that used in the traditional diff-in-diff approach.[21] Suppose we had two countries A and B identical in any respect at time t. At time $t+1$ an educational reform is exogenously introduced in country A. The effect of this reform can be then estimated comparing changes in mean educational attainment between year t and $t+1$ in the two countries. In this setting country B provides a perfect counterfactual situation for country A in the absence of the reform. In our case we are dealing with a multitude of educational reforms introduced over long time period in several countries and thus we cannot clearly define a treatment and a control group. Nevertheless, we can adopt the same intuition in our empirical exercise where we compare changes in educational attainment over time across countries that introduced reforms in the school system at different points in time. In this way, at every moment, countries that are not affected by policy changes constitute a suitable counterfactual for the countries where a policy change occurs.

This strategy provides an unbiased estimate of the causal effect of the policy under two identifying assumptions. The first one is that on average changes in individual outcomes of two consecutive cohorts in different countries would have been the same in the absence of the reforms. In our analysis we account for systematic differences across countries in the evolution of the dependent variable[22] by introducing country specific time trends. The second assumption is that the treatment (i.e. having been exposed to a particular institutional school setting) is assigned to individuals exclusively based on the exogenously given date of birth. If the reforms were implemented based on past levels of educational attainment, then the exogeneity hypothesis would be violated. We tested this assumption by

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[21] For a critical review of the potential bias involved in using diff-in-diff estimation in cross-country analysis see Bertrand et al. 2004.
[22] Systematic differences in the *levels* are accounted for by country fixed effects.

regressing the alternative reform indicators on past levels of educational attainment (5-year lags) controlling for country and cohort fixed effects. The results (see table B.2 in Web Appendix B) reassure us that almost all the reforms included in the analysis are not related to changes in countries' educational attainment. This obviously does not prevent the possible occurrence of country specific shocks affecting the de-trended dependent variable, while at the same time triggering the introduction of the policy reform. Thus a causal interpretation of our correlation holds as long as we can exclude this event.

In practice, we use individual level data matched to our original dataset on school reforms (as described in section 3) to estimate the following equation:

(1)
$$h_{ict} = \alpha + \beta \cdot F_{ict} + \sum_{j=1}^{k} \gamma^j \cdot \mathbf{R}_{c,t+n}^j + \theta \cdot PB_{ict} + \delta_c + \delta_t + \delta_s + \tau \cdot \delta_c + \varepsilon_{ict}$$

where i, c and t denote individual, country and birth cohort respectively; h_{ict} is our outcome of interest (years of schooling of individual i in country c born in year t), F_{ict} is a gender indicator (1=female), $R_{c,t+n}^j$ is the index of the reform activity in area j in country c at time $(t+n)$ where n captures the age at which the reforms are supposed to affect individuals educational career[23]; PB_{ict} is a measure of family background (captured by a dichotomous variable that takes value one if at least one parent has tertiary education), δ_c, δ_t and δ_s are country, birth year and survey fixed effects (controlling for all time-invariant country specific characteristics and for all the time-specific shocks that affected all countries simultaneously), and $\tau \cdot \delta_c$ is a country specific time trend. Finally ε_{ict} is the stochastic error term.

Starting from the classification of basic reforms presented in the previous section, we run two separate sets of regressions: one for the reforms of the primary and the secondary level of education and one for the reforms of the tertiary level of education. We perform the analysis both with the single reform variables and with the synthetic indices. Other than for theoretical reasons, the chosen grouping is justified by data availability, since for reforms on tertiary education we have a smaller sample size[24].

Since our variables of interest vary at the (country × cohort) rather than at the individual level, the random disturbances in the regression are likely to be correlated within groups and this causes OLS to produce standard errors that can be seriously biased downward (see Moulton, 1990). We therefore cluster the standard errors by country and cohort, treating them as if there were only as many observations as there are combinations of countries and cohorts in the regression (see also Brunello and Checchi, 2007). Our coefficients of interest (γ) provide the sample average effect of each reform.

In order to study the distributional effects of various reforms, we adopt three alternative strategies. We first test the potential heterogeneity impact of educational reforms along the distribution of educational attainment. It may well be the case that some reforms do not affect the mean educational level, but they only impact educational attainment of people in some points of the distribution. Think for example of the impact of changes in compulsory education laws (Brunello et al. 2009). We may expect that an increase in the minimum leaving age of compulsory education raises school attainment of those who would have left full time education at the minimum leaving age, thus affecting the bottom of the distribution only. On the other hand, other reforms such as the introduction of standardised tests, may have little impact on the bottom part of the distribution but may push achievement of those with better performance (Jacob, 2005). Therefore the next step of our empirical analysis is to estimate the impact of each reform on different percentiles of years of education distribution. More specifically, we group individual-level observations by country, cohort and survey and then we compute for each cell (country×cohort×survey) the value of different percentiles of the dependent variable distribution.[25] If h_{pcti} denotes the pth percentile of the individual distribution of attainment in country c for cohort t and survey s then we estimate the following equation, where $p = (10,20,30,40,50,60,70,80,90)$ and δ_c, δ_t, δ_s are respectively country, cohort and survey fixed effects.

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[23] In particular, $n=3$ for reforms regarding pre-primary school, $n=6$, $n=10$ and $n=15$ for those concerning primary, secondary and tertiary education respectively.
[24] For reforms on tertiary education we only have information on 17 out of 24 countries in our sample.
[25] We choose this strategy instead of the more appealing one of estimating quantile regressions, because country and year fixed effect would have not remained constant over the quantiles.

$$(2) \qquad h_{pcts} = \alpha_p + \sum_{j=1}^{k} \gamma_p^j \cdot \mathbf{R}_{c,t+n}^j + \delta_t + \delta_c + \delta_s + \varepsilon_{pcts}$$

The vector γ_p^j will provide the differential impact of each reform on the unconditional distribution of attainment, thus allowing evaluating whether and to what extent the policy had entailed some distributional effects. When the reform (positively) impacts more on the bottom tail, we expect a reduction in inequality, while the reverse case occurs when (still positively) impacting on the upper tail (Freeman et al. 2010).

In the same vein, as a second strategy, we estimate a new set of regressions where the dependent variable is a synthetic index of dispersion of the years of education variable, calculated for each country, cohort and survey. Specifically, we have chosen to use the Atkinson index with inequality aversion parameter $\varepsilon = 2$, which puts more weight on the bottom tail of the distribution. In particular, for each cohort t in country c, we run the following regression:

$$(3) \qquad ATK_{ct} = \alpha + \eta \cdot \bar{h}_{ct} + \sum_{j=1}^{k} \gamma^j \cdot \mathbf{R}_{c,t+n}^j + \theta \cdot \overline{PB}_{ct} + \beta \cdot \overline{F}_{ct} + \delta_t + \delta_c + \varepsilon_{ct}$$

where ATK_{ct} is Atkinson index for country c and cohort t (averaged over measures taken from different surveys), $\bar{h}_{ct}$ is the average years of education of the same cohort, $R_{c,t+n}$ is the reform measure associated to cohort t in country c, $\overline{PB}_{ct}$ is the fraction of individuals with at least one parent with tertiary education in a given group (cohort$\times$country$\times$survey), $\overline{F}_{ct}$ is the fraction of women in the same group, and δ_c, δ_t are respectively country, and cohort fixed effects. In order to account for the different sample sizes underlying inequality indices in each group, we weight our dependent variable with the number of observations used to compute inequality indices in each cell.

Finally, a complementary strategy to characterise the distributional effects of educational reforms over time is looking at their impact on intergenerational persistence in educational attainment. An important dimension of educational inequality is in fact related to inequality of opportunities and can be quantified looking at the extent to which individuals' educational achievement depends on their socio-economic background. We quantify the effect of educational reforms on intergenerational persistence through a two step procedure. We first estimate the intergenerational correlation of educational attainments in each (country$\times$cohort) cell and then we regress the estimated coefficients on the corresponding reform variables adding country and cohort fixed effects. The regressions in the second step are weighted using the inverse of the standard errors of the coefficients estimated in the first step.

$$(4) \qquad \begin{cases} h_{ict} = \alpha + \theta_{ct} \cdot PB_{ict} + \beta_{ct} \cdot F_{ict} + \delta_s + \varepsilon_{ict} & \text{first step} \\[2mm] \hat{\theta}_{ct} = \alpha + \sum_{j=1}^{k} \gamma^j \cdot \mathbf{R}_{c,t+n}^j + \delta_c + \delta_t + \omega_{ct} & \text{second step} \end{cases}$$

where all the variables are defined as above and $\hat{\theta}_{ct}$ is the estimated intergenerational coefficient capturing the impact of parental background on individual school attainment for each country c and cohort t. As in equation (1), also in equations (3) and (4) reforms are grouped according to the target population (primary+secondary *versus* tertiary).

5. RESULTS

The correlation among reform variables suggests that the reforming activity of policy makers invests several dimensions of educational systems all at the same time. One reason for that are the potential complementarities among alternative dimensions. The simplest example is when a government intends to raise the number of years of compulsory education. Expecting an increase in school attendance, it has to consider the increase in the number of

required teachers, which in turn may produce changes in the recruitment requirements. Similarly, a policy-maker observing a spontaneous increase in university attendance may consider the possibility of introducing some selection in college admission; at the same time, in order to reduce the risk of social selectivity, she may consider to expand the financial aid to deserving students. Following this argument, we chose to jointly include all reforms in the same regression, so that the potential omitted variable bias is arguably minimised. As discussed in the previous section, we present the results on school and university reforms separately, in order to keep constant the sample size in each group.

For each group of reforms in what follows we present the *mean effect* (the estimated effect of reforms on average years of education), the *dispersion effect* (the estimated effect of reforms on Atkinson inequality index with aversion parameter $\varepsilon = 2$) and the *persistence effect* (the estimated effect of reforms on the intergenerational elasticity of educational attainment). Finally, the potential *heterogeneous effect along the attainment distribution* is shown graphically *via* estimates (with their relevant confidence intervals) at different percentiles of the years of education distribution (see figures 3 and 4).

Before going to the effects of the reforms, let us recall that in our dataset being born in a family where at least one parent holds a college degree is associated to almost three additional years of schooling; there are obviously a variety of reasons why this may occur (financial resources, cultural resources, parental expectations, or even genetics), but we do not have sufficient information to discriminate among these alternatives. Furthermore, being woman corresponds to an average disadvantage of 1/3 of a year of schooling. Additional demographics like age and residency are controlled by means of country and birth years fixed effect.[26] Different stages of development may correspond not only to different levels of attainment, but also to different trends, which are also controlled by means of country specific time trends.

5.1 Reforming the school system

Table 6 reports the estimated mean, dispersion and persistence effect for the reforms in the school system. Columns 1, 3 and 5 display the impact of single reforms, while columns 2, 4 and 6 show the effect of the four summary indices that describe the four areas of reforming activity in the school system: pre-primary schooling, expansion of access, teachers' qualification and school autonomy.

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[26] Ethnicity cannot be controlled because of lack of proper information, as foreign born individuals are excluded from the sample.

Table 6 – Reforms in school system and educational attainment

	(1) years of education	(2) years of education	(3) Atkinson(2) inequality index	(4) Atkinson(2) inequality index	(5) intergener ational coefficient	(6) intergener ational coefficient
Pre-primary expansion	0.119** [0.047]		0.000 [0.004]		0.026 [0.195]	
Beginning age compulsory education (years)	-0.555*** [0.108]		0.031*** [0.011]		0.217 [0.295]	
Pre-primary summary index		*0.264*** [0.092]*		*0.005 [0.007]*		*-0.056 [0.382]*
Duration compulsory school (years)	0.059*** [0.015]		-0.002** [0.001]		-0.117*** [0.045]	
Tracking age (years)	-0.012 [0.010]		-0.001 [0.001]		-0.099** [0.045]	
Expansion of university access	0.106** [0.051]		-0.004 [0.004]		-0.214 [0.166]	
Standardised tests (for career advise)	-0.417*** [0.074]		0.042*** [0.007]		0.734* [0.381]	
Expansion summary index		*0.301** [0.150]*		*-0.067*** [0.013]*		*-2.345*** [0.493]*
Pre-primary teacher qualification	-0.137*** [0.048]		0.001 [0.004]		0.293* [0.175]	
Primary teacher qualification	-0.129** [0.056]		0.001 [0.003]		-0.067 [0.175]	
Secondary teacher qualification	0.076 [0.055]		0.002 [0.004]		-0.099 [0.243]	
Teacher summary index		*0.080 [0.074]*		*-0.003 [0.005]*		*-0.025 [0.290]*
School evaluation	-0.087 [0.095]		-0.013** [0.007]		-0.602* [0.319]	
School autonomy	0.057 [0.085]		-0.001 [0.006]		0.132 [0.200]	
Teacher autonomy	0.065 [0.081]		0.003 [0.006]		0.246 [0.251]	
Standardised tests (for school accountability)	0.416*** [0.095]		0.002 [0.006]		0.033 [0.187]	
School autonomy summary index		*0.682*** [0.145]*		*-0.009 [0.008]*		*-0.177 [0.325]*
Constant	15.770*** [0.683]	12.190*** [0.129]	-0.018 [0.073]	0.199*** [0.024]	4.280** [2.068]	4.902*** [0.709]
Observations	329,102	329,102	1,396	1,396	1,362	1,362
R²	0.258	0.258	0.847	0.840	0.525	0.520

Note: standard errors clustered by country×age cohorts in brackets – statistical significance: *** p<0.01, ** p<0.05, * p<0.1 – Constant, gender, parent graduate, birth year, country, survey controls and country specific time trend included in column 1 and 2. Data in columns 3 to 6 are collapsed by country×birth year. Regressions in columns 3 and 4 include mean years of education, female and graduate parent shares. Regressions in columns 5 and 6 include female share and are weighed by the inverse of the standard error in first stage regression

Let us start our discussion with two reforming activities associated to early schooling: one intends to capture the expansion of pre-primary schooling mainly through intensified public subsidisation, the other pushing the matter up to the point of lowering the starting age of compulsory education (thus incorporating pre-primary education). In line with previous findings in the literature (for example Cunha et al. 2006, Cunha and Heckman 2007), reforms **expanding the access to pre-primary education** seem to be associated to an increase in average educational attainment (column 1) while later entry in the school system reduces average educational attainment. Consistently, later start of primary education is also associated to greater educational inequality (column 3), suggesting that lowering the **beginning age of compulsory education** is an effective tool to reduce educational inequality. No effect is instead found on intergenerational persistence (column 5), The summary index of reforms in pre-primary education exhibits positive correlation with the mean educational attainment, without statistically significant association with educational inequality and intergenerational persistence. It is interesting to look at figure **3** (panel **a**), which shows that most of the benefits of pre-primary education accrues to individuals with lower educational

attainment, confirming that this line of intervention has an equalising impact on educational opportunities. It is worth remembering that this is a composite effect of availability of pre-primary educational facilities and starting age of compulsory education: when looking at the heterogeneous impact of the latter (not shown), we observe that delaying school start has a detrimental effect on children for culturally poor families, while has positive association with educational attainment for culturally advantaged children.

The second group of reforms pulls together elements of institutional design which are intended to expand the participation to schooling. The main instrument available to policy-makers is clearly the imposition of a minimum number of years of **compulsory education**, which favours mean education achievement (column 1) mostly through keeping students in schools up to later stages (thus confirming Brunello et al. 2009 which studied a smaller subset of 12 European countries). The second variable considered is the **age of initial allocation of students to tracks**, where they are available in secondary school. From the literature we know that the earlier this age, the lower is school performance through reduced competence acquisition (Hanushek and Woessmann 2006); but we also know that it reduces the drop-out rate by retaining weaker students into vocational tracks (Brunello and Checchi 2007). Possibly because of these two conflicting channels, we do not find any significant statistical association between the age at which students are sorted into different tracks and average educational attainment[27]. However, postponing the differentiation of the curricula significantly helps reducing intergenerational persistence (column 5), thus increasing the equality of opportunities. Part of the negative effect of student sorting by ability may be captured by the introduction of **standardised tests** aimed at guiding career advancement which is associated to a reduction in average educational attainment - implying that students would be discouraged by lower test scores in further proceeding in education (column 1) - and to an increase in inequality measured both in terms of dispersion (column 3) and in terms of intergenerational persistence (column 5). Finally, as long as more and more students come out from secondary schools, a pressure is created to open up the doors of universities, which were typically reserved to students from academic tracks. The **expansion of university access** variable collects information about a combination of alternative measures, like open access from vocational high schools, geographical expansion of universities and creation of polytechnic institutions providing non-university vocational higher education. As expected, it has a positive association with the mean educational attainment. The joint consideration of these variables creates a push for educational expansion, as clearly detectable by the summary index which offers a positive and significant correlation with mean educational attainment (column 2), as well as a negative one with inequality in the distribution (column 4) and with intergenerational persistence (column 6). Considering the distributional effect, the estimates suggest that longer stay in the formal educational system reduces inequality while the introduction of standardized tests tends to increase it. The age at the first tracking and the expansion of the university access are not correlated with inequality (column 3). The intergenerational persistence is lower when duration of compulsory education or tracking age increase, while it is higher when standardized tests for career advancement are introduced (columns 5). When looking at the heterogeneity of the association between the summary index for expansion and educational attainment (see figure 3 , panel **b**), we notice that the strongest impact pertains the middle of the distribution. This is consistent with the idea that these reforms were effective in raising the educational attainment of the middle classes, given the fact that *élites* were already reaching the highest stages of education.

The third group of reforms accounts for the **teacher recruiting**, which should imply an improvement in the quality of teaching and therefore a positive correlation with educational attainment (Hanushek 2010). We are aware of the fact that the quality of teaching also relies on the incentive structure which is offered to teachers: by offering relatively more generous salaries some countries are able to attract best graduates in the profession; and by creating appropriate career incentive other countries obtain high performances over long spans of working lives (Dolton and Marcenaro 2011). Unfortunately information about the working conditions (teaching hours, salary, career ladder) is not available before the initial publication of Education at a Glance in 1996, thus reporting data on teachers who at best affected students belonging to the boundary of our sample. Thus we take the introduction of higher educational requirements, as well as additional training, as proxies for the quality of those who self-sorted into the teaching

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[27]The point estimate turns out to be positive and statistically significant only when we do not include a country specific time trend. When looking at the heterogeneity of the impact (not shown) we observe a positive correlation increasing in magnitude with deciles.
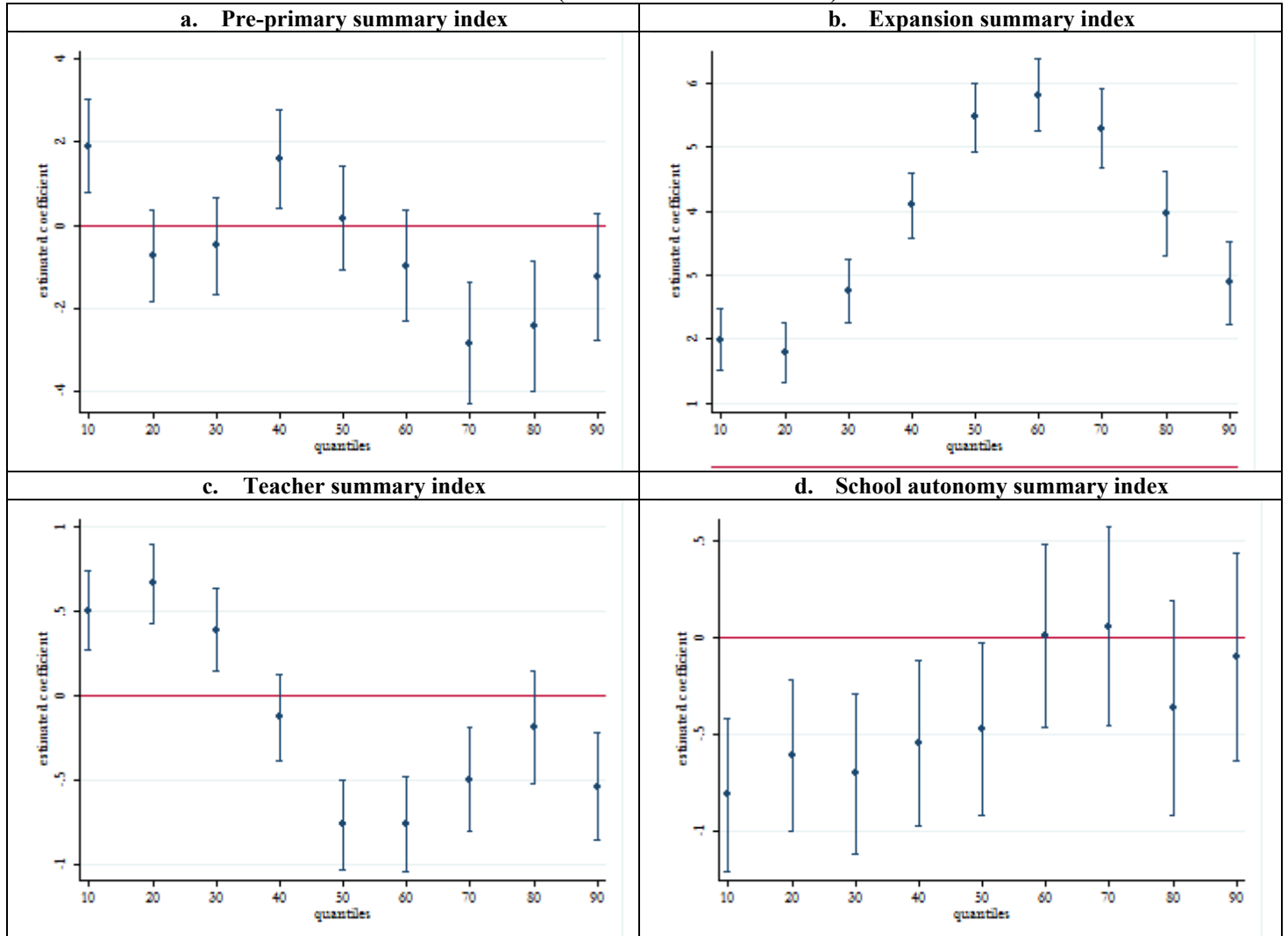
profession.[28] Using these variables, we obtain a counterintuitive negative correlation of teacher qualification requirements in pre-primary and primary schools, and an insignificant correlation for teachers in secondary schools (column 1). These variables do not exhibit any effect on inequality nor on intergenerational persistence. However, when looking at the correlations at various points of the distribution (see figure 3, panel **c**), we recognise a common pattern of stronger association at the bottom of the distribution. Also the summary index does not display any statistically significant effect on our three outcome variables.

The fourth group of reforms relates to innovating the organisation of schools at primary and secondary levels. It combines increased **autonomy to schools** in managing the teaching staff and to teachers in **adapting teaching contents** to students' needs (see Woessmann et al. 2009). Following the analysis of Woessmann (2005, 2007) who stresses the complementarity between autonomy and accountability (in order to avoid opportunistic behaviours from the teachers), we have also included reforms introducing and/or improving **school accountability**, mostly through **testing students**[29]. Most of the reforms in this area of policy occurred rather recently, as it can be seen from time plots reported in figure B.4 in Web Appendix B. This may explain why we find limited evidence of statistical association between reforms and mean educational attainment: only student testing exhibits positive association with the mean educational attainment (column 1). Symmetrically, school evaluation reduces dispersion and intergenerational persistence (column 3). It is worth stressing the role of accountability practices, as they emerge from the summary index, in enhancing school attainment in the population (columns 2). If we look at the heterogeneity of the correlation at various points of the distribution (see figure 3, panel **d**), we notice that it has a detrimental effect on the bottom part of the distribution. One possible interpretation of this apparently contradictory evidence (positive impact on mean and dispersion, negative impact for the lowest deciles) is the following: accountability puts pressure on more autonomous schools in order to raise student achievements. This can be obtained by raising the performance of culturally poor students and/or fostering the performance of more brilliant students. When the latter strategy prevails on the former, we may obtain increasing mean and dispersion, with less advantaged students lagging behind.

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[28] In accordance with McKinsey (2007) report, best performing countries in student test (Korea, Finland) hire teachers from the top of the ability distribution of potential candidates to the teaching profession. A proper test of this claim is difficult to implement, especially along a temporal dimension, which is what we would need in our framework.

[29] In school evaluation we have included reforms that have established independent structures for the evaluation of schools, or that have introduced some form of measurement of school performance through the testing of samples of students or legislations that strengthened the importance of school evaluation.

Figure 3: impact of summary indices of reforms in school system on different deciles of educational attainment – estimated coefficients (and 90% confidence intervals)

| a. Pre-primary summary index | b. Expansion summary index |
| c. Teacher summary index | d. School autonomy summary index |

Note: Estimates obtained by collapsing data by country×birth year×survey×deciles in years of education distribution

5.2 Reforming the university system

Among the reforms of the tertiary level of education we first include those related to financial support for students from poor families. We find that the increase in the availability of grant financing for university students is positively associated to average years of education, whereas higher proportion of loan to grant and higher interest rates charged to the student for loans are negatively correlated with the mean educational attainment (column 1 of table **7**). As expected, the distributional effect and the intergenerational persistence are lower when grant size is higher, while they are higher when the loan component is relatively higher than the grant component (column 3 and 5 of table **7**). We construct the add-on summary index for financial support, using the opposite of loan to grant component variable and the interest rate variable, in order to obtain an index which is increasing when the cost afforded by students is reduced. As expected, this summary index exhibits a positive and significant correlation with the mean attainment (column 2), a negative correlation with the Atkinson inequality index (column 4) and an insignificant impact on intergenerational persistence (column 6). We interpret this result as suggesting that students from culturally deprived families do not take advantage from financial aid to university attendance, which over most of the sample period remained prerogative of students from higher classes. This would be confirmed by the heterogeneous effect displayed in figure 4, panel **a**.

Another reform included in the regression is the introduction of **selective admissions** and accounts for improving universities performance. This type of reforming activity does not present significant correlation with both mean and dispersion of educational attainment. Although not reported in the paper, selectivity shows an interesting profile along the distribution of attainments, because the correlation increases along the deciles, suggesting that selectivity favours students with high potential, which were already intended to achieve more education. Finally, we include a variable for changes in the level of **university autonomy** in seven areas: budget, recruitment, organization, logistic, courses organization, self-evaluation and development plans. This variable has a clear inequality enhancing association with educational attainment, since its correlation bears a negative sign with mean achievement (column 1) and a positive (although not significant) sign with intergenerational persistence (column 5). The summary index for university autonomy obtains a negative and significant sign in affecting mean educational attainment (column 2). This may not come at a surprise: while primary and secondary school level have a mission of expanding school participation (which it pursued by means of autonomy in adapting to local environments), in the case of tertiary education institutions greater autonomy may be used to improve competitiveness in the higher education market, not necessarily requiring a larger student intake. The other token of the coin is represented by the positive and significant correlation with the intergenerational persistence (columns 6). This is clearly represented by the heterogeneous effect along the distribution of educational attainment: the individuals intended to lower achievements are hampered by more autonomous universities, while high potential students obtain advantages from the existence of selection and university autonomy. Thus the correlations of this group of reform are mirror-like opposite to those found for reforms aiming to expand schooling participation.
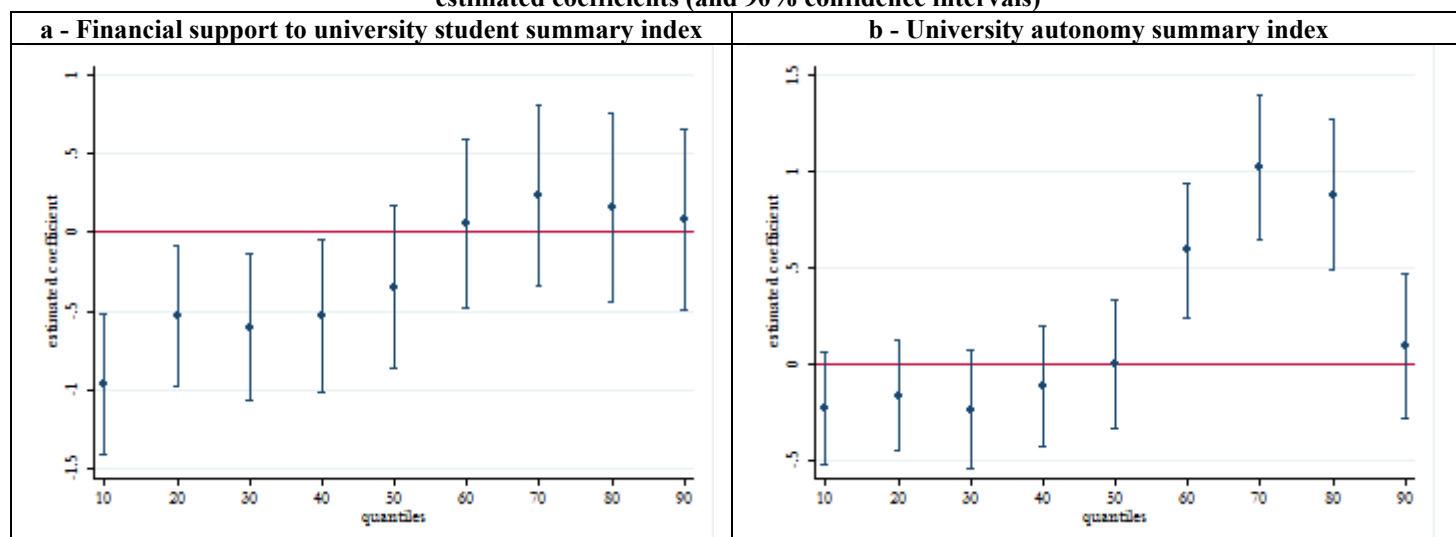
In the previous case reforms can be read in terms of *inclusiveness*, since everyone was pushed to stay in school longer, raising the average attainment and reducing its variance in the population. In the present case, reforms tend to reinforce the *exclusiveness* of the upper steps of the educational ladder, since they may improve the performance of those students who are retained within the system, at the cost of excluding a larger fraction of low potential individuals.

Table 7 – Reforms in university system and educational attainment

	(1) years of education	(2) years of education	(3) Atkinson(2) inequality index	(4) Atkinson(2) inequality index	(5) intergenerational coefficient	(6) intergenerational coefficient
Increase grant size	0.160*** [0.059]		-0.016*** [0.005]		-0.277** [0.117]	
Increase loan to grant component	-0.146** [0.069]		0.009** [0.004]		-0.249** [0.127]	
Increase interest rate on student loans	-0.243* [0.125]		0.004 [0.007]		-0.002 [0.147]	
Index of financial support for university student		*0.518*** [0.138]*		*-0.031*** [0.009]*		*-0.242 [0.275]*
Selective university access	-0.058 [0.084]		-0.002 [0.005]		-0.063 [0.190]	
Index of university autonomy	-0.236** [0.100]		0.004 [0.008]		0.372 [0.292]	
University autonomy index		*-0.232** [0.110]*		*0.003 [0.007]*		*0.255 [0.234]*
Constant	13.090*** [0.240]	12.777*** [0.227]	0.190*** [0.031]	0.206*** [0.031]	3.820*** [0.757]	3.699*** [0.752]
Observations	224,969	224,969	989	989	961	961
R²	0.287	0.287	0.849	0.848	0.566	0.562

Note: standard errors clustered by country×age cohorts in brackets – statistical significance: *** p<0.01, ** p<0.05, * p<0.1 – Constant, gender, parent graduate, birth year, country, survey controls and country specific time trend included in columns 1 and 2. Data in columns 3 to 6 are collapsed by country×birth year. Regressions in columns 3 and 4 include mean years of education, female and graduate parent shares. Regressions in columns 5 and 6 include female share and are weighed by the inverse of the standard error in first stage regression. Data on these reforms are not available for Estonia, Hungary, Latvia, Poland, Slovak Republic, Slovenia and Czech Republic

**Figure 4: impact of summary indices of reforms in university on different deciles of educational attainment –
estimated coefficients (and 90% confidence intervals)**

a - Financial support to university student summary index	b - University autonomy summary index

5.3 Robustness checks

Having presented the basic results of our analysis, in this section we perform several robustness checks to test the validity of our identification assumptions. One possible concern for our identification is the non-random allocation of reforms over time and across countries. We therefore perform a falsification test in which we estimate our basic equation (1) using as regressors a vector ($R_{c,t+n}$) of randomly generated institutional features prevailing when individuals enter different stages of the school system. The estimated coefficients are presented in table B.3 in Web Appendix B. We randomly allocate reforms to individuals in three different ways. Since a first concern is the fact that reforming activity could be simply country specific, starting from our original dataset, we first generate a random series of year of birth that we use to assign to each individual the institutional school setting prevailing in her country. Point estimates for both the single reforms variables and for the synthetic index in each area are no longer statistically significant and when significant they obtain the wrong signs (Colum 1 and 2). Our second counterfactual test checks whether the reform patterns we are observing are driven by Europe-wide waves of reforms that are not country specific: we randomly re-shuffle educational reforms across countries, generating a random series of countries of birth and assigning reforms to individuals according to the randomly generated country of birth. Also in this case we do not find almost any statistically significant effect of the changes in the institutional setting (see columns 3 and 4 in table B.3 in Web Appendix B). In the third falsification test, we randomly re-shuffle both year of birth and country of birth to individuals before assigning them to reforms to which they were supposedly exposed. According to point estimates presented in columns 5 and 6 of table B.3 in Web Appendix B, reforming activity is not statistically correlated with individual school attainments; in two cases of statistical significance, the effect goes in the opposite direction with respect to the economic theory. Overall these falsification tests suggest that our original regressions actually capture the true effect of changes in the educational setting and do not contradict a causal interpretation of the results.

A second concern for our identification is the fact that the behaviour of a single country could drive our results. Although we control for country fixed effect and the source of variation that allows identifying coefficients is at country and year level, we re-estimate all our models excluding from the sample one country at a time. When we retain the specification including only the summary index by areas (see table B.4 in Web Appendix B), the estimated effects are the same in terms of direction, magnitude and significance of those obtained in previous sections. Only in few cases we do not achieve statistical significance, although the sign and the magnitude are coherent with previous estimates.

A third concern regards the choice of our measure for inequality. One could argue that our results are driven by the choice of a specific inequality index, while alternative results would be obtained if considering indices assigning

different weight to different part of the distribution. We conducted two sensitivity tests performing the analysis on the distributional effects of reforms using as measures of inequality either the Gini index or the Atkinson index with a different inequality aversion parameter $(\varepsilon = 0.5)$ (which places more weight to the upper part of the distribution). In both cases, all the results presented in the previous sections remain mostly unaltered[30].

A fourth concern is the aggregation of datasets obtained from survey conducted from different institutions in different years. We cope with this problem by including a survey fixed effect in all regressions reported in tables 6 and 7. As an additional robustness check, we performed separate regressions for the four surveys, despite such estimates being not fully comparable with those presented above, because different surveys have different country coverage, different observation numerousness and different years of survey. However, the signs of our variable of interest are consistent with the results we obtain in the core analysis, but we loose statistical significance for a fraction of reform measures because they are identified by individuals belonging to specific combinations of country and year.[31]

Overall, we believe that our reform measures identify genuine source of exogenous variations across countries and years. Based on these results, we proceed in the next section with the discussion of the policy implications, which rely on a causal interpretation of our findings

6. POLICY IMPLICATIONS

6.1 Policy options

Despite the robustness checks presented in the previous section, we are fully aware that implementing an institutional reform is more complex than a (0,1) switch associated to our variables. First of all, *many reforms take time to become effective*. Reforming the recruitment of teachers may be effective in altering the entry flow of new teachers, but does not change the pre-existing stock. Raising the leaving age of compulsory education is not always accomplished by the affected population, depending on the availability of more schools and teacher. Increasing the financial support to university students require some learning by the affected population.

Second, there are *potential complementarities between reforms* that may increase or reduce the effectiveness of specific policies: expanding pre-primary and/or compulsory education require more teachers; autonomy of schools should be may accompanied by strengthening of their accountability, which may require the introduction of student testing; more autonomy for universities may imply greater freedom in setting tuition fees, which in turn require stronger financial support for students; teacher autonomy should be enhanced with an increasing degree of teacher qualification; and so on. In the literature reviewed in section 2 the standard approach is correlating the change of *one* single policy instrument with some educational achievement (either competences or attainments). Neglecting the possible clustering of policies leads to an over-estimate of the impact of each single policy. We do not fully solve this problem (because we do not explore the above mentioned complementarities by means of interactions), but the joint inclusion of more than one policy instruments should attenuate this bias.

Third, the absence of a reliable scale of measure for most of the reform variables renders our results essentially qualitative. By implication, when we add on several policy variables we come to measure not a specific policy instrument but rather a *policy line of action*, which may use different instruments in different combination. As we will discuss below, different countries experienced different combinations of the same set of instruments, depending on their starting points, their availability of public resources, and the development of private alternatives. For all these reasons, in the sequel we take our empirical results as representative of the typical experience of an (average) European countries, being well aware of the fact that national experiences are not necessarily close to what we are describing.
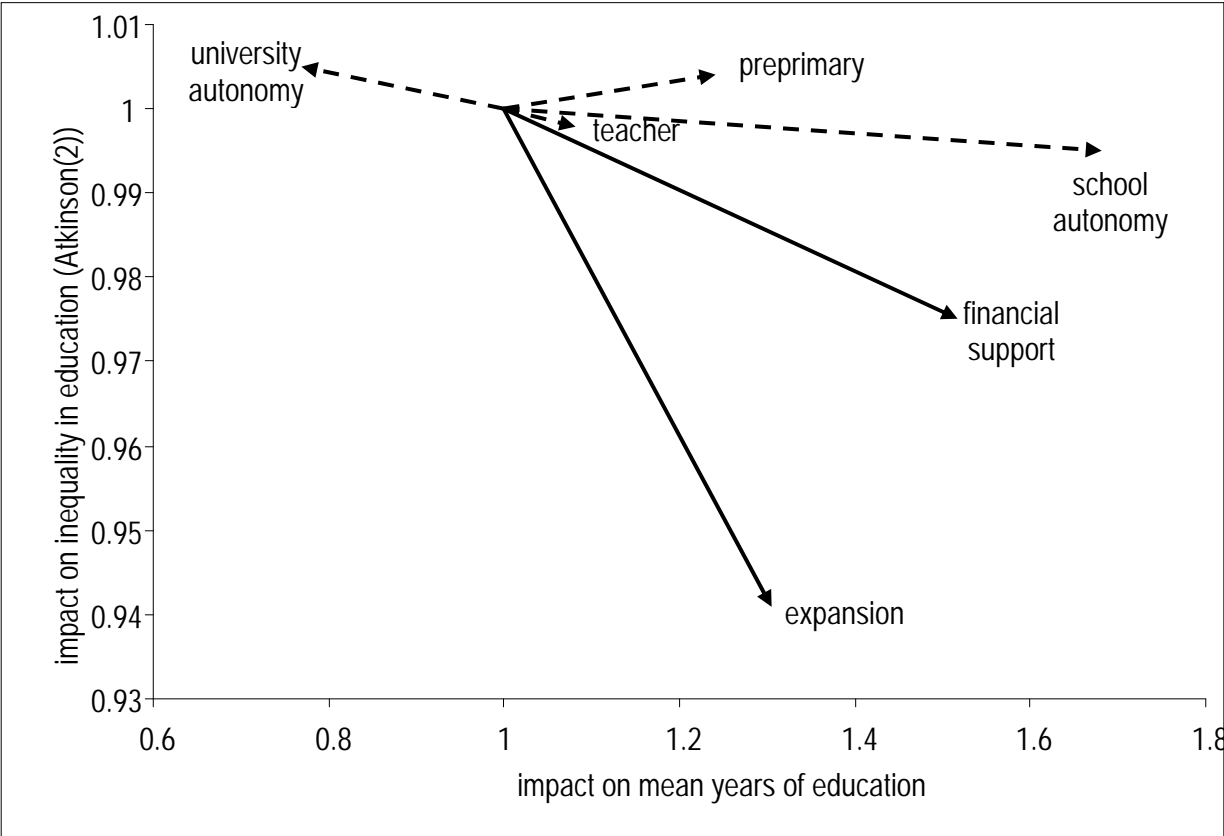
Having all these caveats in mind, we now move to discuss the policy implications of our analysis. Our main findings can be summarised in the next figure, where we have reported the impact of a unitary variation of the

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[30] Results available from the authors.
[31] Results available from the authors.

summary indices on mean educational attainment and on inequality in educational attainments (figure 5) or on intergenerational persistence in education (figure B.8 in Web Appendix B), as estimated in columns 2-4-6 of table 6 and 7. Solid lines are used when both coefficients are statistically significant, while dashed lines correspond to cases when at least one of the coefficients is statistically insignificant. Figure 5 represents a sort of "menu of policies" available to governments: if we exclude reforms in the area of "university autonomy and selectivity", all other interventions have a positive impact on the average educational attainments, though with different magnitudes of impact. Policy interventions intended to retain students into the educational system (**expansion of access**) and/or to support student enrolment at tertiary level (**financial support**) accomplish the simultaneous goals of increasing the mean and reducing the dispersion in the distribution of educational attainments. Similar (but statistical weaker) impacts are recorded for policies that improve the quality of school (**school autonomy** and **teacher qualification**). Policies that improve preschool attendance (**pre-primary** education) can be beneficial to mean educational attainment, but they have no effects on the dispersion in the distribution. Similar results emerge when we consider the alternative between mean achievement and intergenerational persistence in educational attainments (figure B.8 in Web Appendix B), which may be considered as a proxy for the equality of opportunities. Also in this case, policies aiming to expand school participation yield an increase in attainment coupled with increased intergenerational mobility, whereas the other policies seem ineffective in reducing mobility.

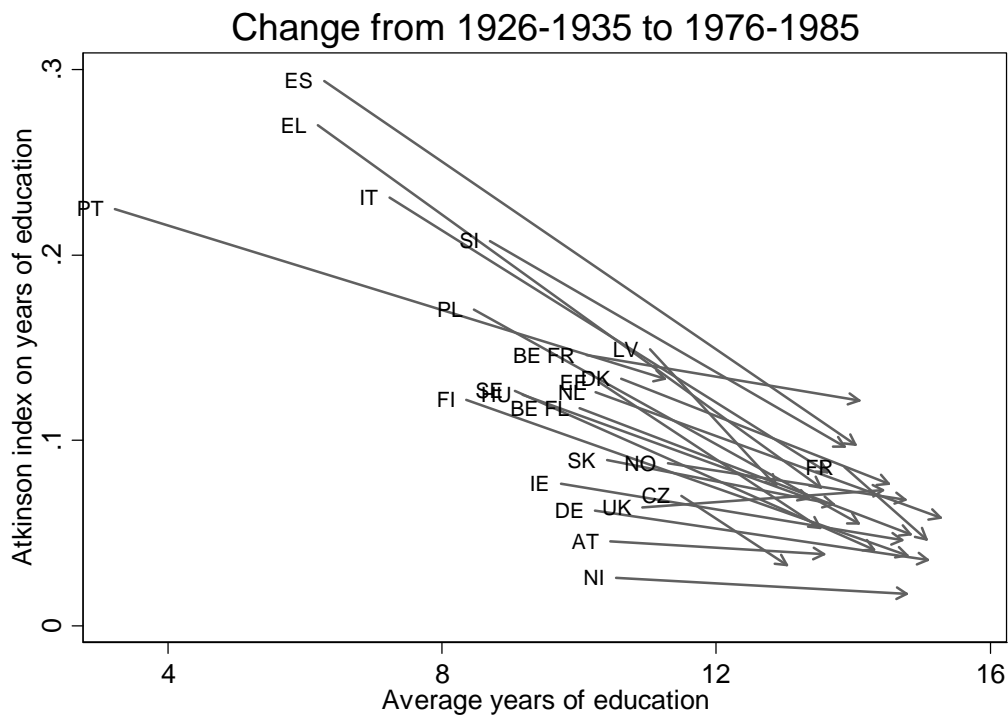**Figure 5 – Estimated effects on mean and dispersion of summary indices of reforms**

If we abstract from policies enhancing university autonomy, often intended to other goals (like scientific productivity), we may rationalise this evidence by indicating the alternative strategies in educational policies faced by each government. In order to raise the (domestic) human capital a government may work on both tails of the distribution of educational attainments. If it works on the bottom tail it will bring in the educational system more students and/or retain them longer, thus increasing the mean and reducing the dispersion (see figure B.9a in Web Appendix B). We could call *inclusive* any policy implying a movement in the south-east direction of graph 5, thus including expansion of access and financial support of university students. Alternatively, a government may work on the upper tail of the same distribution, boosting the excellences through intensified competition to emerge: in this case the increase in the mean is accompanied by a rise in dispersion (see figure B.9b in Web Appendix B). We

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would term *selective* any policy leading to a movement in the north-east direction of graph 5: in our analysis they include policies that expand pre-primary education as well as university autonomy.

Obviously countries have adopted different combination of policies over time, thus making it impossible to identify maintained patterns of behaviour. In the case of *inclusive policies*, the options identified in figure 5 allow a government to escape the usual trade-off between efficiency (higher mean educational attainment) and equality (either reduced dispersion within one generation or reduced persistence across adjacent generations). In the case of *selective policies* the available options recreates the traditional trade-off between equality and efficiency. Different governments in different countries have chosen different combinations of these groups of policies, yielding the actual movements observed over the sample period (see figure 6, where we have plotted the changes over the sample period in mean and dispersion of educational attainment, by countries).

All countries have clearly pointed towards an increase in educational attainment of their populations (Portugal, Spain and Italy being the most successful countries in catching-up countries characterised by early schooling (France, Germany and Austria). While the majority of countries accompanied their progress in education with a reduction in educational inequality, there are some exceptions to this pattern (notably Great Britain and Northern Ireland) since inequality increased over this transition period. Over the sample period the figure 6 shows a decline in both *within-countries inequality* in education (consistently with a reduction in intergenerational persistence) and in *between-country inequality* (obtained almost by construction, since the years of education are top-censored).

Figure 6 – Actual changes experienced by different countries over half century

Change from 1926-1935 to 1976-1985
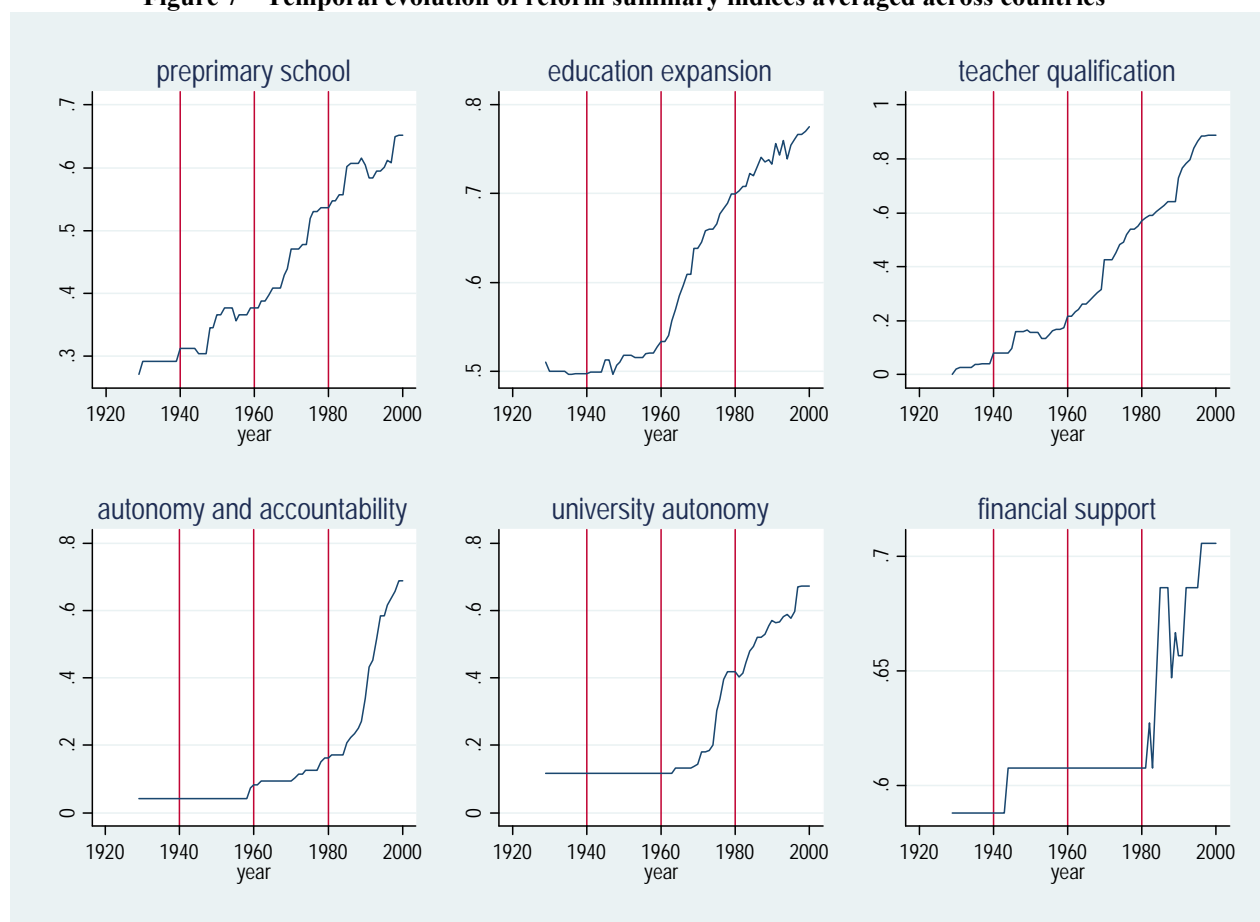
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6.2 Policy choice

We now turn to the discussion of the factors that may drive the choice of a country among existing policy options. Without any claim of completeness, we may think of at least three elements that may influence this choice:

i) the (optimal) sequence
ii) the availability of public resources
iii) the ideological orientation of government

6.2.1 Sequencing of policies

With respect to the first element, the historical evidence suggests that, on average, the countries of our sample have initially pursued inclusive policies, switching to selective policies at later stages. If we take the average of our summary indices across countries, we may get an idea of the temporal dynamics of each group of reforms for the average of the countries (see figure 7). It comes with no surprise that all measures are upward trended, since by construction each reform is summed to another.

Figure 7 – Temporal evolution of reform summary indices averaged across countries

From the graph we observe that the first waves of reforms among European countries in the aftermath of World War II involved pre-primary schooling, teacher qualification and expansion of access. The latter intensified in the following decades, when many countries raised the leaving age for compulsory education and/or increased the comprehensiveness of their secondary school systems. Widening school access required recruiting more teachers, which led to reforms raising the qualification requirements to enter the profession during the same period. At the beginning of the 80's the pressure for increasing the access to universities led many countries to widen admission rules and/or to introduce grant policies for financially constrained students. Another common trend experienced by European countries is towards increased autonomy for universities, which took off at the end of the 70's and continued during the 80's and 90's. Eventually, by the end of the 80's we also witness greater emphasis towards the

accountability of the educational systems, which pushed many countries to establishing national assessment agencies.

This suggests the existence of an optimal sequence in policy adoption, which derives from the vertical integration nature of the educational process. A country cannot expand tertiary enrolment if it has not achieved a sufficient number of secondary school graduates; similarly, a country cannot increase the degree of teachers' autonomy if the teachers do not possess a sufficient level of qualification. Without imposing more structure to this theoretical argument we cannot proceed much further. But a general teaching that emerges from the past century experience in Europe is that countries initially expanded the access to education by bringing in more students and teachers into schools and only later on they intervened to reorganise the system in a more efficient and/or accountable way.

6.2.2 Costs and benefits of reforms

With respect to the second dimension of resource availability, we are all aware that each reform is costly, but some reforms are more expensive than others. Given the fact that schooling is a highly labour intensive process, we expect that most of access /expansion policies be more costly, because in general they require the hiring of additional teachers, at all levels. The vast majority of countries has teachers' pay scales which increase with their educational levels (Dolton and Marcenaro 2011), thus yielding an increasing marginal cost for expanding education. On the contrary, policies that increase schools and teachers autonomy by decentralisation of responsibilities affect the internal organisation of the production technology, and can be relatively less expensive; however they require the financing of potential incentives (to teachers, in order to induce them to exert more effort while taking more responsibilities), as well as the creation of assessment agencies in order to increase the accountability of the system.[32] It is therefore plausible that the gradual switch from inclusive policies to selective policies experienced by many countries at the end of the 80's could be accounted by the greater cost effectiveness of these latter policies, as well as by the reduction of public resources devoted to education, caused by the increased burden of public debts. In the next paragraph we will take into account the conditioning role of resource availability in determining the choice among alternative policy options.

Mostly for lack of appropriate data we have abstracted from assessing cost effectiveness of the reforms we have studied. On the other side we are also aware that the extent of social benefits of education is hard to quantify. We tried to provide a rough attempt to quantify costs and benefits of reforming each dimension of schooling (leaving tertiary education out of the picture due to the complete absence of data), showing that early schooling is the reform line with a high (estimated) impact on domestic product, as well as being one of the most cost- effective policy (more details on the cost benefit analysis can be found in Box 5 of Web Appendix B).

6.2.3. Ideological orientation of government

The third factor affecting the policy choice by government concerns social preferences as interpreted by the ruling parties. Educational reforms are structural reforms, which require some time to yield some result. For this reason, they cannot be undertaken frequently and, in general, they necessitate a wide support, both in the parliament and in the public opinion. Political parties may have different opinions with respect to what is the appropriate skill composition in the domestic labour force, as well as about the desirable degree of social differentiation. Both variables crucially depend on the distribution of educational attainment in the population, which can be modified by policy interventions (as we have shown in previous sections).

We deem plausible that parties with a left-wing orientation are more supportive of inclusive policies, because they benefit the lower tail of the educational attainment distribution, where their supporters are largely over-represented. In addition, they may expect a more intense political participation of low class people, which should translate in stronger electoral support.[33] Moreover, leftist parties may support generalised expansion of schooling as a poverty alleviation measure (Brady 2003) and/or as a mean of increasing public expenditure (Hicks and Swank 1992, Moller

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[32] On the costs associated to school accountability see the discussion in Hoxby (2002).

[33] Gradstein and Justman 1999 considers a model where expansion of education enlarges the franchise, thus moving the median voter towards the bottom and raising the electoral support for more egalitarian taxation, which in turn translates into more resources invested in education.

et al. 2003). Conversely, conservative parties are more reluctant towards any generalised expansion of schooling, for at least two reasons: on one side educational expansions require an increase in public expenditure; on the other side, they raise people expectations in terms of future life-time incomes, which may translate in higher wage pressure and rigidities. In both cases, policies are undertaken under varying external circumstances, concerning growth and availability of public resources. Parties' differences may have been attenuated in recent years due to reduced ability to financing public expenditure (Korpi and Palme 2003), but given our long run perspective, this concern may be less pertinent.

Following this line of argument, we have analysed the correlation between our summary indices of reforms and political orientation of (democratically elected) governments in European countries. Data on policy orientation of political parties elected in parliament and selected cabinets are taken from ParlGov database (Döring and Manow 2010). A less detailed source of data is from Woldendorp, Keman and Budge (2000). External circumstances are controlled for using data from Penn World Tables v.7.0. Descriptive statistics are reported in table 8.

Table 8: Political variables – descriptive statistics

	Mean	Std. Dev. (overall)	Std. Dev. (between)	Std. Dev. (within)	Min	Max	Obs.	N. of countries
Right-wing orientation of the government[1]	5.119	1.506	0.775	1.308	0	8.154	928	24
Right-wing orientation of the parliament[1]	5.095	0.756	0.648	0.558	0	7.194	928	24
Cabinet support in the parliament[1]	0.562	0.124	0.07	0.097	0.123	1	928	24
Political complexion of parliament and government[2]	5.8	1.895	1.069	1.666	2	10	940	24
Log of PPP Converted GDP Per Capita at 2005 constant prices[3]	9.604	0.5	0.33	0.411	7.869	10.71	963	24
Government Consumption Share of PPP Converted GDP Per Capita at 2005 constant prices[3]	0.103	0.028	0.028	0.011	0.027	0.21	963	24

Notes: 1= Döring and Manow 2010; 2= Woldendorp, Keman and Budge 2000 – rank-reversed for comparability; 3= Penn World Tables v.7.00

There are some subtle measurement issues when trying to define the political orientation of policy makers. Döring and Manow (2010) have coded each party elected in Parliament on a 0-10 scale, ranging from 0-most left oriented to 10-most right wing oriented. By taking seat-weighted average of parties elected in a legislature or supporting a cabinet, we obtain a measure of the *political orientation of policy makers*. Given data availability, we also control for strength of cabinets in parliament by taking the share of seats taken by parties supporting a cabinet over the total number of seats available. An alternative measure of the *ideological complexion of government and parliament* is proposed by Woldendorp, Keman and Budge (2000), which classifies government on a 1 (left wing dominance) to 5 (right wing dominance) scale.[34] The information provided in the two sources of data is consistent, as can be seen from the correlation matrix reported in table 9 (and from figure B.10 in Web Appendix B).

Notice that the ideological orientation of governments is more volatile than the corresponding measure for parliaments, since changing coalitions in order to form cabinets induce noise in this measure. The same graph highlights one additional problem that we face once we take these data to statistical analysis. A group of countries does not have information on the political orientation of democratically elected parties because either there were no free elections (this is the case of dictatorships: Spain, Portugal and Greece) or these entities did not exist as independent states (this is the case of formerly planned economies: Czech and Slovak republics, Estonia, Hungary, Latvia, Poland and Slovenia). This produces an unbalanced panel when studying the correlation between educational policies and ideological stance of governments.[35]

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[34] The original coding is reversed and halved, but we have converted it for ease of comparability with the variable from Parlgov. Thus 2 is associated to "left-wing dominance (share of seats in Government and supporting parties in parliament larger than 66.6 per cent", 4 is associated to left-centre complexion (share of seats of Left and Centre parties in Government and supporting parties between 33.3 and 66.6 per cent each)", 6 is associated to " balanced situation (share of Centre larger than 50 per cent in Government and in Parliament; or if Left and Right form a government together not dominated by one side or the other" and so on for right-wing dominance.
[35] A further point worth remarking is that in previous sections we have considered two regions of Belgium (Flemish and Francophone) as well as Northern Ireland and Britain as separate entities, but they are ruled by a unique government. In order to retain the maximum variability across countries/regions, we have retained these regions as separate, since they are characterised by potentially different educational policies.

Table 9: Political variables – correlations

	right-wing government	right-wing parliament	cabinet support	political complexion	log GDP per capita	government share
right-wing orientation of the government	1					
right-wing orientation of the parliament	0.6440*	1				
cabinet support in the parliament	-0.0322	-0.0755*	1			
political complexion of parliament and government	0.7255*	0.3973*	-0.1316*	1		
log GDP per capita	-0.0225	0.1669*	-0.1020*	-0.1587*	1	
government share	0.0845*	-0.0275	0.2454*	0.0627	0.2346*	1

Note: * indicates statistically significant at 5%

Our dependent variables are the six summary indices of reforms obtained from original reform variables in the previous section and we estimate the following equation:

$$(5) \qquad R_{ct} = \eta + \varphi \cdot W_{ct} + \zeta \cdot Z_{ct} + \delta_c + \delta_t + \tau \cdot \delta_c + \varepsilon_{ct}$$

where c and t denote country and year respectively, R_{ct} is our reform measure, W_{ct} is the political orientation of either the cabinet or the parliament in office, Z_{ct} are potentially confounding factors controlling against the risk of spurious correlation (GDP per capita at PPP US 2005 dollars, share of public expenditure on GDP), δ_c and δ_t are country and year fixed effects and $\tau \cdot \delta_c$ is a country specific time trend. Finally ε_{ct} is the stochastic error term.

Equation (5) is estimated using OLS and robust correction for heteroscedasticity. Our main results are reported in table 10, while alternative specifications are reported in table B.5 in the Web Appendix B. Let us start with noticing that the specification introduced by equation (5) is the most stringent one, because it controls not only for country specific trends (as it is done in table B.5 in the Web Appendix B) but also for country and year fixed effects. This means that the effects of political inclination of parliaments are captured by unpredictable variations in the preference of the electorate exercising their voting rights. From this table we observe that educational reforms that we classified as *inclusive* (since they increase the mean educational attainment and reduce its dispersion, thus raising the bottom tail of the years of education distribution) tend to be negatively correlated with a right wing attitude of parliaments. This is always true under any specification for access expansion policies, while reforms of pre-primary schooling and teacher qualification change sign according to the policy measure we use. While the correlations with synthetic index of school expansion is not statistically significant, when we take into account single reforms variables, we always find negative and statistically significant coefficients for inclusive variables such as such as duration of compulsory education and tracking age.[36]

On the contrary, *selective* policies exhibit positive correlation with right-wing parliaments (in all cases but the school autonomy index). It is then clear that political orientation of the parliament matters for the type of educational policies undertaken. The other regressors suggest that inclusive educational reforms are more likely in richer countries/periods, given the positive association per-capita income, while public expenditure i

on value added seems to favour reforms. It is worth noticing that reforms associated to school autonomy and accountability do not exhibit statistically significant correlations with either the ideological orientation of parliaments nor with the availability of resources, but tend to be negatively correlated with (log of) GDP per capita. Given the inclusion of country-specific time trends, this suggests that these policies are more likely to occur in recession years.

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[36] The coefficient of duration of compulsory school is -0.355***, while that of tracking age is -0.283***

Table 10 - Educational reform and political variables – OLS – 1950-2000

	1 pre-primary	2 expansion	3 teachers	4 school autonomy	5 university autonomy	6 financial support
right-wing orientation of parliament	-0.023*	-0.004	0.033**	0.016	0.029**	0.030**
	[0.013]	[0.006]	[0.015]	[0.015]	[0.012]	[0.013]
log GDP per capita	0.317***	0.228***	0.202*	-0.363***	-0.552***	0.467***
	[0.097]	[0.046]	[0.122]	[0.113]	[0.109]	[0.101]
government share	1.782***	4.387***	2.340***	0.117	4.528***	4.942***
	[0.574]	[0.406]	[0.868]	[0.776]	[0.831]	[0.770]
Observations	843	843	843	843	770	770
R²	0.844	0.895	0.871	0.864	0.893	0.828
Countries	24	24	24	24	17	17

Note: Robust standard errors in brackets - * significant at 10%; ** significant at 5%; *** significant at 1% constant, country and year fixed effects, country-specific time trend included

The parliament ideological orientation displays the strongest correlation with reform activity in the educational field. When we consider the cabinet orientation, we do find much weaker correlations. Despite the set of controls we have introduced in table 10, we do not claim the existence of causal links between electoral outcomes and reforming activity of governments, since reversal causality is a real issue in this type of analysis (that is, people may vote following promises that are implemented later on). However, finding significant correlations with ideological inclinations of parliament reinforces our claim that the reforming activity variables are truly exogenous for individual educational choices, and therefore they matter in shaping the distribution of educational attainment in the populations.

7. CONCLUSIONS

In the present paper we have merged several datasets in order to obtain a large sample of the European population. By associating individuals to educational reforms they were exposed to, we have exploited cross-country and temporal variations to show that reforming the educational systems affects the educational investment of the corresponding populations.

We grouped available information on reform activities in six areas of intervention: pre-primary schooling, expansion of access to education, teacher qualification, autonomy and accountability of schools, autonomy and selectivity of universities, financial support to students. For each reform area we have created a summary index of reforming activity. We have then studied their effects on mean educational attainment, inequality and intergenerational persistence. We have also explored the heterogeneity of this impact across deciles of the educational attainment distribution.

We have noticed that some reforms affect the achievement by raising the bottom tail of the distribution, while others enhance the upper tail. Combining the results obtained about the reforms' impacts on mean achievement as well as on educational inequality, we have proposed a classification of the reforms along two dimensions, identifying two main groups: *inclusive* and *selective reforms*. Existing reforms offer a policy menu available to policy-makers, who have to take into account at least three orders of problems: sequencing of reforms (since inclusive policies tend to be adopted at early stages of mass schooling, while selective policies come later), availability of funds and ideological orientation of ruling parties. Exploring the correlations between the political orientation of parliaments and/or governments in office and the six indices of reforms, we have shown that *inclusive policies* were favoured by left-wing parliament, while *selective policies* tended to be promoted in more conservative ones.

Our analysis has mostly a positive content. When we move to a normative approach, we should emphasise that we have maintained that more schooling is good *per se*. There are good reasons supporting this working assumption: leaving apart private monetary returns in the labour market, social returns have been proved to extend to health, life expectancy, delinquency, social participation (Oreopoulos and Salvanes 2011). Even restricting to the return associated to output growth, our analysis indicates that educational reforms are cost effective.

However these effects are measured at the mean of the distribution. When we consider heterogeneous populations, social preferences are hard to identify. Our analysis on the correlation between party ideologies and type of reforms

suggests that different groups of voters have different ideas about the optimal distribution of schooling in the society. Even if every party agrees on the social desirability of more years of education, right and left wing parties seem to disagree about which tail of the distribution should accomplish this result. The former stress the excellence and meritocracy, striving for improvements among better endowed students, while the latter are concerned with equality of opportunities, pushing disadvantaged students to achieve more. A typical example of this alternative is provided by the problem of allocating grants and scholarships in college admissions. If scholarships are distributed according to family conditions, they will favour disadvantaged students, who are less likely to apply for admission. If scholarships are distributed according to best performing students, they are more likely to end up in the hands of students from affluent families. None of these (admittedly extreme) alternatives clearly dominates the other, and this may explain why different countries have chosen different combinations of policies (helping the econometrics to identify their individual contribution).

In addition to social preferences, there are additional reasons why a government may be induced to adopt one policy instead of another. The first one is historical path dependence. Some countries (like the Nordic ones) are early achievers in mass schooling, while others (like the Mediterranean ones) are late comers. We have shown that the vertical integration of the educational production function requires that a country initially expands compulsory education, then opens out tertiary education and eventually shifts to granting more autonomy to schools and universities. Historical experience described by our dataset indicates that almost all countries passed through an initial phase of inclusive policies, later on shifting to selective policies in many instances. But resource constraints matter as well. Different reforms have different costs and different timing for implementation. In the paper we provide a measure of their overall impact on mean and dispersion, but we ignore many details of their actual carrying out (like for example the target population, the time required to achieve the policy goal, the cost per capita).

However, the rough picture emerging from our analysis allows us to provide policy makers with a menu of alternatives. In addition to growth concerns, if a policy maker aims at reducing inequality in education, she should adopt inclusive policies, among which expansion of compulsory education and financial support of students are the dominant options. On the contrary, if one believes that over-education does represent a waste of resources, she should move in a different direction, favouring selective policies like the enhancement of university autonomy.

With all possible caveats about conducting this exercise, we believe that our results bring in a clear message: despite market incentives (which we do not explicitly model in this paper), educational choices can be shaped by policy makers, who may affect both the mean and the variance of the distribution of attainments..

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APPENDIX A

A.1: Sources of information on institutional features of education systems

REFORM	SOURCES
Pre - primary expansion	- Eurydice: National Education System Descriptions (Section 3) - Garrouste (2010)
Entry age	- Eurydice: National Education System Descriptions (Section 2,3,4) - Garrouste (2010) - Brunello, Fort and Weber (2009)
Duration compulsory education	- Eurydice: National Education System Descriptions (Section 2,4,5) - Garrouste (2010) - Brunello, Fort and Weber (2009)
Tracking age	- Eurydice: National Education System Descriptions (Section 2,4,5) - Garrouste (2010)
Expansion of university access	- Eurydice: National Education System Descriptions (Section 6) -Garrouste (2010) - Eurydice (1999): "Key Topics in Education, Volume 1, Financial Support for Students in Higher Education in Europe" - Eurydice (2000) "Two Decades of Reform in Higher Education in Europe: 1980 Onwards"
Standardised test (for career advancement)	- Eurydice (2009): "National Testing of Pupils in Europe: Objectives, Organisation and Use of Results"
Pre-primary school teacher qualification	- Eurydice: National Education System Descriptions (Section 8)
Primary school teacher qualification	- Eurydice: National Education System Descriptions (Section 8)
Secondary school teacher qualification	- Eurydice: National Education System Descriptions (Section 8)
School evaluation	- Eurydice: National Education System Descriptions (Section 9) - Eurydice (2004): "Evaluation of Schools Providing Compulsory Education In Europe" thematic study
School autonomy	- Eurydice (2008) "School Autonomy in Europe Policies and Measures"
Teacher autonomy	- Eurydice (2008) "Levels of Autonomy and Responsibilities of Teachers in Europe"
Standardised test (for other purposes)	- Eurydice (2009): "National Testing of Pupils in Europe: Objectives, Organisation and Use of Results"
Selectivity in university access	- Eurydice (1999): "Key Topics in Education, Volume 1, Financial Support for Students in Higher Education in Europe"
Index of university autonomy	- Eurydice (2000) "Two Decades of Reform in Higher Education in Europe: 1980 Onwards" (p. 91)
Increase grant size	- Eurydice (2000) "Two Decades of Reform in Higher Education in Europe: 1980 Onwards"
Loan component to grant component	- Eurydice (2000) "Two Decades of Reform in Higher Education in Europe: 1980 Onwards"
Interest rate	- Eurydice (2000) "Two Decades of Reform in Higher Education in Europe: 1980 Onwards"

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