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PUBLIC EDUCATION SPENDING: EFFICIENCY, PRODUCTIVITY AND POLITICS

PAOLA AZAR DUFRECHOU

Universitat Autònoma de Barcelona

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Author:

PAOLA AZAR DUFRECHOU

Advisors:

ORIOL ROCA SAGALÉS & ALFONSO HERRANZ LONCAN

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"*If you think education is expensive, try ignorance***."**

Derek Curtis Bok (1930-...)

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Chapter 1

Introduction

1.1. Background and motivation

The numerous benefits arising from education have become a consensual issue among scholars and policy-makers. Education has been recognized as a key factor of economic growth and development (Lucas, 1988; Romer, 1990), democracy (Sen, 1999; McMahon, 1999), social mobility and individual fulfillment (Ravallion and Chen, 1997; Sen, 1999; Bénabou, 2005). The strength of these advantages has reached the political discourses, which have often seen education upgrading as a crucial development goal (Busemeyer et al., 2013). However, this widespread agreement becomes hazy when it comes to the decisions about the allocation of public resources. Then, macroeconomic and technical objectives, pressures of social elites or political interests of governing parties seem to end up shaping policy choices.

This dissertation examines public education spending and educational outcomes across countries and over time. Its three chapters explore different aspects of the topic: Chapter 2 analyses the efficiency of public education outlays. Chapter 3 revolves around the economic growth impacts of tertiary education and of the resources it captures at the expense of primary education. Chapter 4 assesses the partisan motivations behind the decisions on primary education budget allocations. Although inspired by these general questions, all chapters pay special attention to the performance of upper-middle income Latin American countries (LACs). More specifically, Chapter 2 and 3 analyse upper-middle LACs in the context of a set of developed and developing economies for the period 1970-2010. In turn, Chapter 4 focuses on the case of Uruguay during the first half of the 20th century.

LACs provide an interesting case study to think about the relevance of education resource allocation, its structure and outcomes. Historically, they have devoted more fiscal funding to education than other developing regions, which contrasts with their insufficient accumulation of human capital (Lindert, 2009), and their disappointing low position in international cognitive tests (Hanushek and Woessmann, 2012). Besides, over the last 40 years, they have been characterized by poor productivity gains and relative stagnation, specially compared to other peripheral countries that have been able to catch-up (IDB, 2011; Daude and Fernández, 2010).

The three chapters focus on the performance of the public sector, for it is the main provider of educational services in most countries. Government sets the design and main operation of the formal education and training system. It also conditions the whole structure of educational institutions and creates the incentives and costs to acquire skills. Thus, the level of public education expenditure is essential. However, what matters is not just the amount of tax support devoted to schooling, but also how this amount is spent.

Through the different chapters of this thesis it is argued that how efficiently and effectively spending is translated into educational outcomes is crucial for the accumulation of those skills that will be applied in all social, economic and political interactions. Moreover, government's choices about the distribution of education investments across different educational levels may encourage certain education attainments and forms of human capital at the expense of others, thus limiting the progress of certain groups or empowering those who would not contest the political power of the incumbent political leaders. Ultimately, these decisions related to the allocation of funds can affect the mechanisms behind economic growth and redistribution (Nelson and Phelps, 1966; Barro, 1991).

Finally, the following chapters have in common the attention to the performance of public education spending *over time*. The analysis in Chapters 2 and 3 considers a 40-year time scope to take advantage of the long-run differences in educational records between nations. The period is also suitable to unveil the long-term implications of education resource allocation decisions. As for Chapter 4, it provides evidence on primary education provision at the beginning of the 20th century, aiming at emphasizing the role of history for our understanding of the evolution and long term persistence of government biases in the management of schooling systems. From an analytical perspective, the long-term view adopted in the thesis required the compilation and adaptation of several international and national-level databases, some of them used for the first time in quantitative studies on the economics of education.

1.2. Three empirical studies on public education spending

This section presents a summary of the three central chapters of the dissertation, including their main contributions.

Chapter 2. The efficiency of public education spending in Latin America: a comparison to high-income countries[*]

Public expenditure is deemed to be efficient when it produces the largest possible benefit, given the amount spent. Following this definition, this chapter analyses the efficiency of public education spending and its conditioning factors for upper-middle income LACs, compared to high-income economies over 1970-2010.

The economic value of efficiency is particularly relevant for economies suffering from severe resource and macroeconomic constraints that limit the scope for expenditure increases. Indeed, inefficiencies in public education spending have been frequently put forward to explain the low education achievements of LACs. The main hypothesis of this study is that, desirable as it is, in low spending settings the mere efficiency increase would not be enough to lead to better outcomes. The empirical assessment resorts to a two-stage approach, first obtaining country-efficiency scores through a Data Envelopment Analysis (DEA), and then identifying their possible determinants by means of panel bootstrapped and truncated regressions.

The results show a relative minor role of inefficiencies since 1990, particularly for LACs, and allow distinguishing different profiles depending on the country's education outlays. Besides, income per capita, globalization and democracy emerge as essential factors determining efficiency gains.

The chapter makes two main contributions to the available literature. On one hand, it draws the attention to the performance of the most developed LACs compared to the world richest countries from a long term perspective. In previous studies, LACs have been considered as part of a big sample in a cross-section basis. In those cases in which they have been the specific object of study, the analysis would not distinguish their relative level of development. The setting provided in this chapter allows a better assessment of the current policy challenges of upper-middle income LACs', which tend to remain hidden when regional, developing or world-wide samples are analysed. On the other hand, the determinants of efficiency variability are

[*] This chapter has been published in: International Journal of Education Development 49(2016), 188-203.

explored through a set of panel bootstrapped truncated regressions. As suggested by Simar and Wilson (2007), this methodology corrects for small sample biases and serial correlation while improves the identification of the efficient individuals usually applied in the prior research works.

Chapter 3. The economic impact of tertiary education: the role of public spending and skill choices

This study examines the cross-country impact of tertiary education on the level and growth of income per capita. Specifically, it explores the extent to which the contribution of tertiary educated people to productivity changes depends on the tertiary tilt in public education expenditure and the share of students trained at the fields of mathematics, physics and life sciences. The analysis is applied to a panel of high and upper-middle income countries between 1970 and 2010.

The widely recognized positive externalities of tertiary education provide good arguments for its public support (Aghion and Howitt 1998; Benhabib and Spiegel 2005; Nelson and Phelps 1966; Romer 1990). Still, this type of public expenditure has been subjected to suspicions based on the budgetary resources it captures at the expense of mass schooling (Gruber and Kosak, 2014). Besides, the literature has suggested that not all skills produced by the tertiary system are important if the objective is to boost innovation and productivity. Putting these different statements together, this chapter tests whether the structure of resource allocation among educational levels and the type of tertiary education contents affect the benefits from higher education. The analysis is based on a set of system GMM regressions and Hierarchical Linear Models, which allow dealing with endogeneity concerns and account for parameter heterogeneity.

The chapter finds that the effect of tertiary schooling depends negatively on how much government tilts education outlays towards tertiary students. Moreover, for a given share of tertiary educated, the range of scientific and technological enrolment compared to other skill profiles becomes into a potent determinant of economic growth.

The main contributions of this study can be summarized as follows. First, it provides new evidence about the economic impact of tertiary education. Second, it revises and compiles information for a 40-year period to examine the relevance of two mechanisms mediating in the effects of tertiary schooling, for which not many references are found in the available empirical research. Third, the country sample allows focusing on the challenges for higher education in countries that have largely surpassed minimum education standards. In this sense, though the

discussion is not exclusively focused on LACs, it brings on insights to reflect over the role of education spending on their modest development results.

Chapter 4. Electoral politics and the diffusion of primary schooling: evidence from Uruguay, 1914-1954

The last chapter analyses whether the extent of government fiscal commitment to primary education is explained by the interests of tactically motivated politicians. The study focuses on Uruguay between the years 1914-1954, a period of significant expansion of the country's primary education system. The diffusion of public primary education is one of the first signs of an emerging social relationship between state and masses and it is crucial to foster socialization and nation-building (Ansell and Lindvall, 2013). Besides, it historically was essential to provide the labor force of newly independent countries with the new skills and values needed to become competitive.

The analysis frames into the "pork barrel" or "distributive politics" models that posit that government allocates public resources seeking either to obtain a greater political support or to avoid losing it (Cox, 2009; Golden and Min, 2013). In this line, the central hypothesis is that, when distributing basic education funds, the ruling party weighted its political strengths across the country regions. The empirical test on this premise relies on panel data fixed effects models covering 18 Uruguayan departments. The estimation is based on the compilation of department-level data of number of available schools, electoral results and legislative composition for the period.

The findings of this chapter reveal that political motivations have had a significant role in schooling provision across the territory. Throughout the period, the incumbent government has used the resource allocation in primary education some times to reward its core supporters and other to persuade political opponents. The results challenge the vision prevailing in the Uruguayan historical literature about the genuine commitment of politicians with public education. They also provide an additional argument to the ongoing debate about the reasons behind the backwardness of the consolidated LACs' primary education systems after the mid-20th century (Lindert, 2010; Frankema, 2009). Similarly, they can be useful to explain the roots of the poor quality of education that features the region at the end of the 20th century (Hanushek and Woessman, 2012).

References

Aghion, P. and Howitt, P. 1998. Endogenous growth theory. MIT Press, Cambridge, MA.

Ansell, B. and Lindvall, J. 2013. The political origins of primary education systems: ideology, institutions, and interdenominational conflict in an era of nation-building. The American Political Science Review 107(3), 505-522.

Barro, R., 1991. Economic growth in a cross section of countries. The Quarterly Journal of Economics 106(2), 407–443.

Benhabib, J. and Spiegel, M.M., 2005. Human capital and technology diffusion. In Aghion, P., Durlauf, S. (eds.), Handbook of Economic Growth. Elsevier, Amsterdam, 935–966.

Busemeyer, M., Franzmann, S. and Garritzmann, J. 2013. Who owns education? Cleavage structures in the partisan competition over educational expansion. European Politics 36(3), 521-546.

Cox, G. 2009. Swing voters, core voters and distributive politics. Department of Political Science University of California, San Diego. Unpublished manuscript.

Daude, C. and Fernández, E. 2010. On the role of productivity and factor accumulation in economic development in Latin America and the Caribbean. IDB Working Paper Series 155.

Engerman, S. and Sokoloff, K. 2001. The evolution of suffrage institutions in the new world. Working Paper 8512, National Bureau of Economic Research.

----------2000. Institutions, factor endowments and path of development in the new world. Journal of Economic Perspectives 14(3), 217-232.

Golden, M. and Min, B. 2013. Distributive politics around the world. Annual Review of Political Sciences 16, 73-99.

Gruber, L. and Kosack. S. 2014. The tertiary tilt: education and inequality in the developing world". World Development 54, 253-272.

Hanushek, E. and Woessmann, L. 2012. Schooling, educational achievement, and the Latin American growth puzzle. Journal of Development Economics 99(2), 497-512.

Huber, E., Pribble, J. and Stephens, J. 2008. The politics of effective and sustainable redistribution. In Estache, A. and Leipziger, D. (eds.), Fiscal Incidence and the middle class: implications for policy, The World Bank, Washington, DC.

IDB-Inter-American Development Bank. 2011. Social Strategy for Equity and Productivity in Latin America and the Caribbean. Washington, DC: Inter-American Development Bank.

Lindert, P. 2010. The unequal lag in Latin American schooling since 1900: follow the money. Revista de Historia Económica / Journal of Iberian and Latin American Economic History 28(02), 375-405.

---------- 2009. Revealing failures in the history of school finance. NBER Working Paper No. 15491.

Lucas, R. 1988. On the Mechanics of Economic Development. Journal of Monetary Economics 22 (1), 3-42.

McMahon, W. W. 1999. Education and Development: Measuring the Social Benefits, New York: Oxford University Press.

Nelson, R. and Phelps, E. 1966. Investment in humans, technology diffusion and economic growth. The American Economic Review 56(2), 69-75.

Ravallion, M. and Chen, S. 1997. What can new survey data tell us about recent changes in distribution and poverty? World Bank Economic Review 11(2), 357–382.

Romer, P.M. 1990. Endogenous technological change. Journal of Political Economy 98(5), S71-102.

Sen, A. 1999. Development as freedom. New York: Alfred A. Knopf Inc.

Simar, L., Wilson, P., 2007. Estimation and Inference in Two-Stage, Semi-Parametric Models of Production Processes. Journal of Econometrics 136 (1), 31-64.

Chapter 2

The efficiency of public education spending in Latin America: a comparison to high-income countries

2.1 Introduction

Over the last years, concerns about public sector efficiency have increasingly become a focus of interest for policymakers. More efficient public interventions are deemed to alleviate budget constraints by reaching the same results with fewer resources or improving the outcomes from current investments. This principle would hold, even for sensitive policy objectives and for countries at different development levels. Hence, the lack of efficiency in public education spending has been frequently put forward to explain the low education achievements of Latin American countries (ECLAC, 2015a; IADB, 2011; IMF, 2014). Conversely, the fact that these countries have been also characterized by relatively low public education outlays, seem to have gradually received far less attention. Still, lack of resources may jeopardize the ability of mere efficiency improvements to lead to better outcomes.

The goal of this chapter is to track the presence of the alleged resource misuse in Latin American countries by estimating education spending efficiency and the conditions shaping efficiency in the region from a long-term perspective. It considers a sample where 11 upper-middle income Latin American economies are compared to 24 high-income countries (from now on, LACs and HICs, respectively) in the period 1970-2010.

The study applies a Data Envelopment Analysis (DEA) to determine an efficiency score for each country. In a second stage, *bootstrapped* truncated panel regressions models are estimated to account for possible determinants of the efficiency path, with a specific attention on LACs. The primary focus is on the role played by income per capita, economic globalization and democracy.

Though still far from the average 6% of GDP invested in education by HICs, the figure in LACs went up from 3.1% in 1970 to 4.5% in 2010 (World Bank, 2015). However, these spending levels are rather low compared to other upper-middle income regions. Per-pupil spending in primary and secondary education -that account for more than 80% of the total - has been, respectively, 12% and 14% of GDP per capita in LACs *vis-à-vis* 15% and 18% in countries from other regions with similar GDP per capita levels. This heterogeneity in expenditures is not exclusive of upper-middle income countries; for instance, among HICs, the average education

spending ranges from 5% (Switzerland) to 7.13% of GDP (Denmark). Given that spending profiles do not seem to strictly follow from GDP levels, this study aims at understanding the relationship between efficiency and changes in per capita income levels.

Along with income, two significant changes might have affected efficiency during the period. The first one is the acceleration of economic globalization. The shock was particularly intense for LACs, as international exposure had been historically low during the "inward-looking development stage" (1950-1973). Since then, a drastic trade and financial liberalization was combined with hard budget constraints seeking to curb inflation and gain international competitiveness.[1] The second essential change is the democracy recovery. While political participation and competitiveness were already consolidated in HICs, after the mid- 1980s several LACs could overcome *de facto* regimes and restore democratic institutions. Regarding the amount of public education spending, the available literature finds that economic openness has had a positive impact on HICs' (Cameron, 1978; Garrett, 2001; Rodrik, 1998), but not on developing economies (Kaufman and Segura, 2001; Wibbels, 2006). By contrast, democracy and social outcomes have appeared more clearly linked with increasing education expenditures at LACs' recently recovered democratic systems than at HICs' long lasting democratic contexts (Adserá and Boix, 2002; Brown and Hunter, 1999; Kaufman and Segura, 2001). Adding to this background, this study discusses whether these factors have also exerted a differing influence in terms of spending efficiency in LACs and HICs.

The data and estimation methods used in the present analysis are different from previous cross-country DEAs studies. A large proportion of the existing literature measures education efficiency for recent periods based on the results of the Programme for International Student Assessment tests (PISA) and, with few exceptions, it mainly covers high income countries (Afonso and St. Aubyn, 2005; 2006; Mandl et al., 2008; Sutherland et al., 2007 and 2009; Verhoeven et al., 2007, Thieme et al., 2012). By contrast, and due to scarcity of data on PISA scores, cross-country studies available for developing economies have generally measured efficiency in terms of enrolment rates and adult illiteracy (Afonso et al., 2010; Grigoli, 2014; Gupta and Verhoeven, 2001; Hauner and Kyobe, 2010; Herrera and Pang, 2005; Jayasuriya and Woodon, 2005). Within this group, the particular case of Latin American countries has been barely considered (Machado, 2006; Afonso et al., 2013; Salazar Cuellar, 2014). On the other hand, the determinants of efficiency variability have generally been explored by means of cross-section Tobit models. The use of panel data and truncated regression techniques have been less frequent (Grigoli, 2014; Hauner and Kyobe, 2010; Wolszczak and Parteka, 2011).

[1] These policies were part of the "Washington Consensus", a term applied to the set of structural reforms for the region, promoted by the International Monetary Fund and the World Bank.

This study contributes to the previous literature in various ways. First, it significantly enlarges the time span of previous analysis by using education attainment to estimate efficiency. Second, the country-sample combines the LACs' more advanced economies and the world's richest ones. This setting attempts to better assess LACs' current policy challenges, which tend to remain hidden when regional, developing or world-wide samples are analysed. Finally, it applies panel *bootstrapped* truncated regressions, as suggested by Simar and Wilson (2007), to address the differing impact of efficiency determinants between country-groups.

The rest of the chapter is organized as follows. Section 2.2 provides an overview of the data sources used to compute efficiency and its determinants. In Section 2.3, the methodological approach and empirical strategy are explained. Results are presented in Section 2.4, while Section 2.5 tests their robustness. Section 2.6 discusses the main findings and Section 2.7 concludes.

2.2 Data and sources

2.2.1 DEA scores

The study builds on a panel comprised by 11 Latin American upper-middle income economies and 24 high-income countries, as classified by the World Bank (Table A.2.1 in the Appendix). The data cover the period 1970-2010.

Following the Data Envelope Analysis (DEA), given a set of comparable individuals, efficiency measures the degree to which their use of some inputs to produce certain outputs matches the optimal one. In the present analysis, the output indicators are "average schooling years" and "population with secondary level as highest attainment" (not necessarily complete) for those aged more than 15 years old. The latter is expressed in absolute terms, to reflect the size of each country. This output-mix is deemed to capture the stock of qualifications or education capital produced by each domestic education system, providing an idea about the effectiveness of the access to formal education. Its advantage against the more common "enrolment rate" is that the latter includes those that drop-out of school prematurely and is affected by the number of repeat students.

The input is per capita public education spending. As output variables are not attached to any particular education level, the input measures the bulk of public resources invested by a country to sustain its education system from pre-school to university and tertiary educational levels.

Data on school attainments come from the Barro and Lee database, version 2.0 (2013). It compiles information on 146 countries from 1950 to 2010, at 5-year intervals. This restricts the efficiency estimations for each country to 9 time-spans between 1970 and 2010.

Public education expenditure data have been obtained from several sources, as they were not directly available from a single database or, in some cases, did not cover the General Government- the most suitable category to account for the real fiscal effort addressed to education.[2] Information has been compiled from ECLAC, IMF, OECD.stats, UNESCO and the World Bank, together with statistical information from each particular country. Azar and Fleitas (2012) contain detailed references. Data are expressed in constant purchasing power parity adjusted dollars (PPPs) and in per capita terms, based on the series of GDP and population of the Penn World Tables (PWT, 8.0) (Feenstra et al., 2013). Table A.2.2 contains the descriptive statistics for the output and input variables.

It must be noted that while the input refers to public spending, the outputs reflect the education attainment of the whole population, not just of those who have participated in the public subsystem. Since the available data do not allow distinguishing between the public and private education sector output, the estimates will not exactly capture "public" spending efficiency. However, this bias is partially neutralized by the weight of the public subsystem within the country sample. On average, during the period, public enrolment in LACs has been 83%, 78% and 70% of total at the primary, secondary and tertiary levels, respectively. The equivalent percentages in HICs have been 82%, 81% and 80%. Within both country groups, the diversity of public enrolment shares has been higher for tertiary education, where in addition, the presence of the public sector has tended to decrease over time (Table A.2.3). Yet, tertiary education represents the lowest share of education spending (an average of 20% of the total in both country-groups). Therefore, the evolution of the output indicators that are considered in this chapter would have been mostly driven by the action of the public sub-system.

Likewise, school attainment and spending figures call for some caution. Databases compiling schooling levels have been criticized, as their information has frequently resulted in implausible time-series and there have been numerous attempts to improve them (Cohen and Soto, 2007; de la Fuente and Doménech, 2006). The new version of the database compiled by Barro and Lee (2013) accounts for most criticisms by using information by age groups to substitute the old perpetual inventory methodology based on enrolment ratios that proved to

[2] General Government consists of central, state and local governments and social security funds.

be very inaccurate. However, it might not be completely free from measurement errors, which can also affect the education spending series, since they have been built from several sources.

2.2.2 Conditioning factors

In a second stage, efficiency scores will be regressed against a set of explanatory factors which may have conditioned the efficiency path. Hence, data on constant per capita GDP is taken from PWT 8.0. The effect of economic openness is *proxied* by an index of "economic globalization" built by Dreher (2006). This variable combines two indices: one measures trade, foreign direct investment and portfolio investment as a percentage of GDP, and the second measures restrictions on trade and capital (import barriers, tariff rates, capital controls). Their combination ranks the increasing flows of trade and investments and decreasing restrictions on trade and capital movements from 0 to 100 and is available since 1970. As noted, LACs underwent a drastic economic liberalization process which operated through a simultaneous openness of the capital account (that mainly attracted portfolio investment and short-term debt) and freer entry conditions for imports into the domestic market. Therefore, the combined Dreher's indicator is deemed to better represent the whole process than the traditional "trade openness" measure given by the sum of exports and imports over GDP.

As for democracy, it is assessed through a scale variable (0-10) taken from the Polity IV Dataset. It summarizes the presence of free elections and institutionalized constraints to the exercise of power by the executive (Marshall and Jaggers, 2002).

Apart from these relationships, the panel regressions control for other possible influential factors. A potential incidence of the dimension of public sector will be appraised by an index of "government size", which ranges between 0 (large government) and 10 (small government). It combines indicators of general government consumption, transfers and subsidies, government enterprises, investment and top marginal tax rates (Gwartney et al., 2012).

Interest paid on debt will also be introduced to calibrate the influence of budget constraints on efficiency during the period. Data have been compiled from several sources detailed in Azar and Fleitas (2012). To control for the influence of income inequality, data on Gini household gross income are taken from the "Standardized World Income Inequality Database" (Solt, 2014). The indicator mirrors the economic and social context prevailing before government intervention has taken place, because this intervention is already considered by the inclusion of the rest of fiscal variables. Regressions also include two demographic controls: the share of younger people over the whole population and the share of urban population in the largest

city (World Bank, 2015). A summary of the descriptive statistics of the second-stage variables is presented in Table A.2.4.[3]

Scholars have raised the importance of a sound institutional context in the areas of governance, regulation and bureaucracy quality to shape efficiency. Regretfully, systematic quantitative information on these aspects is not available for the time-frame covered in this study, although per capita GDP and income distribution may partially capture them.

2.3 Methodological approach and empirical strategy

2.3.1 DEA efficiency computation

According to Farrell (1957), economic efficiency is a combination of technical and allocation efficiency. The former indicates the competence with which inputs are transformed into valued outputs and the latter whether the used inputs ensure a minimal cost for the given market prices.

The present study assesses technical efficiency of a set of decision making units (DMUs) by means of a DEA. Consequently, prices are not under study, despite being implicitly part of the efficiency problem, because public spending is used as an input. The method identifies the optimal performance within a sample and computes efficiency scores by taking differences between observed and best practice DMUs (here countries). It belongs to a range of nonparametric frontier methods inspired by Farrell (1957) and later generalized by Charnes et al. (1978).

DEA assumes the existence of a production possibilities frontier (an "envelope") that defines which linear combination of observed input-output bundles are feasible. Taking as known prices or multipliers $\bar{u}_r$, $\bar{v}_i$ associated with r outputs (y) and i inputs (x), the relative efficiency of unit j ($e_j, j = 1, \dots n$) can be expressed as the ratio of the weighted outputs to the weighted inputs: $e_j = \frac{\sum_r \bar{u_r} y_{rj}}{\sum_i \bar{v}_i x_{ij}}$

However, as multipliers are unknown, Charnes et al. (1978) introduced a linear programming problem where the weights are not pre-assigned, but generated as a by-product of the statistical estimation process. The dual form of the original model is equivalent to the "output-

[3] The variables "economic globalization", "democracy" and "size of government" have been obtained from the QOG database that compiles several datasets (Teorell et al., 2015).

oriented envelopment" program that aims to maximize the output production of each DMU subject to a given input level.[4]

Consider the case of DMU_1:

$$max\delta_1 \qquad (1)$$

$$\sum_j \lambda_j y_{rj} \geq \delta_1 y_{r1} \qquad r = 1, \dots s \qquad (2)$$

$$\sum_j \lambda_j x_{ij} \leq x_{i1} \qquad i = 1, \dots m \qquad (3)$$

$$\sum_j \lambda_j = 1 \qquad (4)$$

$$\lambda_j \geq 0 \quad \forall\, i, j, r \qquad (5)$$

δ_0 unconstrained

where $\delta_1 \geq 1$ in (1) is the optimal solution to this problem, representing the "output-efficiency score". It indicates the proportion by which the s outputs need to increase for DMU_1 to be located on the production possibility frontier. Thus, it measures technical efficiency as the distance to the production frontier. If $\delta_1 > 1$, the DMU is inside the frontier, that is, it is inefficient. Meanwhile, if $\delta_1 = 1$ it is on the frontier.

Equation (2) stands for the "output constraint", indicating that the weighted sum of outputs from all DMUs in the sample must be greater than or equal to the potential output for DMU_1, given the "input constraint" shown by equation (3). There, each λ_j is a constant representing the weights with which the DMU replicates the behaviour of the others and follows its practices in the use of inputs to produce outputs. This sum must be less or equal than the input available for DMU_1. Each λ_j is applied to compute the location of an inefficient DMU if it were to become efficient. The maximization problem is solved as many times as DMUs in the sample.

The above specification assumes Variable Returns to Scale (VRS) (restriction 4). This condition, proposed by Banker et al. (1984), imposes convexity to the frontier. Thus, each DMU is compared to its observed efficiency peers only: that is, the ones entailing its closer reference. Dropping this restriction would lead to assume Constant Returns to Scale (CRS), which imply that all DMUs are operating at their technically most efficient scale and able to scale the inputs and outputs linearly without increasing or decreasing efficiency.

[4] Alternatively, an "input-oriented" envelopment program seeks to minimize the inputs given the attained outputs.

Some studies apply an alternative frontier-approach: the "Free Disposal Hull" (FDH). This is more flexible than DEA, requires fewer assumptions and removes the convexity restriction. As a result, it tends to assign perfect efficiency to a larger number of DMUs. DEA is the preferred estimation in this analysis since the interest lies in exploring the diversity in efficiency levels across units.

2.3.2 Second stage model

Once computed, efficiency scores can be adjusted to reflect the impact of "non discretionary" or environmental variables. These are considered non-controllable inputs, because they cannot be directly manipulated by the producer but do influence the DEA estimates (δ). In this study, the impact of potential conditioning effects is accounted by a panel data regression analysis, which takes on the following general specification:

$$\hat{\delta}_{jt} = a + z_{jt}\beta + \varepsilon_{jt} \qquad (6)$$

where j refers to the DMUs in the sample, t represents the time period, a is a constant, β is the vector of parameters assessing the influence of non-discretionary inputs or explanatory variables (z_{jt}) on efficiency, and ε_{jt} is a statistical noise.

According to Simar and Wilson (2007, 2011), the regression analysis should consider a truncated model, to respect the bounded domain of efficiency scores and their true Data Generating Process. They argue that truncation reflects the accumulation of observations at 1, stemming from the way the DEA scores are computed. A score of 1 is just an estimated bound for the true (unobserved) efficiency, as even the best producers have room for improvement. Under these assumptions, $\varepsilon_{jt} \geq 1 - a - z_{jt}\beta$ and represents a truncated normal random variable. The Tobit approach, prevalent in applied research would be unsuitable, because it wrongly takes the concentration of DEA scores at 1 as reflecting a censoring mechanism. [5]

An important econometric issue arises from the fact that non-discretionary variables (z_{jt}) might be correlated to the error term (ε_{jt}) through the relationship between the inputs and outputs used to estimate the scores. Simar and Wilson (2007) note that as non-parametric DEA estimators tend to converge slowly, the correlation amongst the errors does not disappear quickly enough to make inference valid. However, as this trouble tends to disappear

[5] For some scholars, DEA scores are descriptive measures of technical efficiency with respect to an observed best-practice inferred from a sample (Hoff, 2007; Mc Donald, 2009). Therefore, the scores can be regressed by Ordinary Least Squares or other Maximum Likelihood specification like any other dependent variable.

asymptotically, the authors developed a cross-sectional bootstrap approach that yields valid inference in the second stage regression. They call the method "algorithm 1" (Simar and Wilson, 2007: 41) and it is the procedure followed in the present chapter.

2.3.3 Empirical strategy

Based on the referred methodologies, the present analysis computes education spending efficiency for a panel of countries (DMUs) where governments act as producers of 2 education outputs by using 1 costly input under VRS. In this way, each country is grouped taking into consideration its achievements respect to its spending levels. Besides, the study adopts an "output-oriented" perspective. Therefore, countries are considered efficient if, other things equal, they produce the greatest possible output for the given input.

The assumption of CRS has been discarded from the main analysis because it implies that the inputs and outputs reflect the size of the DMUs and their technically most efficient scale. As a result, DMUs would be able to scale the inputs and outputs linearly without increasing or decreasing efficiency, something that does not make sense for the input-output mix analysed in this study. The "input-oriented approach" has been also disregarded. It is focused on input-reductions to attain the maximum output, but it results unsuitable given LACs' relatively low human capital investments.

DEA estimates for each period take the input variable as an average of the previous 5 years. That specification conforms to the availability of output measures (at 5 year-intervals) and serves as a way to recognize that the main impact on current education attainment comes from past expenditure. The DEA scores have been computed by using two software: DPIN 3.0 (O'Donnell, 2010) and EMS (Scheel, 2000).

In the second stage, building on the efficiency scores, the purpose is to explore whether economic and political conditions might have caused variations in the efficiency path, particularly in the case of LACs. The baseline model takes the following form:

$$\hat{\delta}_{jt} = a + \beta_1 pcGDP_{jt-1} + \beta_2 pcGDP_{jt-1}^2 + \beta_3 LACs_j + \beta_4 eg_{jt-1} + \beta_5 dem_{jt-1} + \Pi Z_{jt-1} + \varepsilon_{jt} \quad (7)$$

where δ_{jt} is the efficiency score for country (j) in period (t); $pcGDP_{jt-1}$ is the real GDP per capita (U$ 2005 PPP); $LACs_j$ is a regional dummy aiming to capture any possible variation in the score due to a distinct regional feature; it equals 1 for LACs, 0 otherwise; eg_{jt-1} stands for economic globalization; dem_{jt-1} corresponds to the democracy index; Z_{jt-1} denotes other

variables that may affect efficiency and ε_{jt} is the error term. Explanatory variables are lagged one period (*t-1*). This implies missing some observations, but in turn, it better reflects that covariates are expected to have a delayed effect on efficiency. Besides, it can also alleviate possible endogeneity concerns, particularly in relation to per capita GDP.

In order to distinguish differing effects on LACs, the regional dummy has been interacted with the globalization and democracy variables (Equation 8):

$$\hat{\delta}_{jt} = a + \beta_1 pcGDP_{jt-1} + \beta_2 pcGDP^2_{jt-1} + \beta_3 LACs_j + \beta_4 eg_{jt-1} + \beta_5 LACs_j \times eg_{jt-1} + \\ + \beta_6 dem_{jt-1} + \beta_7\, LACs_j \times dem_{jt-1} + \Pi\, Z_{jt-1} + \varepsilon_{jt} \qquad (8)$$

Equations (7) and (8) include per capita GDP to explore whether efficiency varies with income levels, as in Afonso et al. (2005), Grigoli (2014) and Herrera and Pang (2005). However, unlike these previous analyses, in this study the model fits a quadratic relation to identify non-linear effects. A negative and significant sign on the squared term would express that inefficiency tends to shrink at the highest per capita levels.

Prior studies have found that higher degrees of international competition over labour and capital increase public sector's efficiency (Afonso et al., 2005; Hauner and Kyobe, 2010). Likewise, more democratic systems would be associated to higher government accountability, which in turn might improve the effectiveness of public policies (Hauner and Kyobe, 2010).

In relation to the control variables, several papers have come up with a negative association between efficiency and public sector dimension (Afonso et al. 2010, Gupta and Verhoeven 2001, Jayasuriya and Woodon, 2005). By contrast, the burden of debt interests might possibly force government to make a more efficient use of resources to honour debt obligations. A similar effect is expected from an equal income distribution, as it is identified with better institutional settings, less prone to abuses and corruption (Herrera and Pang, 2005; Grigoli, 2014). This variable is of particular interest, because LACs have historically held high-inequality standards. In 2011, after one particularly successful decade, their post- tax income Gini coefficients ranged from 0.43 to 0.57 compared to 0.24 to 0.41 for HICs (World Bank, 2013). Finally, the share of young people is expected to increase the cost of the education system relative to the outcome indicators (thus, adding to inefficiency), while the share of urban population in the largest city might be a source of efficiency gains (Hauner and Kyobe, 2010; Herrera and Pang, 2005; Jayasuria and Woodon, 2005).

The models are estimated by panel *bootstrapped* regressions with truncation of the dependent variable at 1, which excludes the "efficient units". Bootstrapping is performed by taking 1000 withdrawals of residuals from a left- truncated normal distribution, and then re-estimating the truncated regression for each drawing.[6]

Although this technique avoids problems of inference, Simar and Wilson (2007) also suggest a second bootstrap procedure ("algorithm 2") to solve possible serial correlation of the efficiency scores. However, for small sample sizes this "bias correction" hardly changes the original relative efficiency performance. In Wolszczak and Parteka (2011), who consider a larger sample, the score distributions are just slightly moved towards lower efficiency standards compared with the original ones. Indeed, by applying Monte Carlo simulations, Simar and Wilson (2007) found that this second correction appear to worsen the root mean square error of the second stage regressions relative to the simpler bootstrap and introduce additional noise to the computation.

In Section 2.5, several robustness checks are implemented to validate results both, from DEA computations and regression estimates.

2.4 Results

2.4.1 DEA relative efficiency results

Despite their economic and social heterogeneity, efficiency comparisons amongst sample members are interesting, given the important progress made by LACs in terms of education attainment (Table 2.1).

Table 2.1 Education outputs by country-groups (people aged 15 and over)

	Total schooling years		People with secondary education as highest level (%)	
	LACs	HICs	LACs	HICs
1970	4.8	7.3	17	35
2010	8.8	10.8	44	50.5

Source: Barro and Lee (2013)

Moreover, there is a positive correlation in the sample between the outputs and the input (Figures 2.1a and 2.1b). However, a closer look indicates that LACs have tended to achieve rather similar education outputs as compared to richer countries but with lower resources.

[6] The bootstrap procedure is based on the specification by Wolszczak and Parteka (2011).

Figure 2.1a Public education spending and years of schooling (averages 1970-2010)

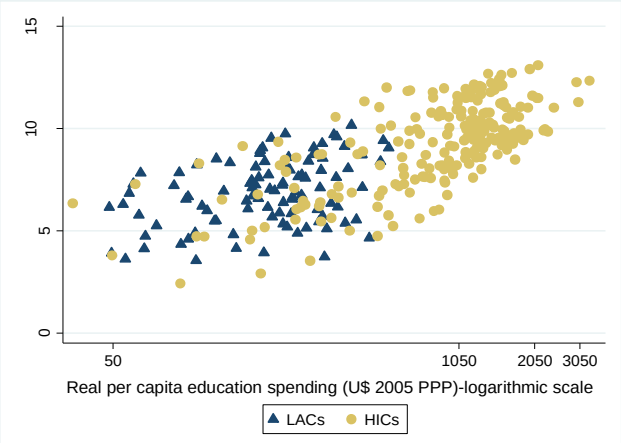
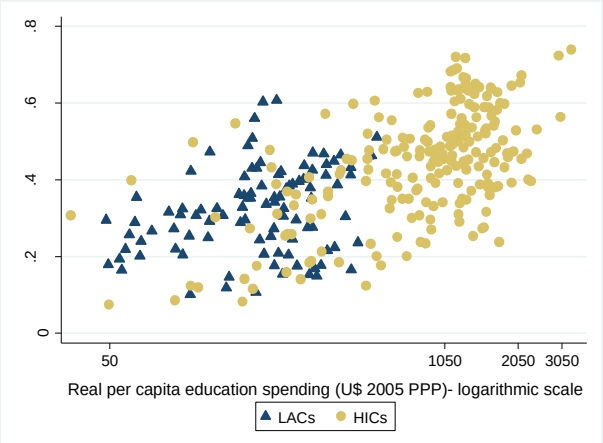


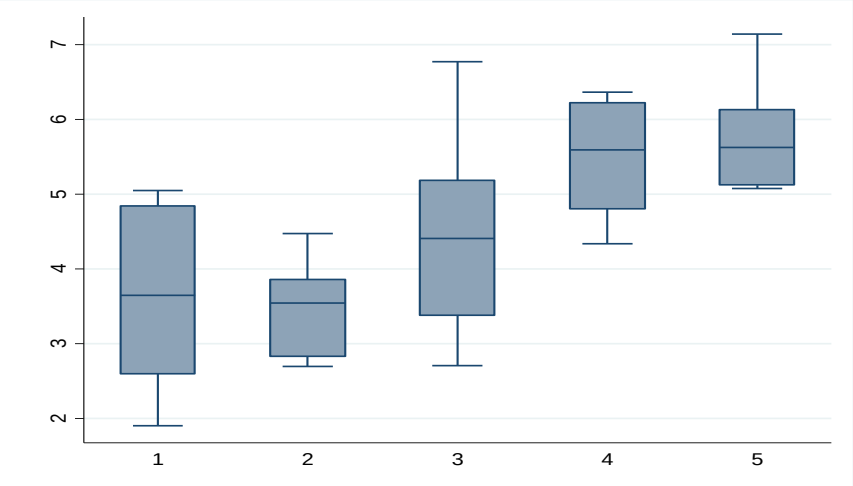
Figure 2.1b Public education spending and population with secondary education as the highest level attained (averages 1970-2010)



Sources: own computation based on Barro and Lee (2013); PWT, 8.0 and Azar and Fleitas (2012)

LACs are both the less developed sample members and also low education spenders. Note that the average per capita expenditure in real PPP of HICs has been almost 5 times as high as the average in LACs: $513 and $147 in 1970 and $1596 and $352 in 2010, respectively. On the other hand, when countries' education expenditure is sorted by quintiles according to per capita GDP, it is possible to observe a higher dispersion for the relatively poor countries and also for the ones situated in the middle of the distribution (Figure 2.2).

Figure 2.2 Dispersion in education expenditure according to per capita GDP quintiles (averages 1970-2010)



Note: Countries in the 1st. quartile are Argentina, Colombia, Costa Rica, Dominican Republic, Jamaica, Peru; in the 2nd: Chile, Mexico, Uruguay, Venezuela, Portugal, Korea Rep., Turkey; in the 3rd.: Greece, Ireland, Italy, Japan, New Zealand, Spain, Israel; 4th: Austria, Belgium, Finland, France, Germany, Sweden, United Kingdom; and in the 5th: Australia, Canada, Denmark, Netherlands, Norway, Switzerland and United States.
Sources: based on Barro and Lee (2013); PWT, 8.0 and Azar and Fleitas (2012)

Though they only provide a very rough approach, these data suggest that income levels are not the only determinant of each country's fiscal efforts in education. In fact, the variability in terms of funding across countries gives another argument to track possible differences in efficiency/inefficiency paths.

Based on the above data, output-technical efficiency scores (OTE) have been computed for each country. A score of 1.3, for example, implies that to attain an optimal performance outputs should be expanded by 30%, without changing current inputs. Table 2.2 reports the averaged scores and their variability by country-group.

Table 2.2 Average Output Technical Efficiency by country group, 1970-2010

Period	Output Technical Efficiency (OTE)					
	Group averages			**Standard Deviation by group**		
	Total sample	LACs	HICs	Total sample	LACs	HICs
1970	1.28	1.38	1.24	0.19	0.17	0.19
1975	1.28	1.35	1.25	0.17	0.15	0.17
1980	1.26	1.30	1.24	0.15	0.13	0.16
1985	1.23	1.24	1.22	0.14	0.15	0.14
1990	1.19	1.19	1.19	0.14	0.16	0.13
1995	1.16	1.12	1.18	0.12	0.13	0.12
2000	1.14	1.12	1.16	0.10	0.11	0.10
2005	1.11	1.10	1.11	0.10	0.10	0.10
2010	1.10	1.08	1.11	0.10	0.09	0.10
Mean (1970-2010)	1.20	1.21	1.19			
Between var. (1970-2010)	0.12	0.10	0.12			
Within var. (1970-2010)	0.10	0.14	0.08			

Source: own computation based on Barro and Lee (2013); PWT, 8.0 and Azar and Fleitas (2012)

There have been significant efficiency gains during the period. Considering the whole sample, the output expansion needed to achieve efficiency is 10% in 2010, much lower than the 28% required in 1970. Besides, differences within countries have tended to shrink: they fell by 47.3% between 1970 and 2010. However, the efficiency scores still present variation both across and within countries. The reasons will be tackled in the second step regression approach.

In terms of country-groups, LACs have been largely responsible for the average efficiency progress. From the 1990s onwards their efficiency levels have exceeded those in HICs and by 2010 they were closer to the efficiency frontier. By contrast, the LACs' ratios for 1970-1985 reveal important inefficiencies.

Efficiency in HICs was also lower before 1990. Their performance improved afterwards, but they remained behind LACs' levels. It might be argued that HICs' relative inefficiency at the end of the period could be explained by a deeper interest in quality aspects and their already high education attainment records. However, at least two facts cast doubts about this claim. First, the group is made up by numerous European countries that are found to be inefficient when compared to other rich economies and using quality related outputs (such as PISA scores) or alternative measures as enrolment (Afonso and St. Aubyn, 2006; Mandl et al., 2008). Second, the present study finds that two non-European HICs are perfectly efficient throughout the period: United States and South-Korea.

The complete series of efficiency scores by country and year are presented in Table A.2.5. To summarize the results, Table 2.3 shows each LACs' position in the efficiency ranking and the corresponding efficiency score in parenthesis.

Table 2.3 Efficiency score and relative ranking positions for LACs

	1970	1975	1980	1985	1990	1995	2000	2005	2010
Argentina	2	1	1	1	1	5	20	11	9
	(1.02)	(1.00)	(1.00)	(1.00)	(1.00)	(1.08)	(1.18)	(1.08)	(1.10)
Chile	10	11	9	13	4	3	5	7	4
	(1.22)	(1.25)	(1.21)	(1.20)	(1.11)	(1.02)	(1.08)	(1.05)	(1.05)
Colombia	21	24	27	24	19	22	25	5	1
	(1.39)	(1.40)	(1.39)	(1.35)	(1.24)	(1.22)	(1.26)	(1.03)	(1.00)
Costa Rica	26	27	25	21	21	23	24	24	23
	(1.52)	(1.43)	(1.37)	(1.30)	(1.28)	(1.24)	(1.23)	(1.21)	(1.23)
Dominican Rep.	24	25	21	1	1	1	1	25*	1
	(1.44)	(1.40)	(1.33)	(1.00)	(1.00)	(1.00)	(1.00)	(1.23)	(1.00)
Jamaica	18	21	23	18	14	4	2	2	1
	(1.36)	(1.37)	(1.35)	(1.27)	(1.20)	(1.08)	(1.02)	(1.01)	(1.00)
Mexico	27	28	28	27	25	2	1	1	1
	(1.52)	(1.48)	(1.45)	(1.40)	(1.34)	(1.01)	(1.00)	(1.00)	(1.00)
Panama	22	18	16	15	17	14	11	14	8
	(1.40)	(1.31)	(1.26)	(1.21)	(1.23)	(1.14)	(1.11)	(1.09)	(1.09)
Peru	19	17	14	9	1	1	1	1	1
	(1.38)	(1.31)	(1.25)	(1.17)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)
Uruguay	17	13	12	14	12	16	15	23	20
	(1.32)	(1.26)	(1.21)	(1.20)	(1.17)	(1.15)	(1.15)	(1.19)	(1.19)
Venezuela	31	31	29	31	30	30	30	29	21
	(1.66)	(1.60)	(1.48)	(1.50)	(1.51)	(1.42)	(1.30)	(1.26)	(1.19)

Note: (*) the relative lower position in 2005 responds to a remarkable increase in public education spending not immediately accompanied by an output-variation.
Source: own computation

Some individual evolutions are worth commenting. Venezuela has been ranked at the lower positions for most of the period. However its scores reveal a substantial effort to increase efficiency over time, at the end of the period the country is still below the regional average. On the other hand, progress in efficiency scores has been general since 1990, except for Argentina, Costa Rica and Uruguay. The former was amongst the most efficient countries up to that date, but has lost its relative position onwards. Costa Rica and Uruguay have generally occupied mid to low positions in the ranking. For the latter, a similar result has been obtained by Afonso and St. Aubyn (2006) and Grigoli (2014) in different education efficiency assessments for the 2000s.

Figures 2.3a and 2.3b depict to what extent fiscal efforts have accompanied the improvement in education efficiency in the two country groups. While efficiency has generally improved (efficiency scores display a decreasing trend), education spending growth has been much higher in HICs.

Figure 2.3a Trends of public education spending and efficiency scores in LACs (averages)

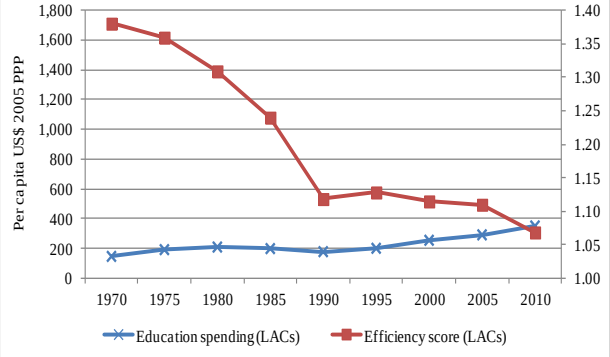
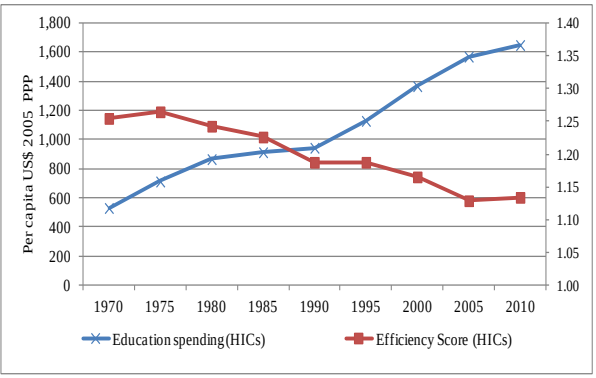


Figure 2.3b Trends of public education spending and efficiency scores in HICs (averages)



Source: own computation

Hence, despite having failed to increase significantly their education expenditure, LACs have managed to obtain very good results from their (scarce) resources, especially since the 1990s. This pattern, already suggested by Figures 2.1a and 2.1b, can be described as "squeezing efficiency". In opposition, a "genuine efficiency" gain would take place when a rather high resource-endowment is also well-managed. This extreme can be observed in Figures 2.4a and 2.4b, where HICs are classified into 3 groups depending on their per capita GDP.

Figure 2.4a Efficiency trends in 3 groups of HICs (averages)

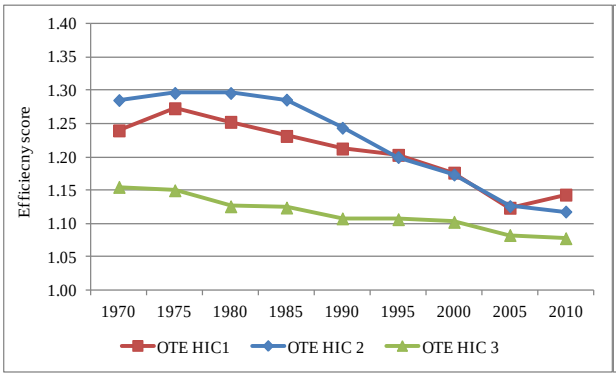
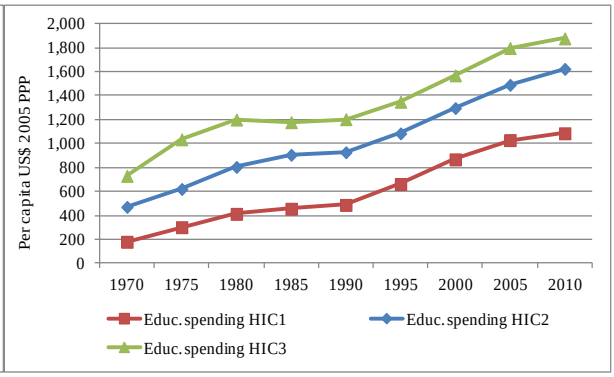


Figure 2.4b Education spending in 3 groups of HICs (averages)



Note: HIC1 includes Greece, Italy, New Zealand, Portugal, Spain, Korea Rep., Israel, Turkey; HIC2, Austria, Belgium, Finland, France, Germany, Ireland, Japan and United Kingdom and HIC3, Australia, Canada, Denmark, Netherlands, Norway, Sweden, Switzerland and United States.
Source: own computation

The richest HICs (HIC 3) have been the most efficient during the whole period. Not only have they kept on expanding their education expenditure at similar rates as their counterparts, but they have also managed to improve on their already good efficiency scores. The situation is different in LACs. As previously noted, high inefficiencies are present amongst the richer countries of the group, such as Argentina, Costa Rica, Uruguay or Venezuela.

2.4.2 Explaining efficiency scores

This section presents the results of the panel truncated regressions on the efficiency score. A positive (negative) sign in the regression coefficient indicates that an increase (reduction) in the variable reduces (increases) efficiency. The lower and upper bounds of the 95% bootstrap confidence intervals allow checking the statistical significance of the estimation. Tables A.2.6 and A.2.7 contain the pair wise correlations across dependent and independent variables. They are generally low, thus alleviating the concern about multi collinearity issues. The initial sample consists of 315 observations, but some data are missing for variables like the Gini index, the interest paid on debt or the size of government (Table A.2.4).

Table 2.4 reports the results from 4 specifications. Column 1 contains the simplest estimates based on Equation (7). The next two columns allow the effect of economic globalization and democracy, respectively, to differ between LACs and HICs. Column 4 includes both interactions, as in Equation (8).[7]

[7] The presence of time fixed effects has been explored with an F test of joint significance of the temporary variables. The results do not support their inclusion.

Table 2.4 Determinants of public education efficiency

Dep. Var: *OTE*	1	95% conf int.		2	95% conf. int.		3	95% conf. int..		4	95% conf int.	
		low	high		low	high		low	high		low	high
GDP pc (million U$ 2005 PPP)$_{t-1}$	2.237	-6.893	13.063	1.972	-10.572	8.180	4.15	-4.669	16.034	0.252	-8.136	11.215
GDP pc squared (million U$ 2005 PPP) $_{t-1}$	-179.343*	-417.266	2.198	-126.13	-351.656	49.746	-211.275**	-466.128	-34.927	-163.95*	-407.166	5.164
LACs	-0.08**	-0.139	-0.013	0.242***	0.091	0.413	-0.166***	-0.293	-0.057	0.145*	-0.027	0.319
Economic Globalization $_{t-1}$	-0.128	-0.280	0.029	-0.019	-0.175	0.135	-0.129	-0.282	0.029	-0.016	-0.170	0.137
Economic globalization $_{t-1}$ x LACs		-0.139	-0.013	-0.61***	-0.924	-0.321				-0.625***	-0.951	-0.338
Democracy (10=fully democratic)$_{t-1}$	0.003	-0.006	0.010	0.001	-0.007	0.008	-0.005	-0.018	0.005	-0.008	-0.021	0.001
Democracy$_{t-1}$ x LACs							0.011*	-0.002	0.029	0.014**	0.001	0.031
Debt interest/gdp$_{t-1}$	-1.082***	-1.803	-0.376	-1.023***	-1.713	-0.346	-1.030***	-1.742	-0.355	-0.958***	-1.614	-0.281
Size of governmenty-1 (0=large)	-0.021***	-0.032	-0.008	-0.019***	-0.031	-0.007	-0.022***	-0.033	-0.009	-0.020***	-0.032	-0.008
Share of pop. in big urban agglomerations $_{t-1}$	-0.231***	-0.374	-0.081	-0.158***	-0.293	-0.009	-0.240***	-0.383	-0.088	-0.165**	-0.301	-0.022
Share of pop. under 15 years old/ total$_{t-1}$	0.622***	0.212	0.972	0.320	-0.093	0.655	0.620***	0.213	0.966	0.311	-0.091	0.648
Income distribution (Gini Index)$_{t-1}$	0.413***	0.089	0.696	0.254*	-0.040	0.517	0.439***	0.125	0.736	0.283*	-0.008	0.546
Constant	1.170***	0.937	1.402	1.287***	1.067	1.507	1.212***	0.989	1.456	1.336***	1.122	1.565
Observations	229			229			229			229		

Note: Results obtained from truncated panel bootstrapped regressions.
The statistical significance (*, **, ***) indicates that zero does not fall within the confidence interval of 90%, 95% and 99%, respectively.

The coefficient of the quadratic term of per capita GDP tends to be negative and statistically significant in most regressions. Hence, efficiency gains would be mostly associated to the highest income levels. The dummy for LACs also bears a negative and significant sign, even after the interacted variables are considered. Hence, apart from income, globalization, democracy and the influences captured by the control variables, other factors common to this country group seem to have been behind the efficient LACs' profile during the period.

In Column 4, the indexes for globalization and democracy are interacted with the LACs dummy. Previously, Columns 2 and 3 show that the effects of both variables are independent from each other and from other circumstances like demography, income distribution, government size and indebtedness. Besides, they give support to the idea of differing efficiency drivers between country-groups.

The net impact of economic globalization on the score is negative, but changes with the country group. While the interacted term is negative and statistically significant, the non-interacted coefficient is positive, but not significant. This result points out to an important association between international competition and efficiency improvements in the region, a feature not necessarily present in the rest of the sample.

A similar pattern is found for democracy. Again, the global positive association between democracy and efficiency in the sample is driven by LACs. In this case, the non-interacted index is not statistically significant, which makes sense, given that democratic rules have prevailed in the majority of HICs, which make up an important part of the sample. By contrast, the interacted variable is positive and significant, meaning that more political competition in LACs has added to inefficiency.

Overall, democracy and economic globalization seem to have exerted opposing effects on LAC's efficiency gains. This is important, because both influences started being relevant for the region roughly at the same time (after the mid 1980s). Moreover, though it requires further analysis, the higher statistical significance of the interacted globalization term, compared with the effect of democracy suggests that policy makers, dealing with conflicting social preferences, could have been more receptive to the efficiency demands of those advocating for a tighter fiscal discipline to enhance international competitiveness.

Finally, the coefficients for the control variables in the Table have the expected sign and are statistically significant at the standard levels, except in the case of the share of young population in the total. It maintains its sign, but it is not significant in models (2) and (4). As for the rest, education spending efficiency seems to have been encouraged by debt interest

commitments, a smaller size of the public sector and urbanization. Conversely, high inequality appears to be associated to higher inefficiency. This is an important countervailing effect, particularly for LACs, given their high income inequality levels.

2.5 Robustness checks

The results have been tested through different robustness checks. They allow to partially dealing with concerns about measurement errors and other methodological limitations.

In order to explore whether the baseline ranking and scores are sound descriptors of the efficiency paths, the DEA computations are replicated considering as outputs the years of schooling and secondary highest attainment for population belonging to the 25-29 age interval, taken from Barro and Lee (2013). The age-bracket is supposed to isolate the effects of improvements in education for a specific population. The chosen ages (unlike lower intervals) aim to capture those who have probably completed their education cycle, picking up in that way the influence of the bulk of education expenditure. Rank differences are tested through a Spearman rank correlation test. Table 2.5 presents the sample means for the baseline and alternative score by year and the test results.

Table 2.5 Sample baseline and alternative efficiency scores, 1970-2010

Period	Alternative OTE	Baseline OTE	Spearman Rank correlation (*)
1970	1.31	1.28	0.95
1975	1.25	1.28	0.92
1980	1.22	1.26	0.89
1985	1.18	1.23	0.90
1990	1.14	1.19	0.79
1995	1.13	1.16	0.84
2000	1.13	1.14	0.88
2005	1.11	1.11	0.88
2010	1.12	1.10	0.84

Note: (*) all correlations are significant at 5% or less.
Source: own computation

The alternative scores generally denote lower inefficiency levels, but both computations exhibit the same evolution. In particular, the Spearman test shows that countries appearing as efficient (or inefficient) according to the original indicator are ranked quite similarly with the alternative. When country groups are distinguished, HICs appear as consistently more efficient in the alternative than in the baseline estimation, while LACs' efficiency levels are very similar. Still, in both cases, the scores roughly show the same evolution (Figures 2.5a and 2.5b).

Figure 2.5a Baseline and alternative efficiency scores for LACs (averages)

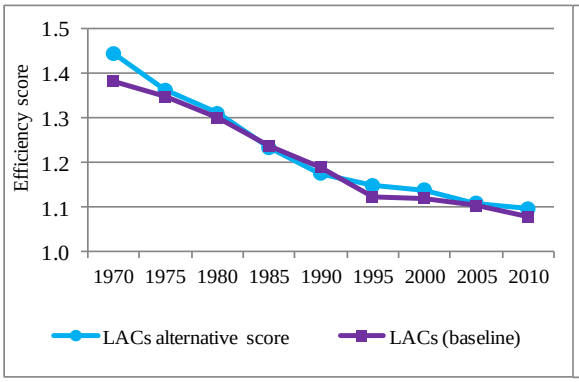
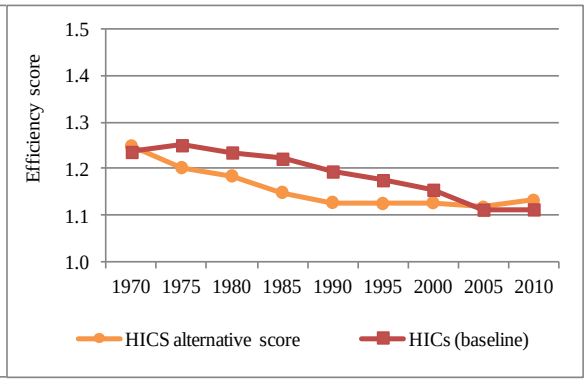


Figure 2.5b Baseline and alternative efficiency scores for HICs (averages)



Source: own computation

Another important issue to interpret the efficiency estimates is the presence of a "technical change", that is, a potential shift in the efficiency frontier over the period. This study resorts to "Färe-Primont" total factor productivity indicators to obtain a measure of technical change (O'Donnell, 2010). The indicator reveals that the value of the frontier in 2010 is a third of that of 1970. This is not surprising: as countries make progress in their education achievements, they find it more difficult to go a step further. This happens not only because it is harder to include more people, but also because of the increasing costs from quality requirements. The implication is that the estimated technical efficiency can be driven by a combination of a frontier regress and a scarce or no movement at all in terms of efficiency. To discard this confounding possibility, the efficiency scores are estimated without allowing for technical regress (that is, keeping the maximum technology fixed at its 1970 level). According to Figures 2.6a and 2.6b, the results still allow tracing a path of genuine efficiency gains similar to the one described by the baseline estimation, but less intense in the case of LACs.

Figure 2.6a Technical efficiency path in LACs not allowing for technical regress vs. original

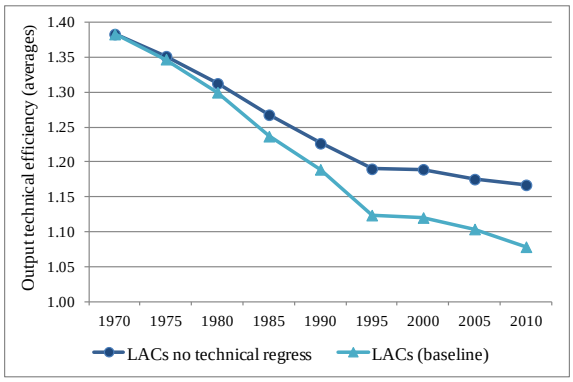
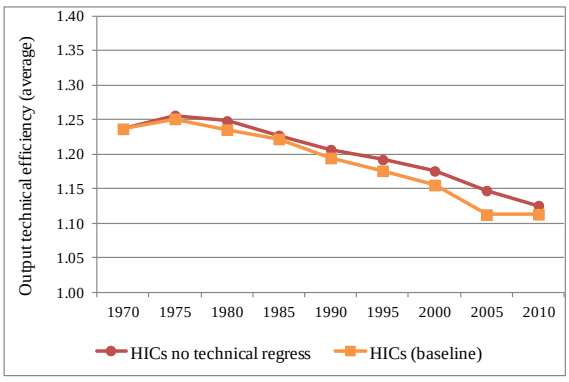


Figure 2.6b Technical efficiency path in HICs not allowing for technical regress vs. original



Source: own computation

One caveat about the methodology is its sensitivity to extreme values or "outliers" (Simar, 2003). Outliers may bias efficiency measures by wrongly determine a segment of the production frontier. Thus, by performing successive DEA calculations "super-efficient" units are identified and removed until no one else are detected (Cook and Steinfor, 2009; Prior and Surroca, 2010). To assess whether outliers bear any impact on the final ranking, the initial and final efficiency scores are compared by a Wilcoxson non-parametric test. Results presented in Table A.2.8 confirm that the presence of outliers does not affect the baseline ranking (the null hypotheses of equality between efficiency scores cannot be rejected).

Finally, Figures 2.7a and 2.7b shows the bias-corrected scores (computed on the basis of Simar and Wilson procedure) for two years. According to the caveats previously mentioned, and given the sample size, the adjustments experienced by the efficiency measure scores hardly modify the baseline efficiency trail. In turn, they seem to introduce more noise to the individual scores.

Figure 2.7a Bias-corrected and original OTE: year 1995

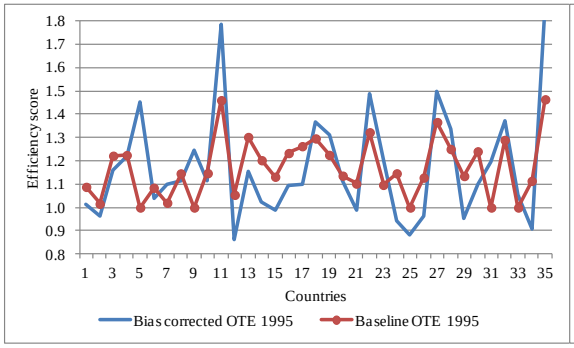
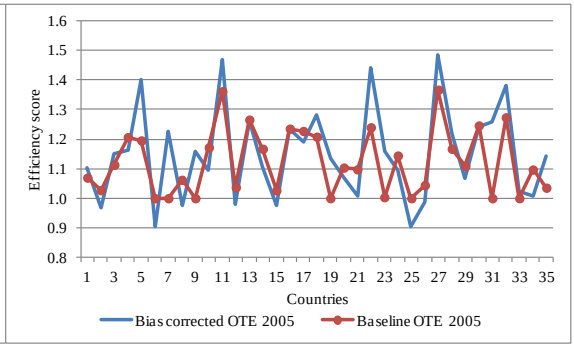


Figure 2.7b Bias-corrected and original OTE: year 2005



Note: country numbers in Table A.2.1.
Source: own computation

Also the validity of regression results have been subjected to different robustness checks. Tables 2.7 and 2.8 summarize the findings for the more complete specification (Equation 8).

Hence, in Column 1 of Table 2.7, direct taxes are included as a *proxy* for the quality of the institutional environment. Tax data have been compiled from ECLAC, World Bank IMF and OECD datasets. This variable is included as a proxy of the institutional setting, as it should account for the degree of government enforcement and the availability of transparent information about economic activities. In Column 2, "size of government" is replaced by the more traditional indicator "share of government consumption over GDP" (PWT, 8.0). In the next column, a dummy to capture any impact related to the period post-1990s has been

considered. Also, to evaluate consistency of results, the bootstraps performed have been extended from 1000 to 1500 (Column 4).

In turn, Table 2.8 reports estimations where, respectively, the set of explanatory variables are taken as averages of the previous 5 years (Column 1) and the dependent variable refers to the output-efficiency score computed for the age interval 25-29 (Column 2).

Table 2.7 Robustness checks: determinants of education efficiency with additional variables

Dep. Var: *OTE*	1	95% conf int.		2	95% conf int.		3	95% conf int.		4	95% conf int.	
		low	high		low	high		low	high		low	high
GDP pc (million U$ 2005 PPP)$_{t-1}$	4.675	-4.603	16.010	-0.470	-10.296	10.737	0.141	-9.423	10.696	0.321	-8.611	11.163
GDP pc squared (million U$ 2005 PPP) $_{t-1}$	-219.159**	-467.219	-39.619	-153.871*	-403.486	43.038	-154.293	-389.511	39.452	-166.274*	-408.065	14.785
LACs	0.139	-0.027	0.316	-0.005	-0.166	0.169	0.154*	-0.006	0.320	0.1433*	-0.027	0.318
Economic Globalization $_{t-1}$	-0.011	-0.159	0.141	-0.054	-0.199	0.138	-0.011	-0.155	0.174	-0.016	-0.173	0.139
Economic globalization $_{t-1}$ x LACs	-0.606***	-0.925	-0.333	-0.682***	-0.972	-0.404	-0.627***	-0.915	-0.355	-0.623***	-0.941	-0.334
Democracy (10=fully democratic)$_{t-1}$	-0.005	-0.018	0.005	-0.028***	-0.042	-0.014	-0.009	-0.021	0.003	-0.008	-0.020	0.002
Democracy$_{t-1}$ x LACs	0.014**	0.001	0.030	0.032***	0.016	0.049	0.015**	0.001	0.030	0.014**	0.000	0.030
Debt interest/gdp$_{t-1}$	-0.837**	-1.483	-0.175	-1.025***	-1.805	-0.271	-0.783**	-1.520	-0.057	-0.953***	-1.627	-0.269
Size of government $_{t-1}$ (0=large)	-0.024***	-0.036	-0.011				-0.019***	-0.032	-0.006	-0.020***	-0.032	-0.007
Share of pop. in big urban agglomerations $_{t-1}$	-0.176***	-0.307	-0.037	-0.164**	-0.314	-0.034	-0.159**	-0.307	-0.028	-0.166**	-0.302	-0.016
Share of pop. under 15 years old/ total$_{t-1}$	0.440**	0.018	0.798	0.244	-0.145	0.623	0.209	-0.176	0.615	0.304	-0.077	0.654
Income distribution $_{t-1}$ (Gini Index)	0.253	-0.040	0.523	0.224	-0.066	0.526	0.282*	-0.004	0.582	0.279*	-0.006	0.543
Direct taxes/gdp $_{t-1}$	**-0.508*** **	**-0.880**	**-0.120**				1.365***	1.132	1.585			
Gov. consumption/gdp $_{t-1}$				**0.208** **	**0.000**	**0.413**						
Dummy post 1990							**-0.027**	**-0.069**	**0.018**			
Constant	1.305***	1.096	1.533	1.428***	1.197	1.655				1.342***	1.116	1.564
Observations	229			229						229		

Note: Results obtained from truncated panel bootstrapped regressions. The statistical significance (*, **, ***) indicates that zero does not fall within the confidence interval of 90%, 95% and 99%, respectively.

Table 2.8 Robustness checks: regressors as 5 year averages and dependent variable based on outputs for 25-29 age-interval

Dep. Var: *OTE*	1	95% conf. int.		2	95% conf. int.	
		low	high		low	high
GDP pc (million U$ 2005 PPP)$_{t-1}$	-15.892***	-23.376	-5.446	-7.472*	-15.591	1.205
GDP pc squared (million U$ 2005 PPP) $_{t-1}$	132.479	-88.930	256.239	99.63	-67.469	245.123
LACs	-0.0168	-0.162	0.152	0.07	-0.076	0.225
Economic Globalization $_{t-1}$	-0.030	-0.168	0.107	0.0459	-0.113	0.236
Economic globalization $_{t-1}$ x LACs	-0.503***	-0.758	-0.272	-0.357***	-0.633	-0.114
Democracy (10=fully democratic)$_{t-1}$	-0.014*	-0.027	0.000	-0.007	-0.019	0.004
Democracy$_{t-1}$ x LACs	0.017*	0.000	0.033	0.015**	0.002	0.030
Debt interest/gdp$_{t-1}$						
Size of government $_{t-1}$ (0=large)	-0.918***	-1.530	-0.282	-1.430***	-2.172	-0.664
Share of pop. in big urban agglomerations $_{t-1}$	-0.021***	-0.032	-0.009	-0.006	-0.019	0.006
Share of pop. under 15 years old over total$_{t-1}$	-0.149***	-0.280	-0.012	-0.260***	-0.408	-0.126
Income distribution $_{t-1}$ (Gini Index)	-0.014	-0.389	0.334	0.484***	0.095	0.862
Constant	0.368***	0.116	0.600	0.438***	0.125	0.742
Observations	229			229		

Note: Results obtained from truncated panel bootstrapped regressions. The statistical significance (*, **, ***) indicates that zero does not fall within the confidence interval of 90%, 95% and 99%, respectively.

The sequence of robustness checks give support to the idea that more open and more democratic contexts have exerted an influence of different sign on the path of LACs' efficiency scores during the period. This result holds even when a dummy to capture the changing environment after the 1990s is included (which is not statistically significant). On the other hand, despite the empirical association between GDP and efficiency gains seems robust, the coefficients in Table 2.8 cast doubts on the presence of non-linearities. In the same line, the regional dummy retains its sign, but it is not always significant.

2.6 Discussion

Though it needs to be taken with caution because of data and methodological limitations, the evidence presented so far may provoke some interesting reflections.

Certainly, the estimates show that efficiency improvements in LACs have been mainly driven by output expansions, along with a rather limited increase in public expenditure. This pro-efficiency orientation is implicit in the sign of the regional dummy in some of the regression estimates. By contrast, efficiency gains in HICs have generally taken place together with input increases. This configuration draws attention to the fiscal effort devoted to education. As already noted, LACs seem to be applying a sort of "efficiency-squeeze" strategy, for they seem to have considerably "squeezed" its education spending to achieve high education attainments from scarce resources. The opposite occurs with the richest HICs that appear to exhibit a sort of "genuine" pro-efficiency performance. In their case, high human capital investments seem to have also been properly managed.

This "efficiency-squeeze" pattern may lie behind the lively debate about the quality of education in Latin America. It is widely recognized that the regional relative success in achieving higher school attainments has coexisted with low learning achievements leading to low education quality (Hanushek and Woessmann, 2012; Aedo and Walker, 2012). However, in a context of limited funding, the reported efficiency gains suggest that the improved educational outputs could, on their own, be responsible for the flawed education quality.

This interpretation is based on a sort of "trade-off" between formal access to education and quality, typical of LACs. Naturally, as schooling participation increases, the system gradually includes those at more disadvantaged economic and social positions, and with more difficulties to develop a successful student path. Nevertheless, this challenge to quality improvement is reinforced by the low education investment, which translates into the insufficient infrastructure, textbooks, and teaching quality that seem to have accompanied the growing access to the formal system. These factors, critical to student learning, are probably the

cornerstone of LACs' serious deficit in educational quality. Furthermore, they could play an important role to reinforce the inequality of opportunities in early life, identified as one of the most significant drivers of the regional income inequality (Hertz et. al. 2007; IADB, 2011).

The emerging picture calls for a careful treatment of the "spending efficiency" idea. Unless fiscal education commitments are taken into account, the concept might be misleading. The case of LACs illustrates that below certain spending thresholds, efficiency may jeopardize valued education learning goals. From a policy perspective, this result suggests that improvements in attainment and learning achievements are not easy to be addressed through separated strategies or considered aside budget constraints. Indeed, funding issues would deserve more attention alongside the recurring concern about "education quality" and education efficiency raised by scholars and international organizations.

Similarly, though not explicitly addressed in the empirical analysis, institutional factors related to fiscal management might be an interesting aspect to complete the discussion. Hence, the role played by clear fiscal rules, useful performance information and accountability to explain HICs' genuine efficiency gains deserves further research, particularly when compared to the LACs' resource saving efficiency strategy.

Looking beyond the regional performance, there is a particular case for Argentina, Costa Rica, Uruguay and Venezuela as they have not been amongst the higher spenders of the region and their efficiency performance has been rather disappointing. The group is lagged not only in terms of education attainment but also in education quality. Note that the average PISA scores show serious performance gaps between them and the worst OECD or East Asian countries (Hanusheck and Woessmann, 2012). As a result, in their case, inefficiencies seem to point out to the presence of unproductive expenditures, which should be translated into more and better outcomes.

Another empirical finding suggests that concerns about spending efficiency might change as per capita income increases. Yet, the non-linearities present in some of the estimates seem to warn that not all countries have been equally able (or willing) to reduce inefficiencies as income became higher. By re-estimating Equation (8) including efficient units, it is possible to find an hypothetical income level above which countries would become more concerned about efficiency. The threshold would be close to U$14,000 (PPP). During the period, LACs have generally been below that level, while Greece, Ireland, Israel, Italy, Japan, South Korea, Portugal, Spain and Turkey have attained this level just after 1985 or 1990. Therefore, income per capita might have acted as a condition constraining efficiency improvements both in LACs and the least rich HICs, at least during part of the period.

From a long term perspective, the analysis has shown that inefficiencies were high until 1990, but not so much thereafter. The change is notable in LACs, where 1970s and 1980s coincided with a catastrophic debt crisis, political dictatorships and the end of the inward-oriented development strategy. This context seems to have left little room for efficiency concerns. Instead, estimates point to the association between efficiency and the increasing economic globalization (which stands for one of the main economic reforms after the 1990s) and democracy recovery.

The effect of economic globalization is consistent with the trend towards fiscal discipline, aimed at conquering international competitiveness, which has prevailed since 1990s. The finding contrasts with the weak evidence about the effect of economic openness on public education outlays in LACs (Kaufman and Segura, 2001; Wibbels, 2006). In fact, it seems that a more (squeezing) efficient spending would have replaced the alternative of expenditure reductions. That policy option might also be less drastic in view of the recent democratic consolidations. In turn, the estimates regarding democracy allow inferring that the least costly way to solve postponed claims on public resources has been to increase investments while disregarding efficiency. The same has been found in prior investigations referred to the amount spent (Brown and Hunter, 1999; Kaufman and Segura, 2001). As a result, starting from low education spending levels, the final efficiency path in LACs would have emerged from the opposed orientations associated on one side, to the promotion of fiscal retrenchments and to the influence of more actors on resource allocation, on the other.

The case of HICs seems to be different. Higher inefficiency levels featured the early period of economic slowdown (1973-1990) and crisis of the welfare states. However, when that period was over, the efficiency drivers do not appear to be associated to economic globalization or democracy consolidations. As previously mentioned, apart from increasing income levels, it is possible that institutional arrangements or political decisions not considered in this study are behind this result. In fact, it is possible that the current conclusions about the role of democracy are constrained by the broad nature of the indicator here used. Hence, if characteristics of the constitutional design, party systems or partisan politics could be considered for a wider time-frame or country sample, this could contribute to uncover more distinct effects.

2.7 Concluding remarks

Inefficiencies in public education spending have been a recurrent argument when assessing unsatisfactory education policy outcomes. This chapter seeks to clarify to what extent LACs have failed to use public resources efficiently, comparing them with HICs for the period 1970-2010.

The empirical approach is based on a DEA computation followed by truncated bootstrapped panel regressions to account for conditioning factors associated to the efficiency path. There are, of course, some concerns with this analysis. Data are not exempted from measurement errors; the efficiency scores might be biased by the assumptions on returns to scale or the role of technical change, while the regression approach might suffer from endogeneity. These drawbacks force to interpret the result with some caution, but they still allow building up some general conclusions.

The analysis identifies a convergent efficiency trend for the whole sample. However, the increase in efficiency prevailing in LACs since 1990s has gone along with a modest expansion of public outlays. While this "efficiency-squeeze" pattern might have contributed to offset the failure to invest heavily in education, poor learning achievements are probably the other side of that strategy. By contrast, the highest spenders amongst the HICs have shown a genuinely pro-efficiency performance. Despite calling for further research, these results contend claims for efficiency improvements as opposed to spending increases, which follow from finding correlations between small public sectors and efficiency (Afonso et al., 2010, 2013) or from the "throwing money at problems" approach, as it has been scornfully labelled (Hauner and Kyobe, 2010: 1536).

Meanwhile, regression estimates show that the LACs' "efficiency-squeeze" trend has partially responded to the influence of economic globalization. Conversely, more democracy seemed to have added to inefficiency, or at least, did not foster efficiency. The results are not so sizeable for the sample of HICs. Finally, increasing income levels are associated to efficiency gains, though the evidence suggests it is possible that both variables are non-linearly related. These relations remain robust under different specifications

The main result of the study reveals that LACs have actually proved to be very efficient during the period and makes a case for bringing the budget constraints back to the main discussion. The argument is not to understate the role of efficiency but to put it into context. The urge for keeping LACs' education attainments along with better learning records seems to be at least as closely linked to the fiscal effort committed to education than to changing policy goals or

solving the remaining efficiency gaps. In fact, efficient spending policies do not seem to be necessarily divorced from more investments to be effective, as shown by the richest countries. That is probably one of the most outstanding challenges for the education policies in the region.

References

Adserá, A., Boix, C., 2002. Trade, democracy, and the size of the public sector: the political underpinnings of openness. International Organization 56, 229-262.

Aedo, C., Walker, I., 2012. Skills for the 21st century in Latin America and the Caribbean, The World Bank, Washington, D.C.

Afonso, A., St. Aubyn, M., 2006. Cross-country efficiency of secondary education provision: a semi-parametric analysis with non-discretionary inputs. Economic Modelling 23 (3), 476-491.

---------- 2005. Non-parametric Approaches to Education and Health Efficiency in OECD Countries. Journal of Applied Economics 8 (2), 227-246.

Afonso, A., Romero, A., Monsalve, E., 2013. Public sector efficiency: evidence for Latin America. School of Economics and Management Working Paper 20/2013, Department of Economics, Technical University of Lisbon.

Afonso, A., Schuknecht. L., Tanzi, V., 2010. Public sector efficiency: evidence for new EU member states and emerging markets. Applied Economics 42 (17), 2147-2164.

---------- 2005. Public sector efficiency: an international comparison. Public Choice 123 (3), 321-347.

Azar, P., Fleitas, S., 2012. Base de datos histórica sobre gasto público social y revisión de sus principales tendencias entre 1950 y 2008. Documento de Trabajo 22/12, Instituto de Economía- FCEyA, Universidad de la República.

Banker, R. D., Charnes, A., Cooper, W., 1984. Some models for estimating technical and scale inefficiencies in data envelopment analysis. Management Science, 1078- 1092.

Barro, R. and Lee, J.W., 2013. A new data set of educational attainment in the world, 1950-2010. Journal of Development Economics 104, 184-198.

Brown, D., Hunter, W., 1999. Democracy and social spending in Latin America, 1980-92. American Political Science Review 93(4), 779-790.

Cameron, D., 1978. The Expansion of the Public Economy. American Political Science Review 72, 1243–1261.

Charnes, A., Cooper, W., Rhodes, E., 1978. Measuring the efficiency of decision making units. European Journal of Operational Research 2, 429–444.

Cohen, D., Soto, M., 2007. Growth and human capital: good data, good results. Journal of Economic Growth 12(1), 51-76.

Cook, W., Seiford, L., 2009. Data envelopment analysis (DEA)-thirty years on. European Journal of Operational Research 192(1), 1-17.

De la Fuente, A., Domènech, R., 2006. Human Capital in growth regressions: how much difference does data quality make. Journal of the European Economic Association 4 (1), 1-36.

Dreher, A., 2006. Does Globalization Affect Growth? Evidence from a New Index of Globalization. Applied Economics 38(10), 1091-1110.

ECLAC, 2015a. Panorama Fiscal de América Latina y el Caribe 2015: Dilemas y espacios de políticas, CEPAL, Santiago de Chile.

----------2015b. CEPAL.stats, retrieved from http://estadisticas.cepal.org/cepalstat.

Farrell, M., 1957. The Measurement of Productive Efficiency. Journal of the Royal Statistical Society Series A-120 Part 3, 253-290.

Feenstra, R. C., Inklaar, R., Timmer, M., 2013. The next generation of the Penn World Table. www.ggdc.net/pwt.

Garrett, G., 2001. Globalization and government spending around the world. Studies in Comparative International Development 35(4), 3-29.

Grigoli, F., 2014. A hybrid approach to estimating the efficiency of public spending on education in emerging and developing economies. Working Papers Nº14/19 Fiscal Affairs Department, IMF.

Gupta, S., Verhoeven, M., 2001. The efficiency of government Expenditures: Experiences from Africa. Journal of Policy Modeling 23, 433–467.

Gwartney, J.D., Joshua, C., Lawson, R., 2012. 2010 economic freedom datase, Economic Freedom of the World Annual Report, Fraser Institute.

Hanushek, E. A., Woessmann, L., 2012. Schooling, educational achievement, and the Latin American growth puzzle. Journal of Development Economics 99(2), 497-512.

Hauner, D., Kyobe, A., 2010. Determinants of Government Efficiency. World Development 38(11), 1527-1542.

Herrera, S., Pang, G., 2005. Efficiency of public spending in developing countries: an efficiency frontier approach. World Bank Policy Research Working Paper Series 3645.

Hertz, T., Jayasundera, T., Piraino, P., Selcuk, S., Simth, N., Vershchagina, A. 2007. The inheritance of educational inequality: international comparisons and fifty year trends. The B.E: Journal of Economic Analysis and Policy 7(2), article 10, 1-46.

Hoff, A., 2007. Second stage DEA: comparison of approaches for modelling the DEA score. European Journal of Operational Research 181, 425–435.

Inter-American Development Bank-IADB, 2011. Strategy on social policy for equity and productivity. Social sector, IADB, Washington, D.C.

International Monetary Fund-IMF, 2014. Fiscal policy and income inequality, IMF, Washington D.C.

---------- Government Financial Statistics. Various issues 1970-1998, Washington, D.C.

Jayasuriya, R. and Woodon, Q., 2005. Measuring and explaining the impact of productive efficiency on economic development. World Bank Economic Review 19(1), 121-140.

Kaufman, R., Segura-Ubiergo, A., 2001. Globalization, domestic politics and social spending in Latin America: a time-series cross-section analysis, 1973-1997. World Politics 53(4), 553–587.

Machado, R. 2006. ¿Gastar más o gastar mejor? La eficiencia del gasto público en América Central y República Dominicana. IADB Serie de Estudios Económicos y Sectoriales RE2-06-027.

Mandl, U., Dierx, A., Ilzkovitz, F., 2008. The effectiveness and efficiency of public spending. European Communities Economic Papers 301.

Marshall, M., Jaggers, K., 2002. Polity IV Project: Political regime characteristics and transitions, 1800-2002: dataset users, University of Maryland.

McDonald, J. 2009. Using least squares and Tobit in second stage DEA efficiency analyses. European Journal of Operational Research 197(2), 792 -798.

O'Donnell, C. J., 2010. "DPIN Version 1.0: A Program for Decomposing Productivity Index Numbers Working Paper Series". Working Paper 01/2010 Centre for Efficiency and Productivity Analysis.

OECD, 2010. OECD Economic Outlook 87, OECD Publishing, Paris.

---------- 2015. OECD.Stat Data retrieved from http://stats.oecd.org/

Prior, D., Surroca, J., 2010. Performance measurement and achievable targets for public hospitals. Journal of Accounting, Auditing and Finances 25(4), 749–765.

Rodrik, D., 1998. Has Globalization Gone Too Far? Challenge 41 (2), 81-94.

Salazar Cuellar, A. F., 2014. The Efficiency of Education Expenditure in Latin America and Lessons for Colombia. Documento 408 Departamento Nacional de Planeación, Archivos de Economía , Colombia.

Scheel, H., 2000. EMS: Efficiency Measurement System. User's Guide, Version 1.3 http://www.holger-scheel.de/ems/ems.pdf

Simar, L., 2003. Detecting outliers in frontier models: a simple approach. Journal of Productivity Analysis 20(3), 391-424.

Simar, L., Wilson, P., 2011. Two-stage DEA: caveat emptor. Journal of Productivity Analysis 36, 205-218.

---------- 2007. Estimation and Inference in Two-Stage, Semi-Parametric Models of Production Processes. Journal of Econometrics 136 (1), 31-64.

Solt, F., 2014. The Standardized World Income Inequality Database. Working paper. SWIID Version 5.0, October 2014, http://myweb.uiowa.edu/fsolt/swiid/swiid.html

St. Aubyn, M., Pina, A., Garcia, F., Pais, J., 2009. Study on the efficiency and effectiveness of public spending on tertiary education. European Commission Economic Papers 390.

Sutherland, D., Price, R, Joumard, R., Nicq, C., 2007. Performance Indicators for Public Spending Efficiency in Primary and Secondary Education. OECD Economics Department Working Papers 546.

Sutherland, D., Price, R., Gonand, F., 2009. Improving public spending efficiency in primary and secondary education. OECD Journal of Economic Studies 2009.

Teorell, J., Dahlberg, S., Holmberg, S., Rothstein, B., Hartmann, F., Svensson, R., 2015. The Quality of Government Standard Dataset. The Quality of Government Institute, University of Gothenburg, www.qog.pol.gu.se

Thieme, C., Giménez, V., Prior, D., 2012. A comparative analysis of the efficiency of national education systems. Asian Pacific Education Review 13,1-15.

UNESCO, Statistical Yearbook. Various issues 1970-1990, Paris.

----------2015. Institute for Statistics, retrieved from www.uis.unesco.org/DataCentre.

Verhoeven, M., Gunnarsson, V., Carcillo, S., 2007. Education and Health in G7 Countries: Achieving Better Outcomes with Less Spending. Working Paper 07/263, IMF Fiscal Affairs Department.

Wibbels, E., 2006. Dependency Revisited: International Markets, Business Cycles, and Social Spending in the Developing World. International Organization 60, 433-468.

Wolszczak, J., Parteka, A., 2011. Efficiency of European public higher education institutions: a two-stage multi-country approach. Scientometrics 89, 887-917.

World Bank. 2015. World Development Indicators, retrieved from http://databank.worldbank.org.

---------- 2013. Shifting gears to accelerate shared prosperity in Latin America and the Caribbean. Document of the World Bank 78507

Appendix

Table A.2.1 Country sample and country-numbers

Latin America upper-middle income countries(LACs)*		
Argentina (1)	Dominican Rep. (5)	Peru (9)
Chile (2)	Jamaica (6)	Uruguay (10)
Colombia (3)	Mexico (7)	Venezuela (11)
C. Rica (4)	Panama (8)	
High-Income Countries (HICs)		
Australia (12)	Greece (20)	Spain (28)
Austria (13)	Ireland (21)	Sweden (29)
Belgium (14)	Italy (22)	Switzerland (30)
Canada (15)	Japan (23)	United States (31)
Denmark (16)	Netherlands (24)	United Kingdom (32)
Finland (17)	New Zealand (25)	South Korea (33)
France (18)	Norway (26)	Israel (34)
Germany (19)	Portugal (27)	Turkey (35)

Note: (*) Brazil is not included because of the lack of data to build consistent time series on education public spending.
Source: www.data.worldbank.org/about/country-and-lending-groups

Table A.2.2 Descriptive statistics of the output and input variables

		Mean	Std. Dev.	Min	Max	Observations
Average schooling (years)[1]	overall	8.52	2.26	2.45	13.18	N = 315
	between		1.85	4.84	12.2	n = 9
	within		1.34	5.23	11.97	T = 35
Share of people aged 15 + with secondary education as highest level (%)[1]	overall	41.2	14.9	7.44	73	N = 315
	between		11.1	19.4	63.7	n = 9
	within		10.1	12.8	74.4	T = 35
Per capita public education expenditure (U$ 2005 PPP)[2]	overall	784.27	618.04	35.10	3322.66	N = 315
	between		272.34	397.87	1204.23	n = 9
	within		562.00	252.67	2976.53	T = 35

Source: (1) Barro and Lee (2013); (2) PWT, 8.0 and Azar and Fleitas(2012)

Table A.2.3 Share of public enrolment by country-group (averages for selected years)

Period	Public enrolment (%) Pre-prim. and primary		Secondary		Tertiary	
	LACs	HICs	LACs	HICs	LACs	HICs
1970	85.4	85.5	80.5	77.0	80.4	80.2
1980	87.1	84.8	80.9	79.5	78.0	82.1
1990	83.3	81.8	80.1	87.3	68.1	79.8
2000	80.7	82.0	78.5	81.7	59.2	76.3
2010	76.3	80.5	76.7	79.2	58.5	74.6
Mean (1970-2010)	82.75	82.51	77.65	80.97	70.23	80.62
Between var. (1970-2010)	9.20	15.80	11.10	20.73	13.28	27.08

Source: own compilation based on UNESCO (Yearbooks and Data Centre)

Table A.2.4 Descriptive statistics of variables applied in the second stage

Variable		Mean	Std. Dev.	Min	Max	Observations
Per capita GDP (thousand 2005 U$)[1]	overall	17.24	10.33	1.91	56.30	N = 315
	between		8.75	4.35	37.14	n = 35
	within		5.66	1.35	38.46	T = 9
Economic globalization index[2]	overall	0.62	0.18	0.21	0.97	N = 315
	between		0.14	0.35	0.88	n = 35
	within		0.10	0.35	0.91	T = 9
Democracy index[2]	overall	8.48	2.85	0.00	10.00	N = 303
	between		1.99	3.56	10.00	n = 34
	within		2.71	-0.15	12.92	T-bar = 8.9
Size of government (0=large)[2]	overall	5.47	1.59	1.63	9.27	N = 301
	between		1.25	2.70	7.31	n = 35
	within		1.01	1.33	8.61	T-bar = 8.6
Debt interest/GDP[3]	overall	3.09	1.89	0.08	17.4	N = 299
	between		1.98	0.65	9.5	n = 35
	within		0.02	-4.4	13.1	T-bar = 8.5
Direct taxes/GPD (%)[3]	overall	10.45	6.04	0.54	30.4	N = 300
	between		5.71	2.38	26.2	n = 35
	within		2.09	2.84	18.61	T-bar = 8.6
People in big urban agglom. (%)[4]	overall	29.2	14.58	5.35	63.9	N = 315
	between		14.5	5.62	62.63	n = 35
	within		2.73	14.5	42.41	T = 9
Share of pop. under 15 / total (%)	overall	25.9	8.47	13.28	47.67	N = 315
	between		7.47	17.25	38.94	n = 35
	within		4.18	14.47	40.36	T = 9
Income distribution (Gini index)[5]	overall	0.44	0.07	0.25	0.78	N = 259
	between		0.05	0.35	0.59	n = 34
	within		0.04	0.32	0.63	T-bar = 7.6
Government Consumption/GDP (%)[1]	overall	16.73	6.32	5.97	56.01	N = 303
	between		4.85	7.41	34.98	n = 35
	within		4.11	4.15	37.77	T-bar = 8.6

Sources: (1)PWT, 8.0; (2) Teorell et al. (2015); (3) Azar and Fleitas(2012) based on details at Section 2 (4) WDI; (5) Solt (2014).

Table A.2.5 Output technical efficiency scores by country, 1970-2010

	1970	1975	1980	1985	1990	1995	2000	2005	2010
				LACs					
Argentina	1.02	1.00	1.00	1.00	1.00	1.08	1.18	1.08	1.10
Chile	1.22	1.25	1.21	1.20	1.11	1.02	1.08	1.05	1.05
Colombia	1.39	1.40	1.39	1.35	1.24	1.22	1.26	1.03	1.00
C. Rica	1.52	1.43	1.37	1.30	1.28	1.24	1.23	1.21	1.23
Dominican R.	1.44	1.40	1.33	1.00	1.00	1.00	1.00	1.23	1.00
Jamaica	1.36	1.37	1.35	1.27	1.20	1.08	1.02	1.01	1.00
Mexico	1.52	1.48	1.45	1.40	1.34	1.01	1.00	1.00	1.00
Panama	1.40	1.31	1.26	1.21	1.23	1.14	1.11	1.09	1.09
Peru	1.38	1.31	1.25	1.17	1.00	1.00	1.00	1.00	1.00
Uruguay	1.32	1.26	1.21	1.20	1.17	1.15	1.15	1.19	1.19
Venezuela	1.66	1.60	1.48	1.50	1.51	1.42	1.30	1.26	1.19
				HICs					
Australia	1.11	1.10	1.06	1.07	1.06	1.08	1.10	1.07	1.09
Austria	1.18	1.26	1.29	1.31	1.29	1.27	1.28	1.26	1.25
Belgium	1.30	1.31	1.29	1.26	1.21	1.18	1.16	1.15	1.16
Canada	1.16	1.17	1.16	1.18	1.14	1.13	1.13	1.02	1.02
Denmark	1.38	1.36	1.32	1.27	1.23	1.20	1.15	1.14	1.14
Finland	1.48	1.42	1.35	1.37	1.36	1.29	1.27	1.24	1.24
France	1.56	1.48	1.49	1.42	1.35	1.26	1.20	1.18	1.16
Germany	1.29	1.38	1.39	1.39	1.26	1.19	1.15	1.01	1.00
Greece	1.12	1.17	1.21	1.16	1.14	1.13	1.17	1.10	1.11
Ireland	1.19	1.18	1.14	1.15	1.13	1.11	1.10	1.06	1.08
Israel	1.00	1.18	1.13	1.13	1.09	1.08	1.09	1.07	1.00
Italy	1.40	1.40	1.33	1.33	1.31	1.31	1.27	1.24	1.22
Japan	1.00	1.05	1.13	1.12	1.13	1.09	1.05	1.00	1.00
Netherlands	1.25	1.24	1.21	1.18	1.14	1.13	1.11	1.14	1.12
Norway	1.00	1.00	1.00	1.00	1.00	1.00	1.02	1.04	1.12
New Zealand	1.24	1.27	1.26	1.20	1.16	1.15	1.13	1.08	1.12
Portugal	1.54	1.50	1.48	1.45	1.41	1.38	1.36	1.41	1.39
Sweden	1.23	1.21	1.17	1.16	1.12	1.10	1.10	1.08	1.12
Switzerland	1.11	1.12	1.08	1.14	1.17	1.22	1.22	1.17	1.01
Spain	1.21	1.29	1.25	1.29	1.32	1.25	1.22	1.13	1.15
South Korea	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
United Kingdom	1.27	1.29	1.29	1.27	1.23	1.19	1.17	1.11	1.05
United States	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
Turkey	1.64	1.64	1.61	1.49	1.44	1.46	1.28	1.00	1.15

Source: own computation based on PWT, 8.0; Azar and Fleitas(2012) and Barro and Lee (2013)

Table A.2.6 Pairwise correlation between variables for the second stage (current values)

	OTE	Per capita GDP	Ec. Glob.	Democ.	Debt int.	Pop. urb. agglom.	Pop. under 15	Inc. Dist	Size gov.	LACs
OTE	1.00									
Per capita GDP	-0.25	1.00								
Ec. Glob.	-0.22	0.63	1.00							
Democ.	-0.12	0.51	0.46	1.00						
Debt int.	-0.08	-0.01	0.30	0.21	1.00					
Pop. urban agglom.	-0.03	-0.50	-0.15	-0.28	0.05	1.00				
Pop. under 15	0.28	-0.75	-0.64	-0.56	-0.10	0.43	1.00			
Inc. dist.	0.24	-0.22	0.03	-0.15	0.00	0.31	0.35	1.00		
Size gov.	-0.22	-0.31	-0.27	-0.23	-0.20	0.26	0.34	0.11	1.00	
LACs	0.06	-0.67	-0.43	-0.45	-0.10	0.48	0.71	0.43	0.50	1.00

Table A.2.7 Pairwise correlation between variables for the second stage (lagged values)

	OTE	Per capita GDP_{t-1}	Ec. Glob. $_{t-1}$	Democ. $_{t-1}$	Debt int. $_{t-1}$	Pop. urban agglom. $_{t-1}$	Pop. under 15 $_{t-1}$	Inc. dist. $_{t-1}$	Size gov. $_{t-1}$	LACs
OTE	1.00									
Per capita GDP_{t-1}	-0.21	1.00								
Ec. Glob. $_{t-1}$	-0.20	0.63	1.00							
Democ. $_{t-1}$	-0.06	0.52	0.44	1.00						
Debt int. $_{t-1}$	-0.17	0.03	0.36	0.23	1.00					
Pop. urban agglom. $_{t-1}$	-0.04	-0.51	-0.16	-0.31	0.05	1.00				
Pop. under 15 $_{t-1}$	0.21	-0.75	-0.64	-0.56	-0.14	0.43	1.00			
Inc. dist. $_{t-1}$	0.19	-0.25	0.01	-0.18	0.00	0.32	0.39	1.00		
Size gov. $_{t-1}$	-0.18	-0.33	-0.30	-0.26	-0.21	0.24	0.37	0.13	1.00	
LACs	0.06	-0.67	-0.43	-0.46	-0.11	0.48	0.73	0.47	0.50	1.00

Table A.2.8 Two-sample Wilcoxon rank-sum (Mann-Whitney) test

Score	Obs	Rank sum	Expected
Sample without outliers	300	92138	92250
Original sample	315	96666	96555
Unadjusted variance		4827750	
Adjustment for ties		-42.92	
Adjusted variance		4827707.08	
Ho: efficiency (sample without outliers) = efficiency (original sample)			
z=-0.051			
Prob > z = 0.9595	No rejection of Null Hypothesis		

Chapter 3

The economic impact of tertiary education: the role of public spending and skill choices

3.1 Introduction

The fraction of highly educated people has increasingly expanded during the last 40 years, particularly in advanced and middle income economies. Still, the benefits obtained from this increase have not been immediately appreciated. For a long time, development goals have focused on the diffusion of basic education, while higher schooling was conceived as "elitist" and just privately rewarding (Kapur and Crowley 2008; Pillay, 2010). It was just by the end of the 20th century that these perceptions gave way to a widely recognition of the role of higher education as a powerful engine of economic and social change at both developed and developing societies (World Bank, 2000).

Today, the main channels of knowledge creation, absorption and dissemination are associated to skills acquired through higher education. From a purely economic perspective, the higher educated are expected to speed-up productivity gains by bringing out new knowledge and learning skills to the production process. Moreover, they are important drivers of innovation and technology diffusion, relevant to explain cross-country differences in income and economic growth (Aghion and Howitt, 1998; Benhabib and Spiegel, 2005; Nelson and Phelps, 1966; Romer, 1990).

However, even substantial improvements in higher educational attainments might not be immediately translated into rapid economic growth. This may happen when the graduated find difficulties to perform in their jobs because they come across a stagnant or insufficient demand. Also when higher educated just occupy privately rewarding jobs with very low social returns (Pritchett, 2001). This study examines two additional reasons connected to public funding that might hamper the achievement of benefits from higher education. Specifically, this chapter argues that the allocation of education spending among different levels and the type of contents that these resources are used on are important conditions to accrue positive returns.

At first sight, the existence of positive externalities from higher education would provide good arguments for its public support. Nevertheless, the extent up to which its private benefits might outweigh its social gains in different societies has often questioned the rationale for a tax-based system (Oketch, 2016). This debate on the relevance of public investment has also

been associated to the funding requirements of basic education. Many economic historians have documented a long lasting "tertiary-tilt" in education spending, particularly in developing countries (Lindert, 2009; Frankema; 2009). This skewed resource allocation has been linked to poverty (Datt and Ravallion, 2002) and to income inequality (Birdsall et al., 1997; Gruber and Kosak, 2014). Following this literature, the present chapter analyses whether this bias has also undermined the economic growth impacts of higher education.

Amid these resource allocation controversies, a further concern has to do with the types of qualifications provided by the higher education systems, for they have relevant economic growth implications. The quality of education affects the labour market performance and might hinder economic and social innovation processes (Oketch et al., 2014). Besides, in the prevailing technology-based economy, lacking of a proper scientific and technological infrastructure colludes against any policy design targeted to fuel productivity growth. In fact, the need to enhance the scientific and technological (S&T) training has gained political interest in the last years (Yusuf and Nabeshima, 2007; Pillay, 2010; Balan, 2013).

Yet, despite the privileged position of S&T skills at the political and academic agendas, individual choices about education contents seem to have reacted slowly. Regardless of the country's income per capita, over the last 40 years more than one third of tertiary students have enrolled in social sciences while over 20% have chosen humanities and education. By contrast, the share of S&T fields has remained around 9% and has only expanded in upper middle income countries (UIS, 2016). Based on these data, this study explores whether the share of S&T skilled have really made up a difference for productivity growth over the last decades.

The empirical analysis resorts to a panel of 22 high-income countries and 19 upper middle-income countries (HICs and UMICs, respectively) at 5-year intervals from 1970 to 2010. This selected sample allows considering the role of higher educated people on economic growth in countries where education attainments are among the world highest (Barro and Lee, 2013) and where the fraction of S&T students over total enrolment is similar (UIS, 2016). At the same time, the panel shows considerable variability as the sample economies exhibit different capacities of technology generation and application and different levels of productivity achievements over the period (Van Ark et al., 2008, ECLAC, 2014).

From a methodological perspective, the empirical work builds on Blundell and Bond (1998) System GMM panel regression models and Hierarchical Linear Models (HLM), following the proposal by Jamison et al. (2007). The former is deemed to deal with endogeneity concerns stemming from the correlation between schooling and economic growth. The latter provides a

way of assessing parameter heterogeneity in cross-country samples. Besides, it allows differentiating the mechanisms through which the tertiary-tilt and the skill profile may influence cross-country income differences.

The remainder of the chapter is organized as follows. Section 3.2 summarizes the main literature on the topic. Section 3.3 presents the empirical methodology while section 3.4 describes the data. Section 3.5 shows the results as well as some robustness checks and Section 3.6 discusses the findings. Section 3.7 concludes.

3.2 Literature background

Research dealing with the aggregate impact of the "upper tail" of the education distribution is not particularly abundant. Moreover, the available studies regarding the productivity effects of higher education find positive as well as negative results (Wolff, 2001; Canton, 2007; de Bloom et al., 2013; Pereira and St. Aubynb, 2009; Holmes, 2013).[8] Indeed, some literature suggests that the returns of tertiary education are linked to each country's development level, though their findings are not conclusive. Hence, some studies limit the importance of higher education to developed countries (Papageoriou, 2003; Self and Grabowski, 2004; Keller, 2006) while others consider that it is also essential in less developed economies (Gyimah-Brempong et al., 2006; Castelló and Mudrokaphy, 2013). Another strand of the literature has shown that, among developed countries, the growth effects of tertiary education in OECD economies increase with the proximity to the technological frontier (Vandenbussche et al., 2006 and Aghion et al., 2009). More recently, Ang et al. (2011) have proved that the same effect also appears in middle income countries.

The case for the education budget to condition the impact of tertiary education on economic growth has not been tackled before. However, some studies have referred to its importance when exploring the unequal growth impact of the education distribution (Castelló and Domènech, 2002; Castelló, 2013) and others have suggested that a tertiary tilt in education outlays has an "anti-growth" effect (Birdsall, et al. 1997, Frankema, 2009). Judson (1998) finds that an inefficient allocation of basic and higher education spending diminishes the economic gains from education. Instead, a tertiary titled education budget has been frequently identified with poverty and a worse income distribution. Particularly, Gruber and Kosak (2014) compute a measure of the tertiary tilt and document its effect on increasing inequality through its impact on primary education enrolment.

[8] Sianesi and van Reenen (2003) and Kimeny (2011) provide a detailed revision of the studies.

As for the role of certain kind of knowledge in accelerating productivity growth, the literature has adopted different perspectives. In particular, entrepreneurial spirits and skills for risk evaluation and firm management have been associated to economic development in middle income economies (Galor and Michalopoulos, 2009); in cities (Glaeser et al., 2009) and across regions (Gennaioli et al., 2013). Iyigun and Owen (1999) argue that these individual natural skills contribute to development when complemented with formal educated professionals.

The positive contribution of technicians and engineers to income has been emphasized in economic history analysis (Mokyr, 2005) and in studies on current economies (Maloney and Valencia, 2014). The latter find that engineering density in 1900 is relevant to explain present income differences at US county level and in a sample of Latin American countries. Comparisons between skill profiles appear in Murphy et al. (1991), who discuss their impact on US productivity from a theoretical and empirical perspective. They compare the role of Law studies (more prone to promote rent-seeking activities) with Engineering (with a higher impact on productivity). Also Cantoni and Yachtman (2012; 2013) analyse the economic policy behind educational investment decisions taking engineering vis-à-vis business and law. Hanushek and Kimko (2000) underline the importance of mathematics to explain individual productivity and income in a study on the quality of education based on test scoring of students for 70 countries. However, science and technology fields (S&T) have not been particularly considered.

This chapter makes various contributions to the existing literature. First, it provides new evidence about the impact of tertiary education on income and economic growth. Second, it examines the role of two barely explored mechanisms affecting that impact. On one hand, it extends Gruber and Kosak's (2014) focus on the inequality effect of the tertiary tilt and, on the other it tests the relevance of the S&T skill profile of tertiary students by compiling the available information between 1970 and 2010. Third, the country sample, which includes HICs and UMICs, allows focusing on the higher education policy challenges faced by those countries which have largely surpassed minimum education standards.

3.3 Methodological approach

3.3.1 Empirical model

The level or *stock* of education is a central piece in the literature about economic growth and development. Following Jamison et al. (2007), this study takes both a "level-growth" and a "level-level" approach. The former considers that the stock of higher educated people accounts for differences in the growth rates of productivity across countries, in line with endogenous growth theories (Romer, 1990; Aghion and Howitt, 1998). Alternatively, the "level-level"

model emphasizes that the international differences in the use of an input like tertiary educated human capital can explain income disparities (Mankiw et al. 1992; Krueger and Lindahl, 2001). The empirical work stemming from both approaches makes it possible to deal with different methodological issues which, if providing similar results, can strengthen the conclusions from the analysis.

The "level-growth" specification is based on the standard model proposed by Barro (1991). It assesses whether countries grow faster because a larger share of its population has attained tertiary education, according to the following equation:

$$g_{it} = \beta_0 + \beta_1 \ln y_{i0} + \beta_2\, stertiary_{it} + \delta\, Z_{it} + c_i + t_t + \mu_{it} \qquad (1)$$

where g_{it} is the growth rate of real GDP per capita or productivity for country *i* in period *t*; $\ln y_{i0}$ is the initial level of real GDP per capita (in logarithms) to account for convergence; $stertiary_{it}$ stands for the share of tertiary educated people; Z_{it} is a vector with factors other than tertiary education affecting economic growth; c_i captures time-invariant unobserved fixed effects; t_t captures individual invariant time-effects; and μ_{it} is a stochastic term, normally distributed.

Within this framework, the use of interactions shows the possible differences in the response of economic growth to tertiary education depending on education spending or the skill profile of students. Hence, in Equation (1.1) the interacted term captures the change in the effect of tertiary education on economic growth associated to the education budget composition per level, summarized in the term *tertiary tilt*. Similarly, equation (1.2) considers whether the preference of students for science and technology fields (*share S&T*) *vis-à-vis* other options alters the effect of the tertiary educated on economic growth.

$$g_{it} = \beta_0 + \beta_1 \ln y_{i0} + \beta_2\, stertiary_{it} + \beta_3\ tertiary\ tilt_{it} + \\ + \beta_4\, stertiary_{it} x\ tertiary\ tilt_{it} + \delta\, Z_{it} + c_i + t_t + \mu_{it} \qquad (1.1)$$

$$g_{it} = \beta_0 + \beta_1 \ln y_{i0} + \beta_2\, stertiary_{it} + \beta_3\, share\ S\&T_{it} + \\ + \beta_4\, stertiary_{it} x\ share\ S\&T_{it} + \delta Z_{it} + c_i + t_t + \mu_{it} \qquad (1.2)$$

The "level-level" approach is built upon a "meta-production function". It assumes that all countries access the same technology, but may operate on different parts of it according to their natural endowments, the relative prices of inputs and the economic environment (Hayami and Ruttan, 1970). From an empirical perspective, the existence of a common underlying production function justifies its estimation by pooling data from different economies (Lau and Yotopoulos, 1989). However, this formulation implies that input shares

are homogenous across countries, a premise criticized by authors who state that estimations should allow for parameter heterogeneity (Temple, 1999; Sianesi and van Reenen, 2003). Therefore, previous studies dealing with meta-production functions have considered country-specific coefficients for technical progress (Boskin and Lau, 2000; Jamison et al., 2003) and also for human capital (Jamison et al., 2007).[9] Drawing upon the latter, the second model specified is as follows:

$$lny_{it} = \beta_{oi} + \beta_{1i} stertiary_{it} + \beta_{2i} time + \beta_3 ln\, k_{it} + \beta_4 lnpopage_{it} + \varepsilon_{it} \quad (2)$$

where lny_{it} is the logarithm of the real GDP per capita in country *i* at time *t*; *time* is a trend which captures the rate of technological progress; $ln\, k_{it}$ is the logarithm of the physical capital per capita; *lnpopage* describes the logarithm of the age structure of population included to complement the characteristics of human capital, as suggested in Jamison et al. (2007) and ε_{it} is the unexplained residual error, unique for each country-time observation and normally distributed.

The equation assumes that only a part of human capital enters the production function: it is the most productive or skilled labour endowment represented by the share of tertiary educated. Human capital is not taken in logarithms in order to reflect that it enters the production function as an exponential function of schooling (Krueger and Lindhal, 2001).

Model (2) uses varying coefficients to reflect the presence of parameter heterogeneity. Note that β_{oi} represents the specific intercept for country *i;* β_{1i} measures the impact of tertiary education on income in country *i* and β_{2i} describes the country-specific effect of "technical progress". Under this setting, it is possible to extend the mechanisms through which the tertiary tilt and the S&T skill profile act on productivity levels beyond their effect on the share of the tertiary educated. In this case, three specifications can be considered simultaneously with model (2):

$$\beta_{0i} = \gamma_{00} + \gamma_{01} geographical\ location_i + \gamma_{02} tertiarytilt_i + \gamma_{03} share\ S\&T_i + v_{0i} \quad (2.1)$$

$$\beta_{1i} = \gamma_{10} + \gamma_{11} tertiarytilt_i + \gamma_{12} share\ S\&T_i + v_{1i} \quad (2.2)$$

$$\beta_{2i} = \gamma_{20} + \gamma_{21} tertiarytilt_i + \gamma_{22} share\ S\&T_i + v_{2i} \quad (2.3)$$

where $v_{0i} v_{1i} v_{2i}$ are country-specific errors, normally distributed with mean zero and uncorrelated with ε_{it}.

[9] Jamison et al. (2007) analyse a panel of 62 countries at 10 year intervals from 1960 to 2000 and explore the mechanisms by which education quality improves per capita income levels.

Equation (2.1) models the tertiary tilt and the S&T skill profile as potential determinants of the country intercepts. This equation also includes a measure of the geographical location of the economies, as this might exert a relevant influence on explaining the persistent differences in productivity levels across countries. Next, equation (2.2) and (2.3) consider that the tertiary tilt and the share of S&T students may affect the productivity impact of tertiary education and technical progress, respectively. Both $tertiarytilt_i$ and $share\ S\&T_i$ are measured as period means at the country level in order to isolate their cross-country impact.[10]

3.3.2 Estimation strategy

One important methodological issue in the estimation is potential endogeneity. As given above, the models state the influence of the share of tertiary educated on income per capita. However, countries with cultural, historical or institutional conditions favourable to economic growth (or to a higher income per capita) might also promote higher education attainments. In this case, the relation would not reflect causality but other attributes of the economy that are beneficial to growth (Hanushek and Kimko, 2000). It might also be argued that, as per capita GDP increases, returns to education might increase as agents have more incentives to invest in higher education (Castelló and Hidalgo, 2012). A similar pattern might affect the share of S&T. This skill profile is expected to improve economic outcomes; but, at the same time, the interest in promoting this skill orientation can be enhanced by a positive growth cycle. Likewise, countries with a higher share of S&T students might also have higher records in capital accumulation, basic education and other factors, which could explain the positive relation between the S&T share and the dependent variable.

These estimation biases might be partially alleviated if higher economic growth rates tend to discourage extensive education cycles and promote an earlier entrance to labour markets. As a result, the variability in the share of tertiary educated across countries could be mostly associated to historical differences in education policies and exogenous initial conditions. However, the endogeneity concerns might still persist. Hence, the empirical strategy must introduce alternatives to alleviate them. Given the different nature of model (1) and (2), the estimation strategies conducted in each of them are explained separately.

[10] The model is in the spirit of Hall and Jones (1999) and Gennaioli et al. (2013) for it aims at disentangling channels through which the productive factors (mainly, human capital) influence productivity.

Level-Growth model

Given the unavailability of adequate instruments, the empirical estimation of the dynamic panel data model (1) resorts to the widely applied "system GMM" technique proposed by Blundell and Bond (1998).[11] It accounts for endogeneity and deals with plausible panel unobserved heterogeneity by using the sample moments of each variable as instruments. Bond et al. (2001) show that the system GMM estimator is the preferred approach for estimating dynamic growth models as it provides more efficient estimates than traditional IV estimators. The estimation has been devised for a sample where *i* is large relative to *t,* as it is the case in the present analysis.

The system GMM estimates simultaneously two equations: one in first differences and one in levels, using different instruments for the endogenous and predetermined variables.[12] Instruments for the equation in first differences are the lagged values in levels following Arellano and Bond (1991). Instruments for the equations in levels are the lagged first-differences. One drawback of this technique is the instrument proliferation. Thus, in order to avoid over-fitting the model, which could lead to biased estimates, it is necessary to limit the collection of instruments by reducing the number of lags and/or collapsing some of the instruments (Roodman, 2009).[13]

Accordingly, the specification for equations 1.1 and 1.2 takes the share of tertiary educated as the potentially endogenous explanatory variable. The tertiary tilt, the share of S&T students and the interacted variables are taken as predetermined. The same treatment is given to the following explanatory variables: logarithm of income per capita, trade openness and capital share of GDP. Besides, all these variables are taken at the beginning of each of the 5-year periods: both to reflect their delayed influence and to further alleviate endogeneity concerns. The rest of controls included in matrix Z_{it} in model 1 are geographical location, active population, size of government and political participation. They are assumed to be exogenous. Both these controls and the dependent variable are calculated as averages over 5 years.

In order to restrict the number of instruments, the maximum number of lags has been set at 3 (i.e. up to 3 lags for the difference equation and first difference dated "t"- without lags- for the level equation) and the matrix of instruments collapsed as suggested by Roodman (2009). The

[11] Note that the dynamic characteristic in model (1) is given by the computation of the dependent variable (average growth rate) as $(\ln y_{it} - \ln y_{it-T} / T)$ while $\ln y_{it-T}$ is one of the explanatory variables at the right hand side of the expression (in this paper T= 5-time periods).

[12] Predetermined variables are those not strictly exogenous in the sense that they might be potentially correlated to the lagged values of the structural error (Hayashi, 2005).

[13] The usual procedure is to keep the number of instruments close to the number of individuals in the sample (here, 41 countries).

output tables report the number of instruments together with a Hansen's test of over-identifying restrictions and a test of absence of second order serial correlation in the error term. The estimates follow a two-step GMM procedure that provides more efficient outcomes than the one step equivalent. They also consider the Windmeijer finite-sample correction to the reported robust standard errors in two-step estimation, without which those standard errors tend to be downwards biased (Hayashi, 2005).

Level-Level model

The second model takes the share of tertiary educated as an input in a "meta-production function" where parameter heterogeneity is allowed. The estimation is addressed by using a Hierarchical Linear Modeling technique (HLM). The HLM is a complex form of an ordinary least squares regression, which analyses the variance in the outcome variable assuming that the predictor variables are at different hierarchical levels (Woltman et al., 2012). These models are also known as "random coefficient" or "random slope" regression models.

Panel data may be conceived as a structure where observations per period and country/ cluster (level 1 units) are nested within each cluster (level 2 units) (Hanchane and Mostafa, 2011).[14] Hence, the technique allows computing different coefficients for each cluster-unit (level 2), while at the same time restricts the overall effect at level 1 to be the same across countries. In the present study, the intercept and the coefficient on share of tertiary educated and time (β_{oi}, $\beta_{1i,}$ β_{2i} in model 2) are estimated separately for each country i, but the overall relationship is common across them.

HLM also postulates the presence of mediating mechanisms that cause variables at one level to influence variables at another level (Garson, 2012). Then, level 1 regression coefficients (β_{oi}, β_{1i} and β_{2i}) are used as outcome variables and related to level 2 predictors, which vary across countries (as in equations 2.1, 2.2 and 2.3). As a result, multi-country datasets potentially provide information about 'country effects' as well as 'individual effects', and also about interactions between them ('cross-level effects').

If equations 2.1, 2.2 and 2.3 are substituted into model (2), the nested structure of data can be translated into the following expression:

[14] In the present panel, as N=41 and T= 8 five-year periods, there are 328 measurement occasions (level 1 units) nested within 41 countries (level 2 units).

$$lny_{it} = \gamma_{00} + \gamma_{01} geographical\ location_i + \gamma_{02} tertiarytilt_i + \gamma_{03} share\ S\&T_i + \\ + \gamma_{10} stertiary_{it} + \gamma_{11} tertiarytilt_i * stertiary_{it} + \gamma_{12} share\ S\&T_i * stertiary_{it} + \gamma_{20} time + \\ + \gamma_{21} tertiarytilt_i * time + \gamma_{22} share\ S\&T_i * time + \beta_3 ln\ k_{it} + \beta_4 lnpopage_{it} + v_{0i} + \\ + v_{1i}\ stertiary_{it} + v_{2i}\ time + \varepsilon_{it} \quad (3)$$

In practical terms, the model to be estimated looks like equation (3). This means that 3 types of parameter are estimated: "fixed effect" parameters, which do not vary across countries and refer to the overall expected effect of explanatory variables on income level; the "random level" coefficients that show whether the effect of the intercept, the share of tertiary educated and of time varies across countries and, finally, the variance-covariance matrix. This includes the covariance between level 2 error terms (v_{0i}, v_{1i}, v_{2i}) and the variance in the level 1 (ε_{it}) and level 2 error components.

The HLMs are estimated by Maximum Likelihood while random intercepts and random slopes ($v_{0i} v_{1i} v_{2i}$) are predicted by empirical Bayesian method. A correction is used to obtain errors robust to heteroskedasticity. The Akaike and Bayesian criteria (AIC or BIC) as well as the Deviance (-2 x log likelihood) compare models. The smaller the results, the better the model. To alleviate the endogeneity bias present in this estimation, the share of tertiary educated and the physical capital per capita are taken with a 10-year lag, while income per capita is measured as a 5 year-average. The value for age structure of population is taken at the beginning of each 5 year period.

3.4 Data and sources

To empirically analyse the economic impact of higher education and its determinants this study uses a panel of 41 countries, including 22 HICs and 19 UMICs between 1970 and 2010 (the list of countries is in Table A.3.1 in the Appendix). The classification follows the World Bank, but introduces modifications because some countries which are currently considered as HICs were not under this category during most of the period (such as Chile, South Korea and Poland). The 40-year span has made it difficult to find information on public education spending and enrolment for many UMICs. For that reason, this sub-sample comprises 13 Latin American and 6 Asian countries. The latter include the group known as "tigers", which have made important headway in the main records considered in this study over the period.

Data on per capita GDP at constant terms are drawn from the Penn World Tables-PWT, 8.0 (Feenstra et al., 2013). Regarding the explanatory variables, the stock of higher educated people is measured as the share of those aged 25 and more with tertiary education as highest attainment. The use of this age group aims to account for people actively participating in the labour force. According to UNESCO, tertiary education comprises universities, teacher's colleges and higher professional schools. The indicator includes all people who reached this

education level, either if they completed it or not. Average years of tertiary education will also be used to check the robustness of the estimates.[15] Data come from Barro and Lee 2.0 database (2013), which solves most measurement errors present in previous compilations, such as Barro and Lee (2001), De la Fuente and Domènech (2006) or Cohen and Soto (2007). As the information is reported at 5-year intervals, the estimations are computed at 5-year spans between 1970 and 2010.

The distribution of public education spending is summarized in the term "tertiary tilt". According to Gruber and Kosak (2014), it represents the relative concentration of educational resources at the tertiary level. The tertiary tilt is computed as the ratio of tertiary over pre-primary and primary public education spending per student. The variable is taken in logarithms to minimize the impact of countries with very high tilts (Gruber and Kosak, 2014: 257). As in these authors' paper, secondary education has not been considered in order to emphasize the unbalanced distribution of resources between two extremes: one totally compulsory and the other totally non-mandatory.

Data on public education spending have been taken from several sources: ECLAC, IMF, OECD.stats, UNESCO and the World Development Indicators (WDI), together with statistical information from each particular country. Public education spending per student is obtained as the ratio of expenditure over the number of students enrolled in each level. Unfortunately the available enrolment information comprises the whole educational system (private and public). Therefore, particularly in the case of tertiary education, to estimate the public share of education spending it was necessary to resort to several UNESCO Yearbooks of the period as well as to secondary literature and information at the country level.

In order to explore the economic results of the highly educated people allocated at the fields of mathematics, computing, physics and other natural sciences, these categories have been gathered under the broad name of "scientific and technological" skills (S&T). They represent a stock of highly skilled human capital linked to knowledge generation and/or technology adaptation that could directly drive productivity changes (Table A.3.2 details the academic fields within the category). The rest of skill profiles are classified into humanities and education, health, agriculture, social sciences (including law, business and behavioral sciences) and other majors. The data refer to the percentage of enrolment at each knowledge field and have been compiled from several UNESCO Yearbooks and complemented with UIS. The groups respond to the way data are presented in the original sources, particularly until 1990s, which

[15] According to Castelló and Mukhopadhyay (2013), the measure on shares is better than "years"of tertiary education" because the former is not affected by the fraction of illiterates.

precludes a more detailed consideration of particular disciplines. The enrolment distribution is assumed to provide an idea of the distribution of skills in the labour force.[16]

Note that the available information describes people enrolled not graduated. Anyway, this alternative fits with the measure of tertiary educated people, which includes those who have not finished the level. Besides, the aim is to capture the incentive to be in the field of S&T compared to the rest of options, something that can be better accomplished by the enrolment indicator. An additional caution is required because of the lack of reliable information about the share of engineering students during the period. The main reason is that in several countries (particularly Latin American ones), some social science majors are titled as "engineering". This fact distorts the real size of the category and, as there is not enough information to correct this problem, engineering has not been included in the S&T category and had to be subsumed in the residual group.

Along with the logarithm of the initial GDP per capita to account for conditional convergence (constant 2005 US$, PWT-8.0), the growth regressions include additional covariates to reduce specification error biases (Z_{it} in equations 1, 1.1 and 1.2). Hence, the "percentage of land areas in geographical tropics" (*tropical areas*) is used to control for geographical location, as warm and humid climate in places near the equator might exert a negative effect on income per capita (Sachs and Warner, 1997). Data on this variable have been taken from the Center for International Development (CID). A measure of "political participation" or voting turnout controls for the effect of democracy under the assumption that well-functioning political and legal institutions help to sustain growth (Barro and Sala-i-Martin, 2004). The variable comes from the Quality of Government Database (QOG) compiled by Teorell et al. (2015).[17]

Other possible drivers of economic growth are the domestic investment rate, represented by the share of gross capital formation over GDP, and the participation in the international economy measured by the degree of "trade openness" (ratio of exports plus imports over GDP). These data are drawn from PWT-8.0. The share of people aged 25 to 64 over the total population controls for the size of the active labour force (WDI). Finally, the "size of government" might entail distortions of private decisions, resulting in a negative influence on economic growth (Barro, 1991). This potential effect is appraised by an index which ranges from 0 to 10: large and small government, respectively (Teorell et al., 2015). Overall, this set of

[16] This is rather simplistic, as it assumes that people studying in a country (even foreigners) will remain there. However, the drawback is partially alleviated because despite the different policy schemes to encourage returning, a non-negligible part of foreign students in the most developed countries end up settling abroad (World Bank, 2000).

[17] Under non democratic rules, the degree of participation drops to 0.

variables condition the link between tertiary education and growth because they partially shape the labour markets in which tertiary educated people are able to find their jobs.

The analysis of income per capita determinants (equation 2 and 3) uses information about "capital stock at constant prices" (in 2005 US$) from PWT 8.0 and "share of people under 15 years old in total population", from WDI. The former is built based on accumulated past investments and depreciation rates with the perpetual inventory method. The latter, as stated in Jamison et al. (2003), aims to capture the age structure of population, which might negatively affect income per capita when there is a high dependency ratio. In equation 2.1 the geographical location is measured by the variable *tropical areas,* as in the growth equations.

The country sample presents considerable variation both across and within countries. As for the dependent variable, while European countries experienced a productivity slowdown respect to US between 1973-1995 and 1995-2006, US growth accelerated (Van Ark et al., 2008). Similarly, productivity gains in Asian UMICs have grown threefold on average, but remained barely unchanged in Latin American countries (LACs) (ECLAC, 2014). A summary of the descriptive statistics is presented in Table A.3.3. Here, Table 3.1 describes some general trends in the explanatory variables splitting the sample into HICs and UMICs.

Table 3.1 Descriptive statistics of the main explanatory variables

Country	Share tert.	Publ. spend. per st./pc GDP		Tertiary tilt	Main skill profiles (% enrolment)			
	(%)	Primary(*)	Tertiary	(ln)	S&T	Soc. sc.	Hum. & Educ	Health
				Whole period				
All countries	12.8	15.4	73.7	1.4	8.8	31.3	24.3	10.7
St. Dev	*9.4*	*7.5*	*63.1*	*0.8*	*3.7*	*8.6*	*8.2*	*5.2*
HICs	16.5	19.4	64.1	1.1	10.0	29.4	26.5	11.8
St. Dev	*10.5*	*7.7*	*49.2*	*0.6*	*3.5*	*6.6*	*7.2*	*5.1*
UMICs	8.7	10.9	85.3	1.8	7.0	33.7	21.9	9.6
St. Dev	*5.7*	*4.0*	*75.2*	*1.8*	*3.4*	*10.4*	*8.8*	*4.9*
				1970-1975				
All countries	5.6	13.2	107.0	2.0	9.2	26.1	31.5	10.7
St. Dev	*4.9*	*9.1*	*82.5*	*0.8*	*4.6*	*8.5*	*10.2*	*6.2*
HICs	7.9	17.1	87.6	1.6	11.3	25.4	35.4	11.1
St. Dev	*5.7*	*10.9*	*66.0*	*0.6*	*3.6*	*7.9*	*8.1*	*6.6*
UMICs	3.0	8.8	128.5	2.5	6.9	26.6	27.7	10.8
St. Dev	*1.5*	*3.0*	*94.7*	*0.7*	*4.7*	*9.5*	*11.0*	*5.7*
				2005-2010				
All countries	20.7	16.3	51.7	1.1	9.6	34.5	21.2	12.4
St. Dev	*10.7*	*6.0*	*30.2*	*0.6*	*3.2*	*6.4*	*4.1*	*4.4*
HICs	26.3	19.0	53.5	0.9	9.8	32.6	22.6	14.5
St. Dev	*11.1*	*5.8*	*34.4*	*0.5*	*2.9*	*4.8*	*3.2*	*3.9*
UMICs	14.8	13.0	49.4	1.3	9.5	37.3	19.5	9.8
St. Dev	*6.3*	*4.7*	*26.0*	*0.6*	*3.7*	*7.7*	*4.6*	*3.3*

(*) includes pre-primary

Source: own computation based on Barro and Lee (2013); IMF; ECLAC; UNESCO Yearbooks; UIS; WDI.

The general picture shows that the share of tertiary educated in total population has substantially expanded in both country-groups during the period (consider that for developing countries as a whole, the mean share by 2005-2010 was below 10%). Meanwhile, public spending per tertiary student as a fraction of per capita GDP has been higher than for primary education, being the difference (and therefore the tertiary tilt) particularly large in UMICs. This tilt has tended to decrease, though it has remained higher in UMICs. Finally, there are not huge disparities among the skill profile of tertiary students across country-groups. Over time, the share of S&T students tended to increase in UMICs, whereas those at social sciences noticeably expanded in both country-groups followed by the health disciplines.

3.5 Results

3.5.1 Baseline estimates

Table 3.2 presents the system GMM estimates of the level growth models. In Column 1, the growth impact of the share of tertiary educated people is measured *vis-à-vis* the rest of education attainments. The fraction of those with some or completed secondary education and completed primary schooling are added in Columns 2 and 3, respectively. The results show that tertiary educated people have a positive influence on GDP growth, and that the variable retains its significant effect once controlled for the records at other education levels.

In Column 4 the share of tertiary educated is allowed to depend on the tertiary tilt, as in equation 1.1. The coefficients of the higher educated term and its interaction with the tertiary tilt have opposite signs and both are statistically significant at 1% level. This implies that the higher the tertiary tilt (that is, the relative concentration of educational resources at the tertiary level), the lower the contribution of the tertiary educated people to the rate of GDP growth. Observe that the average value of the tertiary tilt in UMICs (in logs) is 1.81 while it is 1.09 for HICs. If the coefficients in Column 4 are taken as given, the estimation results suggest that the contribution of one percentage point change in the share of tertiary educated to economic growth in UMICs is 60% lower than for HICs (the sums of the interaction term and the coefficient for tertiary educated equal 0.06 and 0.14, respectively). Therefore, the extent up to which the countries tilt their public resources on tertiary students at the expense of primary education seems to lead to a considerable variation in the economic returns from higher education.

Estimates in Column 5 show that, after controlling by the share of the tertiary educated, the fraction of S&T students holds a positive and significant effect on economic growth with

respect to other skill-orientations.[18] Moreover, the impact of students enrolled in any field of knowledge different from S&T is significantly lower than that of the group under analysis (see Table A.3.4). Thus, from this aggregate perspective, beyond the direct contribution of the tertiary educated to economic growth, S&T is the only skill profile conveying a specific positive influence. When that variable is interacted with the tertiary educated (as in equation 1.2), the term bears a positive and significant coefficient, but neither S&T nor the tertiary educated share retain their role (Column 6). This suggests that the growth effect of tertiary educated becomes particularly distinct when they hold one S&T skill profile. In Column 7 the effect of the tertiary tilt (as one interaction) is combined with the share of S&T students as a control. Almost all coefficients in this model have the expected sign and are statistically significant.

The impact of the set of control variables is as expected. Hence, there is evidence of conditional convergence across countries, as the coefficient of the initial GDP per capita is negative and significant. On the other hand, the investment ratio, trade openness and political participation (as a proxy of sound institutions) bear positive and significant effects. The same happens with the share of active population, though its coefficient is not always significant. Finally, a greater size of government and being located in tropical areas seem to discourage economic growth, as has been found in previous studies (Section 3.4). The system GMM estimates satisfy the Hansen's tests for instrument validity and AR (2) tests for absence of second order serial correlation.

[18] Remember that the variable is lagged to capture the effect of past enrolment values on current per capita GDP.

Table 3.2 Education, tertiary tilt and S&T profile as determinants of per capita GDP growth

Dep. Var. g_{it}	1	2	3	4	5	6	7
s.tertiary$_{t-1}$	0.141*	0.113*	0.076*	0.269***	0.168*	-0.073	0.354***
	(0.076)	(0.061)	(0.045)	(0.077)	(0.100)	(0.130)	(0.110)
s.primary$_{t-1}$			-0.063				
			(0.057)				
s.secondary$_{t-1}$		0.060	0.052				
		(0.043)	(0.051)				
tertilt$_{t-1}$				0.021*			0.024***
				(0.011)			(0.006)
s.tertiary$_{t-1}$ x tertilt$_{t-1}$				-0.118***			-0.122***
				(0.039)			(0.032)
s. S&T$_{t-1}$					0.289**	-0.208	0.234*
					(0.143)	(0.230)	(0.137)
s.tertiary$_{t-1}$ x s. S&T$_{t-1}$						2.432*	
						(1.356)	
ln y $_{i, t-1}$	-0.103***	-0.093***	-0.087***	-0.110***	-0.099***	-0.085***	-0.099***
	(0.023)	(0.021)	(0.020)	(0.018)	(0.037)	(0.018)	(0.014)
investment ratio $_{t-1}$	0.162*	0.155*	0.172*	0.209***	0.191**	0.167***	0.244***
	(0.085)	(0.080)	(0.096)	(0.058)	(0.074)	(0.053)	(0.062)
pop. 25-64$_t$	0.362**	0.256	0.222	0.376***	0.302	0.265**	0.337***
	(0.155)	(0.163)	(0.165)	(0.121)	(0.215)	(0.115)	(0.125)
trade openness$_{t-1}$	0.036***	0.034**	0.031**	0.027***	0.025*	0.030***	0.012
	(0.013)	(0.013)	(0.012)	(0.010)	(0.013)	(0.010)	(0.008)
size of government$_t$	-0.006**	-0.005**	-0.005***	-0.007***	-0.005*	-0.005***	-0.007***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)
political participation$_t$	0.001*	0.001*	0.001**	0.001**	0.001*	0.001**	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
tropical areas	-0.054***	-0.050***	-0.051***	-0.059***	-0.033***	-0.036***	-0.044***
	(0.020)	(0.015)	(0.017)	(0.018)	(0.011)	(0.009)	(0.010)
constant	0.760***	0.703***	0.682***	0.774***	0.714**	0.661***	0.665***
	(0.176)	(0.151)	(0.156)	(0.136)	(0.265)	(0.128)	(0.096)
Observations	311	311	311	292	265	272	258
Number of instruments	28	32	36	36	32	36	40
AR(2) test	0.900	0.870	0.993	0.510	0.637	0.653	0.720
Hansen test (p-val)	0.161	0.279	0.336	0.482	0.367	0.755	0.974

Note: Due to missing data related to public tertiary tilt and the fraction of tertiary enrolled in different fields of knowledge, the number of total observations in columns 4-7 is slightly lower than in the previous ones.
Estimates from two-step difference GMM with 1 to 3 lags in endogenous variables and other instruments collapsed; Windmeijer's (2005) finite sample correction, robust standard errors and time dummies. The sample includes 41 countries. *** p<0.01, ** p<0.05, *p<0.1

The next tables report the HLM estimates for a meta-production function with parameter heterogeneity. In Table 3.3, Column 1 describes a model in which the intercept is the only coefficient computed on a country-varying basis (the coefficients of the share of tertiary educated people and time are estimated assuming a common slope for all countries). The specification also includes potential determinants of the constant, as in equation 2.1. The estimation shows that the average of the country's specific intercepts (β_{0i}) is highly dependent on geography (with a negative impact of a tropical areas) and on the share of S&T students (with a positive effect), while the tertiary tilt does not stand significant.

In Column 2 the previous estimation also allows for country-specific variations in the slope of the effect of the tertiary educated. Alternatively, Column 3 introduces a country-specific variation in the slope of the rate of technological progress. The obtained average coefficients are positive and significant in both cases. Finally, Column 4 considers varying coefficient computations for the intercept, tertiary educated and time at once, as in equations 2 and 2.1. The results are similar to the previous estimates but the fit of the model is the best (see the AIC, BIC and deviance criteria). The evidence from Table 3.3 supports the relevance of considering between-country differences to account for the impact of tertiary educated and technological change on income per capita.[19] It also underpins the important effect of the geographical location and the share of S&T students on the level of the production function. Physical capital and the proxy for the dependency ratio have the expected signs, though the latter is not always significant.

[19] The results are supported by the significant variance of the varying coefficients, which are not reported for space reasons.

Table 3.3 Determinants of income per capita in HLMs (♦)

Dep. Var.: lny_{it}	1	2	3	4
β_{0i}				
Υ_{00}	4.046***	5.023***	5.978***	5.237***
	(0.559)	(0.679)	(0.762)	(0.621)
tropical areas Υ_{01}	-0.401***	-0.461***	-0.471***	-0.463***
	(0.123)	(0.144)	(0.181)	(0.125)
ter. tilt$_i$ Υ_{02}	0.062	0.140	0.150	0.011
	(0.077)	(0.093)	(0.101)	(0.079)
s. S&T$_i$ Υ_{03}	3.387***	3.263***	3.944***	3.601***
	(1.145)	(1.198)	(1.157)	(1.145)
s.tertiary$_{t-2}$	0.900***		0.966***	
	(0.319)		(0.349)	
s.tertiary$_{i,t-2}$ (β_{1i})		0.980**		1.249***
		(0.493)		(0.281)
time	0.035**	0.047***		
	(0.016)	(0.017)		
time (β_{2i})			0.059***	0.039***
			(0.016)	(0.013)
capital per capita (log) $_{t-2}$	0.444***	0.329***	0.223***	0.312***
	(0.071)	(0.082)	(0.081)	(0.073)
s. pop. 0-14 (log) $_{t-1}$	-0.201	-0.255	-0.292*	-0.339**
	(0.168)	(0.170)	(0.175)	(0.172)
Observations	287	287	287	287
Number of countries	41	41	41	41
Model fit statistics				
AIC	-162	-212	-228	-266
BIC	-125	-172	-188	-237
Deviance (-2*log likelih.)	-182	-234	-250	-282

(♦) Estimates from model (2) and (2.1)

Note: though not reported, the variance of the intercept, the coefficient of the share of tertiary educated and technical progress are significant at 5%. The number of observations is different from those in the system GMM regressions because there are not missing values in the explanatory variables. Cluster robust standard errors in parentheses. *** p<0.01, ** p<0.05, *p<0.1

To further exploring the channels through which the tertiary tilt and the student's skill choices affect economic outcomes, Table 3.4 provides the results from regressions based on model 2, 2.1 and 2.2 (Columns 1, 2 and 3) and model 2, 2.1 and 2.3 (Columns 4, 5 and 6). Across them, the intercept is explained by a set of variables (as in Table 3.3) while the potential determinants of the country-specific slopes for tertiary educated and technical change are alternatively included. The coefficients are reported following the reduced form representation from equation 3.

In Column 1, the country-varying intercept is explained by the geographical location and the tertiary tilt. The latter has also a significant and negative influence on the size of the country-varying coefficient for the share of tertiary educated. So, a higher tertiary tilt is deemed to reduce the contribution of the share of tertiary educated to income per capita. In Column 2, a

similar model focuses on the effect of the share of S&T students on tertiary educated and it yields non-significant results. Both findings remain unchanged when they are considered together and time is included as a varying coefficient (Column 3). In this specification, however, the S&T variable exhibits a positive and significant effect on the intercept.

In Columns 4 and 5, country-specific coefficients are computed for the intercept and for time. The estimates describe a negative and significant influence of the tertiary tilt on the rate of technological progress, while the share of S&T does not have any effect. The specification in Column 6 reproduces these results when the slope for tertiary educated is also computed on a country-varying basis. This is the only specification in which the net impact of the tertiary tilt on the level of output per capita appears to be positive. Again, across HLM estimates, physical capital and population age have the expected signs and are significant.

Table 3.4 Determinants of income per capita with tertiary tilt and S&T profile in HLMs

Dep. Var. lny_{it}	1	2	3	4	5	6
β_{0i}						
Υ_{00}	4.262***	4.551***	4.996***	5.224***	5.557***	4.825***
	(0.605)	(0.648)	(0.605)	(0.629)	(0.673)	(0.521)
tropical areas Υ_{01}	-0.594***	-0.471***	-0.538***	-0.570***	-0.457***	-0.461***
	(0.144)	(0.128)	(0.126)	(0.152)	(0.145)	(0.123)
tertiary $tilt_i$ Υ_{02}	0.263***		0.173*	0.250**		0.229**
	(0.095)		(0.097)	(0.098)		(0.109)
s. $S\&T_i$ Υ_{03}		1.711	3.494**		2.067	4.013***
		(1.645)	(1.442)		(1.846)	(1.253)
$s.tertiary_{t-2}$				0.936***	1.105***	
				(0.268)	(0.294)	
β_{1i}						
$s.tertiary_{t-2}\Upsilon_{10}$	4.056***	0.139	2.570***			1.116***
	(0.834)	(1.144)	(0.961)			(0.321)
$s.tertiary_{t-2}$ x $tertilt_i$ Υ_{11}	-2.124***		-1.139***			
	(0.508)		(0.381)			
$s.tertiary_{t-2}$ x s. $S\&T_i$ Υ_{12}		13.571	1.092			
		(12.185)	(9.144)			
time	0.031**	0.028**				
	(0.013)	(0.013)				
β_{2i}						
time Υ_{20}			0.041***	0.095***	0.013	0.090***
			(0.012)	(0.022)	(0.026)	(0.021)
t x $tertilt_i$ Υ_{21}				-0.036***		-0.035***
				(0.010)		(0.012)
t x s. $S\&T_i$ Υ_{22}					0.353	
					(0.246)	
capital per capita $(log)_{t-2}$	0.423***	0.410***	0.320***	0.319***	0.297***	0.324***
	(0.066)	(0.078)	(0.072)	(0.070)	(0.079)	(0.054)
s. pop. 0-14 $(log)_{t-1}$	-0.255*	-0.280*	-0.332*	-0.324*	-0.342**	-0.319**
	(0.152)	(0.147)	(0.171)	(0.168)	(0.166)	(0.130)
Observations	287	287	287	287	287	287
Number of countries	41	41	41	41	41	41
Model fit statistics						
AIC	-239	-238	-267	-256	-259	-272
BIC	-195	-194	-230	-212	-215	-239
Deviance (-2*log likelih.)	-263	-262	-287	-280	-283	-290

Note: Random effects at slopes and intercept are significant at 5 per cent in all specifications; cluster robust standard errors in parentheses. *** p<0.01, ** p<0.05, *p<0.1

Overall, the different estimation strategies point to the relevance of a higher share of tertiary educated students to accelerate economic growth and to explain cross-country-differences in the level of income. Within this framework, the empirical approaches yield three broad conclusions. First, the growth enhancing effect of tertiary education and the rate of technological progress depends on the tertiary tilt. As a result, the emphasis in public investments towards the "upper tail" of the education distribution is not favourable when obtained at the expense of lower education levels. Second, the fraction of S&T students

consistently emerges as an important source of economic growth when compared to other fields of knowledge. This is in line with the idea that individual's decisions to accumulate different types of human capital may affect the economy's long run potential. Third, the S&T knowledge does not modify the total impact of tertiary educated, but operates as an independent covariate in growth and income level regressions. In fact, it acts a sort of fixed effect contributing to shift the level of the production function.

3.5.2 Robustness checks

The validity of the findings has been tested through a set of robustness checks. In Column 1 of Table 3.5, the system GMM regressions include one additional lag respect to the baseline estimates and in Column 2 they are performed just with the "collapse" option (without cutting the number of lags to be used as instruments). Next, the share of tertiary educated is replaced by "years of tertiary education" (Column 3). Finally, in Columns 4 and 5 different sets of controls are added to the original specifications aiming to better assess the main relationship under analysis.

The upper portion of Table 3.5 shows that the share of tertiary educated and the average years of tertiary education have positive and highly significant effects on growth, though the size of the coefficient varies across the different estimations. The additional controls reflect that neither the human capital from abroad (*proxied* by the migration stock), or the contribution of the private human capital investment (captured by the share of tertiary students enrolled at private institutions) nor the total education spending have exerted any significant influence on changing the initial results.[20]

The second panel of the table allows checking that the growth effect of tertiary education depends negatively on the tertiary tilt. This result remains unchanged even after considering a proxy for private education investment and total public spending on basic education. Moreover, to check whether this finding could be driven by the performance of a specific country-group, a dummy for HICs has been included. However, conditional on the characteristics of HICs, the main explanatory variables retain their sign and significance.[21]

In the bottom panel, the share of S&T students bears a positive influence on economic growth in all specifications, except for Column 2 (collapse option). In Columns 4-6, the models include as controls the interaction term of tertiary educated with tertiary tilt, the dummy for HICs and

[20] Data for migration stocks are obtained from WDI, while total education spending and the share of private tertiary enrolment are based on UNESCO Yearbooks and UIS.

[21] The regressions including total education spending or basic education spending as controls have also been estimated excluding the size of government variable. The results remained unchanged.

also private education investment. The first two variables are significant, but they do not alter the baseline results.

Table 3.5 Robustness checks for determinants of per capita GDP growth

Dep.Var: g_{it}	1	2	3	4	5	6
s.tertiary$_{t-1}$	0.145**	0.197**		0.189***	0.153**	0.141**
	(0.065)	(0.090)		(0.060)	(0.057)	(0.063)
years tertiary$_{t-1}$			0.047*			
			(0.025)			
migration stock$_{t-1}$				-0.499	-0.262	-0.286
				(0.329)	(0.181)	(0.204)
tertiary private enrolment (%)$_{t-1}$					0.006	0.003
					(0.016)	(0.021)
public education spending/GDP$_{t-1}$						0.473
						(0.500)
time dummies	yes	yes	yes	yes	yes	yes
Observations	311	311	311	310	311	310
Number of instruments	32	44	28	32	36	40
AR(2) test	0.782	0.479	0.936	0.483	0.824	0.762
Hansen test (p-val)	0.237	0.435	0.189	0.445	0.137	0.11
s.tertiary$_{t-1}$	0.256**	0.284**		0.242***	0.267***	0.166**
	(0.107)	(0.140)		(0.065)	(0.088)	(0.078)
years tertiary$_{t-1}$			0.093***			
			(0.025)			
tertilt$_{t-1}$	0.014	0.015*	0.038**	0.015*	0.018	0.009
	(0.010)	(0.009)	(0.018)	(0.008)	(0.011)	(0.007)
s.tertiary$_{t-1}$ x tertilt$_{t-1}$	-0.104*	-0.101*		-0.073*	-0.113**	-0.074*
	(0.059)	(0.062)		(0.044)	(0.053)	(0.040)
years tertiary$_{t-1}$ x tertilt$_{t-1}$			-0.005**			
			(0.002)			
tertiary private enrolment (%)$_{t-1}$				-0.015	-0.001	-0.012
				(0.026)	(0.029)	(0.019)
public prim. & sec. spend./GDP$_{t-1}$					0.690	0.220
					(0.696)	(0.816)
HICs						0.042**
						(0.018)
time dummies	yes	yes	yes	yes	yes	yes
Observations	292	292	292	303	292	303
Number of instruments	42	60	36	40	44	45
AR(2) test	0.429	0.455	0.685	0.515	0.506	0.441
Hansen test (p-val)	0.276	0.989	0.754	0.635	0.541	0.497
s.tertiary$_{t-1}$	0.126*	0.175		0.128*	0.300**	0.302*
	(0.065)	(0.116)		(0.068)	(0.123)	(0.181)
years tertiary $_{t-1}$			0.047*			
			(0.028)			
s. S&T $_{t-1}$	0.295*	0.394	0.275*	0.310**	0.252*	0.362*
	(0.175)	(0.280)	(0.145)	(0.122)	(0.154)	(0.207)
HICs				0.032	0.048***	0.038*
				(0.022)	(0.018)	(0.022)
tertilt$_{t-1}$					0.024***	0.020**
					(0.008)	(0.007)
s.tertiary$_{t-1}$ x tertilt$_{t-1}$					-0.134***	-0.126**
					(0.049)	(0.059)
tertiary private enrolment (%)$_{t-1}$						0.023
						(0.029)
time dummies	yes	yes	yes	yes	yes	yes
Observations	263	263	267	265	267	258
Number of instruments	37	50	40	33	41	45
AR(2) test	0.873	0.873	0.961	0.986	0.651	0.285
Hansen test (p-val)	0.577	0.577	0.985	0.260	0.767	0.895

Note: All regressions include ln $y_{i,\ t-1}$; investment ratio $_{t-1}$; pop. 25-64$_t$; trade openness; size of government; political participation and tropical areas.

Estimates from two-step difference GMM; Windmeijer's (2005) finite sample correction, robust standard errors and time dummies. The sample includes 41 countries. *** p<0.01, ** p<0.05, *p<0.1

Regarding the HLM regressions, the baseline specifications separate the random error into a *within* cluster residual (ε_{it}) and some unobserved *between* cluster heterogeneities ($v_{0i}v_{1i}v_{2i}$ in equations 2.1-2.3). Thus, they assume that the within and between cluster effects are equal. However, these effects can be different, so that observations within a cluster might be correlated as a result of an unobserved cluster effect (Mostafa et al., 2012; Bartels, 2008). According to Bartels (2008), this possible endogeneity could be solved if the HLM estimation includes separately "within" and "between" cluster transformed variables. The idea is that within variables are uncorrelated with between-cluster variables (which are constant within the clusters) and therefore, they are uncorrelated with the between cluster heterogeneities.

A within variable can be obtained by subtracting the cluster-mean from the time-varying covariates: $X^{W}_{it}= X_{it}- X^{average}_{i}$. So, the new set of equations to be estimated is the following:

$$lny_{it} = \beta_{oi} + \beta_{1i}stertiary_{it}{}^{w} + \beta_{2i}time + \beta_{3}lnk_{it}{}^{w} + \beta_{4}lnpopage_{it-1}{}^{w} + \varepsilon_{it} \quad (4)$$

where the superindex *w* represents deviations in units of measurement from the cluster mean and the single subindex *i* indicates the cluster/country mean. Additionally, equation (2.1) turns into equation (4.1) to include all the between cluster transformed variables:

$$\beta_{0i} = \gamma_{00} + \gamma_{01}geographical\ location_{i} + \gamma_{02}tertiarytilt_{i} + \gamma_{03}share\ S\&T_{i} + \gamma_{04}stertiary^{average} + +\beta_{3}lnk_{i}{}^{average} + \beta_{4}lnpopage_{i}{}^{average} + v_{0i} \quad (4.1)$$

The new expression (4.1) includes the cluster-mean (or between transformed variables) as in model 2.1 (*geographical location*$_{i}$, *tertiarytilt*$_{i}$ and *share S&T*$_{i}$) together with the new between-transformed share of tertiary educated, physical capital and a proxy of population age structure. Equations 2.2 and 2.3 remain the same, as all modifications are already included in Equations 4 and 4.1. Table 3.6 contains the estimation results for the country-varying intercept model with determinants and country-specific slopes in education and time (Column 1) while Columns 2 and 3 also consider the tertiary tilt as a determinant of these slopes. The results give support to the previous evidence about the negative role of the tertiary tilt on the slopes for education and technical progress and the positive impact of S&T skill profile to set the level of the production function. Besides, the decomposition shows that it is the positive and statistically significant between-country effect of tertiary educated (not its change across time) which mainly explains income differences. This means that countries with a higher fraction of tertiary students have significantly greater levels of income per capita.

Table 3.6 Determinants of income per capita in HLMs (within-between decomposition)

Dep. Var. lny_{it}	1	2	3
Between-country effects			
β_{0i}			
Υ_{00}	5.296***	5.476***	5.217***
	(1.479)	(1.413)	(1.593)
tropical areas Υ_{01}	-0.157	-0.178	-0.180
	(0.189)	(0.172)	(0.190)
tertiary tilt Υ_{02}		0.151*	0.306***
		(0.077)	(0.093)
s. S&T Υ_{03}		2.951***	3.057***
		(1.019)	(1.016)
s. tertiary Υ_{04}	1.463***	1.669***	1.772***
	(0.495)	(0.501)	(0.568)
capital per capita (log)	0.433***	0.378***	0.374***
	(0.121)	(0.121)	(0.131)
s. pop. 0-14 (log)	-2.790*	-3.073**	-2.987*
	(1.431)	(1.536)	(1.783)
Within-country effects			
s. tertiary$_{i, t-2}$			0.700*
			(0.404)
β_{1i}			
s. tertiary$_{i, t-2}$ Υ_{10}	0.807	3.301***	
	(0.541)	(0.937)	
s. tertiary$_{i, t-2}$ x tertilt$_t$ Υ_{11}		-1.824***	
		(0.607)	
time		0.055***	
		(0.018)	
β_{2i}			
time Υ_{20}	0.057***		0.115***
	(0.018)		(0.024)
time x tertilt$_t$ Υ_{22}			-0.035***
			(0.013)
capital per capita (log)$_{t-2}$	0.386***	0.388***	0.281***
	(0.112)	(0.112)	(0.085)
s. pop. 0-14 (log) $_{t-1}$	0.189	0.026	-0.343
	(0.856)	(0.829)	(0.698)
Observations	328	328	328
Number of countries	41	41	41
Model fit statistics			
AIC	-319.1	-328.5	-329.7
BIC	-269.8	-267.8	-269.0
Deviance (-2*log-lik.)	-345.1	-360.5	-361.7

Note: this approach attends to cluster-level heterogeneity and separates within and between cluster variations in level 1 variables which should contribute to the accuracy of standard errors (Bartels, 2008). The sample includes 41 countries *** p<0.01, ** p<0.05, *p<0.1

Table 3.7 replicates Table 3.4 but taking the share of tertiary educated people aged between 65 and 69 years as the main explanatory variable (*s.tertiary65*).[22] The idea is to further alleviate

[22] The variable is taken from Barro and Lee database (2013).

the possible endogeneity bias present in the relationship between the current levels of income and human capital. The new variable is correlated to the current share but not necessarily to the current income. The procedure is used by Gennaioli et al. (2013). The authors observe that despite this strategy does not completely solve the problem, because long-run factors may determine both past schooling and present income, it provides a useful robustness check for the effects of recent economic growth (Gennaioli et al., 2013: 136). The only change in results is the non-significance of "time" when it is not taken as a varying coefficient (Column 1 and 2). The rest of estimates remain stable.

Table 3.7 Determinants of income per capita with tertiary tilt and S&T profile in random slope models with tertiary educated aged 65-69 years

Dep.Var.: lny_{it}	1	2	3	4	5	6
β_{0i} Υ_{00}	4.061***	4.223***	4.989***	4.990***	5.351***	4.851***
	(0.565)	(0.546)	(0.552)	(0.619)	(0.665)	(0.522)
tropical areas Υ_{01}	-0.579***	-0.456***	-0.528***	-0.555***	-0.465***	-0.496***
	(0.156)	(0.132)	(0.129)	(0.155)	(0.147)	(0.127)
tertiary tilt$_i$ Υ_{02}	0.268***		0.146	0.252**		0.226**
	(0.100)		(0.097)	(0.098)		(0.110)
s. S&T$_i$ Υ_{03}		1.558	3.423***			
		(1.683)	(1.192)			
s.tertiary65				0.866**	0.908**	
				(0.432)	(0.460)	
β_{1i}						
s.tertiary65 Υ_{10}	6.233***	0.793	3.152***			1.477***
	(1.251)	(1.531)	(0.638)			(0.395)
s.tertiary65 x tertilt$_i$ Υ_{11}	-3.026***		-1.420***			
	(0.746)		(0.343)			
s.tertiary65 x s. S&T$_i$ Υ_{12}		15.539				
		(16.210)				
time	0.022	0.021				
	(0.014)	(0.013)				
β_{2i}						
time Υ_{20}			0.046***	0.098***	0.024	0.092***
			(0.012)	(0.023)	(0.025)	(0.021)
t x tertilt$_i$ Υ_{21}				-0.036***		-0.033***
				(0.010)		(0.012)
t x S&T$_i$ Υ_{22}					0.303	
					(0.235)	
capital per capita (log)$_{t-2}$	0.443***	0.448***	0.325***	0.340***	0.317***	0.326***
	(0.059)	(0.063)	(0.067)	(0.069)	(0.078)	(0.054)
s. pop. 0-14 (log) $_{t-1}$	-0.251*	-0.248*	-0.325**	-0.335**	-0.347**	-0.309**
	(0.140)	(0.136)	(0.161)	(0.167)	(0.165)	(0.131)
Observations	287	287	287	287	287	287
Model fit statistics						
AIC	-238	-235	-277	-257	-258	-262
BIC	-194	-191	-244	-213	-214	-203
Deviance (-2*log likelihood)	-262	-259	-295	-281	-282	-294

Note: Cluster robust standard errors in parentheses; 41 countries *** p<0.01, ** p<0.05, *p<0.1

3.6 Discussion

This chapter focuses on the relationship between tertiary education and public resources, going beyond the traditional debate on how much taxpayers should spend on it. It shows that the share of tertiary educated people has played a significant role to accelerate economic growth and to account for cross country-differences in the level of income per capita in HICs and UMICs. This result holds regardless of differences in the range of tertiary education accomplishments across these countries and the varying degrees at which their labour markets could efficiently absorb this high-skilled human capital. This is, indeed, a good reason why government should provide higher schooling. However, the benefits do not merely come from the level of public investment. This study finds that the gains from higher education hinges upon the structure of the education resource allocation and the skill orientation of tertiary schooling.

Hence, if a country increases its tertiary spending tilt over time, it obtains lower income effects from higher schooling and from technological change. Therefore, the spending tilt towards higher education is not only inegalitarian, as claimed in Birdsall et al. (1997), Lindert (2009) and Frankema (2009), but it might also be an "anti-growth" policy.

The result can be surprising as one would expect that the more governments spend in tertiary education, the more knowledge is accumulated, thus fueling productivity growth. However, deficiencies stemming from a relatively low budget allocation to early ages do not seem to be made up for by more tertiary spending. A possible reason for this outcome is that budget imbalances between schooling levels undermine the capacity of basic education to raise the ability of those going into the following education stages and may later turn into a disadvantage when people enter the labour market.

A relatively low funding at the pre-primary and primary levels implies insufficient infrastructure, equipment and teaching quality, which translates into low educative standards. The fact that children are not properly prepared to make headway in the formal system has at least two consequences: first, the low quality of primary and secondary education affects the individuals' capacity to contribute to productivity growth. Second, the quality of the tertiary educated might not be as high as expected. Indeed, the obtained results are in line with the findings about the low impact of total schooling on economic growth in countries with poor educational achievements (Hanushek and Woessmann, 2012; Soto, 2009; Jamison et al., 2007; Castelló and Hidalgo, 2012).

The previous argument is also linked to potential worker complementarities in the labour market. Productivity advantages would emerge from the collective productivity of skilled labour, working in teams where they share and bring into production their knowledge. And, if growth is to be sustained, the whole labour force should be prepared to deal with new or more efficient production methods. This emphasizes the connection between high, medium and low skilled workers to make the division of labour run and the acquisition of ideas advance. From this point of view, the productivity of skilled workers depends on the broader human capital context in which they act (Nelson and Phelps, 1996; Jones, 2014 and 2011). By weakening the first and massive links in this chain, the bias of public spending towards tertiary education also weakens the sources of productivity gains.

Back to the results, for values of the tertiary tilt higher than 2.3, the estimates indicate that the impact of tertiary education on the growth rate becomes negative (Column 4, Table 3.2). In the sample, the majority of countries above this number are UMICs (they are 75% of the total country-year observations over the threshold) and within this group, 77% belong to the Latin American region. This is an interesting result, not only because the evidence appears consistent with the relative poor growth performance of LACs, but also because the arguments already discussed seem to reflect the regional experience. Hence, Hanushek and Woessman (2012) point out that at least half of the Latin American low-growth performance can be attributed to the low levels of cognitive skills among students, as measured by international achievement tests on mathematics and science scores. Regarding the quality of the tertiary educated, Jorgenson and Timmer (2011) and Timmer et al. (2014) find that finance and business services are the most skill intensive industries across countries. However, in LACs these sectors lack technological dynamism and tend to fall behind the world frontier.

It might be claimed that it is the amount spent, not its composition, what matters. In fact, in the 2000s, the HICs of our sample have spent 17,000 constant dollars per tertiary student per year while the figure has been 6,000 in UMICs. However, part of the difference stems from policy decisions and not from resource constraints typical of developing countries: by 2010s, education spending ranged 5% of GDP in HICs but just 3.5% in UMICs. In this context, by the end of the period HICs and UMICs spend roughly the same in tertiary education as a share of their GDP per capita (54%), but the percentages for primary schooling are almost 20% in HICs versus 13% in UMICs. Then, the argument about the need of a higher priority to education funding together with a more balanced budget distribution across education levels still holds.

Another message from this study is that the returns from higher education can be enhanced by the type of skills it creates. The empirical evidence points to the positive influence of S&T skills in relation to other fields of knowledge. Data availability for the period just allowed

considering broad skill profiles, which certainly limits the scope of the conclusions. However, the aggregate result is consistent with the prevailing context of skill-biased technological change.

Besides, in the context of a sample of HICs and UMICs, the relevance of S&T profiles is suggestive of the potential of this orientation to promote economic growth. Thus, this relationship emerges even though the studied countries comprise a very diverse group in terms of the quality of higher schooling. According to the World University ranking by Shanghai Jiao Tong University, in 2014 no Latin American institution was classified among the top 100 and 200 and, among the UMICs included in the sample, only Singapore is within the top 200. Moreover, the economies show different degrees of proximity to the technological frontier (Ang et al., 2011; Vandenbussche et al, 2006). In fact, an additional clue of the significance of S&T skills is that it can act as a growth factor itself, despite representing no more than 10% of the total students. Moreover, the HLM approach suggests that this particular type of human capital directly affects the level of the production function.

Indeed, during the 40-year period under analysis, numerous government measures have sought to widen the countries' scientific and technological capacity (Yusuf and Nabeshima, 2007; Pillay, 2010). This would be partially reflected in the economic impact of the number of people attracted to the S&T fields. From a policy perspective, the findings of this chapter provide further support for the use of public tertiary education resources to encourage S&T skill acquisition, becoming in this way a more growth-enhancing expenditure item.

3.7 Concluding remarks

It is generally accepted that an increasing share of higher educated people can bring on economic gains, so that countries are able to keep up or catch up with the most advanced societies. However, to effectively translate this human capital into a more productive and efficient labour force a society needs a range of labour market and institutional conditions. This chapter seeks to find evidence on the economic returns from tertiary schooling and discuss whether government policy may affect them through the education budget composition and the support to certain skill profiles.

The empirical approach builds on a panel of 41 countries for the period 1970-2010 and estimates system GMM regressions and HLMs. The main results hold through the different specifications and emerge despite data dispersion among country groups, so they allow drawing some general conclusions.

Based on the improved Barro and Lee dataset (2013), this study finds a positive macroeconomic impact of the share of tertiary educated, both in terms of per capita GDP levels and growth rates. However, this result varies depending on the tertiary tilt in public education spending. Therefore, beyond the prevailing and non-negligible budget constraints, the resource distribution matters. According to the estimations, a more balanced education spending between the primary and tertiary levels would reinforce the contribution of higher education to increase GDP growth and levels and would allow a faster technological catch-up. These results remain robust to controls for HICs, the level of public expenditure and a proxy for private tertiary spending. Possible reasons behind this effect are the damage to the quality of basic education and the weakening of complementarities among skilled and unskilled workers stemming from a skewed budget distribution.

Additionally, S&T skills appear as a relevant source of economic growth when compared to other skill profiles. Besides, according to the HLM estimates, a more widespread S&T tertiary education could contribute to improve the ability of countries to increase their income level. It is important to underline that this outcome coexists with a positive impact of tertiary education as a whole, meaning that other specializations may also have positive growth effects. However, what the estimations show is the particularly favourable effect of S&T, regardless of each country's capacity to generate and adapt new technologies or the quality of its tertiary education system. The finding is robust to different specifications.

The evidence presented so far emphasizes the relevance of tertiary education in high and upper middle income economies and provides evidence on the growth-enhancing effects of the education resource structure and the skill specialization of tertiary students. The findings conveys that by shaping the mechanisms by which skills are acquired, public spending determines to what extent countries manage to take advantage of the expansion of education itself as well as of technological progress.

References

Aghion, P., Boustan, L., Hoxby, C. and Vandenbussche, J. 2009. Exploiting States. Mistakes to Identify the Causal Impact of Higher Education on Growth. In Romer, D. and Wolfers, J. (eds.), Brooking Papers on Economic Activity. Conference Draft.

Aghion, P. and Howitt, P. 1998. Endogenous growth theory. MIT Press, Cambridge, MA.

Ang, J., Madsen. J. and Islam, M. R. 2011. The effects of human capital composition on technological convergence. Journal of Macroeconomics 33, 465–476.

Arellano, M. and Bond, S.R. 1991. Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. Review of Economic Studies 58(2), 277-297.

Barro, R., 1991. Economic growth in a cross section of countries. Quarterly Journal of Economics 106(2), 407–443.

Barro, R. and Lee, J. W. 2001. International Data on Educational Attainment: Updates and Implications. Oxford Economic Papers 53(3), 541-563.

----------2013.A new data set of educational attainment in the world, 1950-2010. Journal of Development Economics 104, 184-198.

Barro, R. and Sala-i-Martin, X. 2004. Economic Growth. MIT Press, Cambridge, MA.

Bartels, L. 2008. Beyond "fixed versus random effects": a framework for improving substantive and statistical analysis of panel, time series cross sectional and multilevel data. Department of Political Science, George Washington University.

Balan, J. 2013. Latin American higher education Systems in a historical and comparative perspective. In Balán, J. (ed.), Higher education, government and international collaboration. Institute for International Education, New York.

Benhabib, J. and Spiegel, M.M., 2005. Human capital and technology diffusion. In Aghion, P., Durlauf, S. (Eds.), Handbook of Economic Growth. Elsevier, Amsterdam, 935–966.

Birdsall, N., Ross, D. and Sabot, R. 1997. Education, Growth and Inequality. In Birdsall, N. and Jaspersen, F. (Eds.), Pathways to Growth. Comparing East Asia and Latin America, Inter-American Development Bank, Washington.

Bloom, D., Canning, D. and Chan, K., Luca, D. 2013. Higher Education and Economic Development in Africa. International Journal of African Higher Education 1(1), 1-18.

Blundell, R. and Bond, S. 1998. Initial conditions and moment restrictions in dynamic panel data models. Journal of Econometrics 87,115–143.

Bond, S.R., Hoeffler, A., Temple, J., 2001. GMM Estimation of Empirical Growth Models. Centre for Economic Policy Research Discussion Paper 3048.

Boskin, M. J., and Lau, L. J. 2000. Generalized Solow-neutral technical progress and postwar economic growth. National Bureau of Economic Research Nº8023. Cambridge, MA.

Canton, E. 2007. Social returns to education. De Economist 155(4).

Cantoni, D. and Yuchtman, N. 2012. Educational content, education institutions: lessons from history. Munich Discussion Paper 2012-2.

----------2013. The political economy of educational content and development. Lessons from History. CESifo Working Paper 4221.

Castelló, A. 2013. Education and economic growth. Background paper prepared for the Education for All Global Monitoring Report 2013/4. United Nations.

Castelló, A. and Domènech, R. 2002. Human capital inequality and economic growth: some new evidence. The Economic Journal 112(478) Conference Papers, 187-200.

Castelló, A. and Hidalgo, A. 2012. The role of educational quality and quantity in the process of economic development. Economics of Education Review 31, 391-409.

Castelló, A. and Mukhopadhyay, A. 2013. Mass education or a minority well educated elite in the process of growth. The case of India. Journal of Development Economics 105, 303-320.

CID (Center for International Development) at Harvard University retrieved from http://www.cid.harvard.edu/ciddata/

Cohen, D. and Soto, M. 2007. Growth and Human Capital: Good Data, Good Results. Journal of Economic Growth 12, 51–76.

Datt, G. and Ravallion, M. 2002. Growth and redistribution components of changes in poverty measures. Journal of Development Economics 38, 275-295.

de la Fuente, A. and Domènech, R. 2006. Human Capital in Growth Regressions: How Much Difference Does Data Quality Make? Journal of the European Economic Association 4(1), 1-36.

ECLAC. CEPAL.stats, retrieved from http://estadisticas.cepal.org/cepalstat.

ECLAC 2014. Cambio estructural para la igualdad. Una visión integrada del desarrollo. Comisión Económica para América Latina y el Caribe, Santiago de Chile.

Feenstra, R. C., Inklaar, R., Timmer, M. 2013. The next generation of the Penn World Table retrived from www.ggdc.net/pwt.

Frankema, E. 2009. The expansion of mass education in twentieth century Latin America: a global comparative perspective. Revista de Historia Económica/ Journal of Iberian and Latin American Economic History 27(03), 359–396.

Galor, O. and Michalopoulos, S. 2009. The evolution of entrepreneurial spirit and the process of development. Working Paper 111, Collegio Carlo Alberto.

Garson, D. 2012. Fundamentals of Hierarchical Linear and Multilevel Modeling. In Garson, D. (ed.), Hierarchical Linear Modeling: Guide and Applications, Chapter 1. Sage Publications, Inc.

Gennaioli, N., La Porta, R., López de Silanes, F., Shleifer, A. 2013. Human capital and regional development. The Quarterly Journal of Economics 128(1), 105–164.

Glaeser, E., Rosenthal, S. and Strange, W. 2009. Urban economics and entrepreneurship. NBER Working Paper Series 15536.

Gruber, L. and Kosack, S. 2014. The tertiary tilt: education and inequality in the developing world". World Development 54, 253-272.

Gyimah-Brempong, K., Paddison, O. and Mitiku, M. 2006. Higher education and economic growth in Africa. Journal of Development Studies 42 (3), 509–29.

Hall, R. and Jones, C. 1999. Why do some countries produce so much more output per worker than others? The Quarterly Journal of Economics 114(1), 83-116.

Hanchane, S. and Mostafa, T. 2010. Endogeneity problems in multilevel estimation of education production functions: an analysis using PISA data. Research Paper 14 Centre for Learning and Life Chances in Knowledge Economies and Societies.

Hanushek, E. and Kimko, D. 2000. Schooling, labor force quality, and the growth of nations. The American Economic Review 90 (5), 1184–1208.

Hanushek, E. and Woessmann, L. 2012. Schooling, educational achievement, and the Latin American growth puzzle. Journal of Development Economics 99(2), 497-512.

Hayami, Y. and Ruttan, V.W. 1970. Agricultural productivity differences among countries. The American Economic Review 60, 895-911.

Hayashi, F. 2005. Econometrics. Princeton University Press.

Holmes, C. 2013. Has the expansion of higher education led to greater economic growth? National Institute Economic Review 224.

IMF. Government Financial Statistics. Various issues 1970-1998, Washington, D.C.

Iyigun, M. and Owen, A. 1999. Entrepreneurs, professionals and growth. Journal of Economic Growth 4, 213-232

Jamison, E., Jamison, T. and Hanushek, E. 2007. The effects of education quality on income growth and mortality decline. Economics of Education Review 26, 772–789

Jamison, D., Lau, L., and Wang, J. 2003. Health's contribution to economic growth in an environment of partially endogenous technical progress. Disease Control Priorities Project, Working Paper 0.

Jones, B. 2014. The Knowledge Trap: Human Capital and Development Reconsidered (unpublished).

----------2011. The human capital stock: a generalized approach. NBER Working Paper Series 17487.

----------2009. The Burden of Knowledge and the "Death of the Renaissance Man": Is Innovation Getting Harder? The Review of Economic Studies 76(1), 283-317

Jorgenson, D. and Timmer; M. 2011. Structural Change in Advanced Nations: A New Set of Stylised Facts. Scandinavian. Journal of Economics 113(1), 1–29.

Judson, R. 1998. Economic growth and investment in education: how allocation matters. Journal of Economic Growth 3, 337-359.

Kapur, D. and Crowley, M. 2008. Beyond the ABCs: Higher Education and developing countries. Centre for Global Development Working Paper Nº 139, Washington, DC.

Keller, C. 2006. Investment in primary, secondary and higher education and the effects on economic growth. Contemporary Economic Policy 24(1), 18-34.

Kimenyi, M. 2011. Contribution of higher education to economic development. Journal of African Economies 20, AERC Supplement 3, iii14–iii49.

Krueger, A. and Lindahl, M. 2001. Education for growth: why and for whom? Journal of Economic Literature 39(4), 111-1136.

Lau, L. and Yotopoulos, P. 1989. The meta-production function approach to technological change in world agriculture. Journal of Development Economics 31,241-269.

Lindert, P. 2009. Revealing failures in the history of school finance. NBER Working Paper 15491.

Maloney, W. and Valencia, F. 2014. Engineers, innovative capacity and development in the Americas. IZA Discussion Paper 8271.

Mankiw, G., D. Romer and D. Weil (1992). A Contribution to the Empirics of Economic Growth. The Quartely Journal of Economics 106(2), 407-37.

Mokyr, J. 2005. The intellectual origins of modern economic growth. The Journal of Economic History 65(2), 285-351.

Murphy, K., Shleifer, A. and Vishny, R. (1991). "The Allocation of Talent: Implications for Growth". The Quarterly Journal of Economics 106(2), 503-530.

Nelson, R. and Phelps, E. 1966. Investment in humans, technology diffusion and economic growth. The American Economic Review 56(2), 69-75.

OECD statistics. Retrieved from http://stats.oecd.org/

Oketch, M. 2016. Financing higher education in sub-Saharan Africa: some reflections and implications for sustainable development. Higher Education 72, 525-539.

Oketch, M.,McCowan, T. and Schendel, R. 2014. The impact of tertiary education on development: a rigorous literature review. DFID, London.

Papageoriou, C. 2003. Distinguishing between the effects of primary and post-primary education on economic growth. Review of Development Economics 7 (4), 622–35.

Pereira, J. and St. Aubynb, M. 2009. What level of education matters most for growth? Evidence from Portugal. Economics of Education Review 28, 67-73.

Pillay, P. 2010. Higher education and economic development. Literature Review. Centre for Higher Education Transformation, Wynberg.

Pritchett, L. 2001. Where has all the education gone? World Bank Economic Review 15 (3), 367–391.

Romer, P. M. 1990. Endogenous technological change. Journal of Political Economy 98(5), 71-102.

Roodman, D. 2009. How to do xtabond2: An introduction to difference and system GMM in Stata. The Stata Journal 9(1), 86-136.

Sachs, J. and Warner, A. 1997. Sources of Slow Growth in African Economies. Journal of African Economies 6, 335-376.

Self, S. and Grabowski, R. 2004. Does education at all levels cause growth? India, a case study. Economics of Education Review 23(1), 47-55.

Sianesi, B. and Van Reenen, J. (2003). "The returns to education. Macroeconomics". Journal of Economic Surveys Vol. 17 (2), 157-200.

Soto, M. 2009. The causal effect of education on aggregate income. Barcelona Economics Working Paper Series 394.

Temple, J. 1999. The new growth evidence. Journal of Economic Literature 37, 112-156.

Teorell, J., Dahlberg, S., Holmberg, S., Rothstein, B., Hartmann, F., Svensson, R., 2015. The Quality of Government Standard Dataset. The Quality of Government Institute, University of Gothenburg.

Timmer, M. de Vries, G. and de Vries, K. 2014. Patterns of Structural Change in Developing Countries. GGDC Research Memorandum 149 Groningen Growth and Development Centre, University of Groningen.

UIS-UNESCO Institute of Statistics. 2016. Data retrieved from http://www.uis.unesco.org/

----------Yearbooks. Various issues 1970-1998, United Nations. New York.

van Ark, B., O'Mahony, M. and Timmer, M. 2008. The Productivity Gap between Europe and the United States: Trends and Causes. Journal of Economic Perspectives 22 (1), 25-44.

Vandenbussche, J., Aghion, P. and Meghir, C. 2006. Growth, distance to frontier and the composition of human capital. Journal of Economic Growth 11, 97-127.

Wolff, E. 2001. The role of education in the postwar productivity convergence among OECD countries. Industrial and Corporate Change 10 (3), 735-759.

Woltman, H., Feldstain, J., MacKay, C., Rocchi, M. 2012. An introduction to hierarchical linear modeling. Tutorials in Quantitative Methods for Psychology 8(1), 52-69.

World Bank. 2000. Higher Education in Developing Countries Peril and Promise. The task force on higher education and society. The International Bank for Reconstruction and Development, Washington.

World Development Indicators. Retrieved from http://databank.worldbank.org, World Bank.

Yusuf, S. and Nabeshima, K. (eds).2007. How universities promote economic growth. The World Bank.

Appendix

Table A.3.1 Country sample

High-income Countries (HICs)		
Australia	Ireland	Portugal
Austria	Israel	Spain
Belgium	Italy	Sweden
Canada	Japan	Switzerland
Denmark	Luxembourg	United States
Finland	Netherlands	United Kingdom
France	New Zealand	
Greece	Norway	
Upper-middle income countries (UMICs)		
Argentina	Jamaica	Poland
Brazil	Mexico	Singapore
Chile	Panama	South Korea
Colombia	Peru	Thailand
C. Rica	Uruguay	Turkey
Dominican Rep.	Venezuela	
Ecuador	Malaysia	

Source: www.data.worldbank.org/about/country-and-lending-groups

Table A.3.2 Tertiary programmes within S&T category

Life sciences Biology, botany, bacteriology, toxicology, microbiology, zoology, entomology, ornithology, genetics, biochemistry, biophysics, other allied; sciences, excluding clinical and veterinary sciences.
Physical sciences Astronomy and space sciences, physics, other allied subjects, chemistry, other allied subjects, geology, geophysics, mineralogy, physical anthropology, physical geography and other geosciences, meteorology and other atmospheric sciences including climatic research, marine science, vulcanology, palaeoecology
Mathematics and statistics Mathematics, operations research, numerical analysis, actuarial science, statistics and other allied fields.
Computing Computer sciences: system design, computer programming, data processing, networks, operating systems - software development only (hardware development should be classified with the engineering fields).

Source: UIS-UNESCO

Table A.3.3 Descriptive statistics

Variable		Mean	Std. Dev.	Min	Max	Observations
lny_{it}	overall	9.42	0.72	7.64	11.09	N = 328
	between		0.64	8.31	10.33	n = 41
	within		0.34	8.14	10.43	T = 8
g_{it} (%)	overall	2.60	2.73	-5.98	13.42	N = 328
	between		1.24	-0.42	6.65	n = 41
	within		2.44	-3.36	12.32	T = 8
s.tertiary aged 25 + (%)	overall	13.05	9.58	1.10	53.05	N = 328
	between		7.70	3.91	39.26	n = 41
	within		5.82	-7.25	32.16	T = 8
tert.tilt (ln)	overall	1.39	0.78	-0.21	3.96	N = 320
	between		0.62	0.43	2.76	n = 41
	within		0.49	0.08	3.01	T-bar = 7.8
share S&T (%)	overall	8.73	3.79	1.70	17.42	N = 289
	between		3.14	2.70	14.94	n = 41
	within		2.17	3.35	16.33	T-bar = 7.0
tropical areas	overall	0.32	0.45	0	1	N = 328
	between		0.45	0	1	n = 41
	within		0.00	0.32	0.32	T = 8
capital per capita (log)	overall	10.50	0.81	8.47	12.01	N = 328
	between		0.73	9.20	11.48	n = 41
	within		0.37	8.94	11.87	T = 8
investment ratio (over GDP,%)	overall	24.84	7.36	10.37	62.58	N = 328
	between		6.04	12.33	47.89	n = 41
	within		4.30	6.17	41.94	T = 8
pop. 0-14 (share over total, %)	overall	26.80	8.52	13.58	46.76	N = 328
	between		7.59	17.24	39.23	n = 41
	within		4.02	16.07	39.64	T = 8
pop. 25-64 (share over total, %)	overall	45.97	7.11	30.27	59.32	N = 328
	between		6.02	35.61	53.73	n = 41
	within		3.88	32.34	57.12	T = 8
political participation (%)	overall	46.38	15.13	5.00	70.00	N = 315
	between		13.28	19.89	66.00	n = 41
	within		7.41	15.25	67.79	T-bar = 7.7
size of government	overall	5.57	1.58	1.63	9.27	N = 319
	between		1.24	2.59	7.51	n = 41
	within		0.99	1.56	8.62	T-bar = 7.8
trade openness (%)	overall	68.17	55.74	12.45	410.25	N = 328
	between		54.00	19.59	339.75	n = 41
	within		15.90	-7.58	138.67	T = 8
s.tertiary aged 65-69 (%)	overall	6.54	6.24	0.24	41.79	N = 328
	between		5.05	1.20	25.02	n = 41
	within		3.74	-7.03	24.14	T = 8

Table A.3.3 Descriptive statistics (cont.)

Variable		Mean	Std. Dev.	Min	Max	Observations
years of tertiary education	overall	0.43	0.31	0.04	1.62	N = 328
	between		0.24	0.15	1.22	n = 41
	within		0.20	-0.14	1.05	T = 8
migration stock$_t$ (%)	overall	7.00	8.07	0.15	47.37	N = 324
	between		7.90	0.31	38.25	n = 41
	within		1.88	2.10	16.12	T-bar = 7.9
tertiary private enrolment (%)	overall	25.12	24.76	-21.35	85.92	N = 324
	between		23.49	0.57	77.94	n = 41
	within		8.50	-20.80	60.80	T-bar = 7.9
public education spending/GDP,%	overall	4.47	1.43	1.23	8.39	N = 328
	between		1.26	1.98	7.12	n = 41
	within		0.70	2.16	6.51	T = 8
public prim. & sec. spend./GDP,%	overall	3.00	1.02	0.84	5.89	N = 326
	between		0.89	1.23	4.79	n = 41
	within		0.52	1.06	4.41	T-bar = 8
s. social sciences$_t$ (%)	overall	31.22	8.71	11.82	59.70	N = 290
	between		6.66	18.95	49.33	n = 41
	within		5.96	10.40	48.85	T-bar = 7.1
s. hum. and education$_t$ (%)	overall	24.53	8.24	3.16	48.72	N = 287
	between		5.77	12.98	41.20	n = 41
	within		6.04	9.26	47.65	T-bar = 7
s. health (%)	overall	10.84	5.13	2.32	29.83	N = 290
	between		3.80	4.04	21.14	n = 41
	within		3.51	-3.63	19.54	T-bar = 7.1
s. agro (%)	overall	2.89	1.91	0.44	11.04	N = 274
	between		1.44	0.99	6.91	n = 40
	within		1.28	-1.00	7.93	T-bar = 7
s. other majors (+engineering), %	overall	22.00	8.69	5.54	55.69	N = 275
	between		7.62	9.80	44.80	n = 41
	within		5.21	3.82	39.87	T-bar = 7

Source: Barro and Lee (2013); IMF; ECLAC; UNESCO Yearbooks; UIS; WDI.

Table A.3.4 Skill choices vis-à-vis the share of S&T

Dep. Var*: g_{it}*	
s.tertiary$_{t-1}$	0.137*
	(0.069)
s. social sciences$_{t-1}$	-0.278***
	(0.093)
s. hum. and education$_{t-1}$	-0.263***
	(0.093)
s. health $_{t-1}$	-0.271**
	(0.105)
s. other majors $_{t-1}$	-0.228***
	(0.080)
ln y $_{i, t-1}$	-0.086***
	(0.024)
investment ratio $_{t-1}$	0.204**
	(0.085)
pop. 25-64$_t$	0.301*
	(0.172)
trade openness$_{t-1}$	-0.006
	(0.020)
size of government$_t$	-0.006**
	(0.002)
political participation$_t$	0.000
	(0.000)
tropical areas	-0.017**
	(0.007)
constant	0.881***
	(0.201)
time dummies	yes
Observations	248
Number of countries	41
Number of instruments	32
AR(2) test	0.373
Hansen test (p-val)	0.529

Estimates from two-step difference GMM with 1 to 3 lags in endogenous variables and other instruments collapsed; Windmeijer's (2005) finite sample correction and robust standard errors;

*** p<0.01, ** p<0.05, *p<0.1

Chapter 4

Electoral politics and the diffusion of primary schooling: evidence from Uruguay, 1914-1954

4.1 Introduction

The expansion of public primary education across the newly independent world was crucial in the development of modern states since the late 19th century. It was one of the first signs of a social relationship between state and masses and key to foster socialization and nation-building (Ansell and Lindvall, 2013). Besides, it played an essential role to provide the labour force with the new skills and values needed to make economies competitive in a world rapidly becoming more integrated.

Inequality has been identified by the economic history literature as one of the most important factors affecting public school provision. In the case of Latin America, the high degree of landownership concentration would have delayed the implementation of public primary schooling, leading to inequality in the distribution of human capital and slower economic growth (Coastworth, 1993; Engerman and Sokoloff, 2000, Mariscal and Sokoloff, 2000). A similar argument has been put forward for US and Europe (Galor et al. 2009; Cinnirella and Hornung, 2013; Beltrán and Martínez, 2015; Goñi, 2016) and explored in combination with other aspects of the economic power of elites in several developing regions (Martinez Fritscher et al., 2010; Chaudhary et al., 2012).

Another group of papers have focused on the influence of political regimes and political actors. They have examined the spread of mass schooling in relation to the extension of voting franchise (Lindert, 2004; Go and Lindert, 2010; Cappelli, 2016; Engerman and Sokoloff, 2001; Arroyo, 2016); the active role of some erudite elites (Gao, 2015) and democracy (De la Croix and Doepke; 2009; Gallego, 2010; Stasavage, 2005). In the same vein, schooling provision, like other public goods, has also been historically affected by the degree of political competition. From this perspective, the extent of government commitment to primary education might be explained by the interests of tactically motivated politicians.

This study tests this hypothesis by analyzing the expansion of public primary education in Uruguay. It explores whether the ruling party weighed its political strengths across regions when distributing basic education funds. By doing so, the analysis frames into the "pork barrel" or "distributive politics" models that posit that government could allocate public resources seeking either to obtain a greater political support or to avoid losing it (Cox, 2009; Golden and Min, 2013).

Uruguay is a middle-income South-American country and one of the most advanced economies of the region historically. It has been featured by its early urbanization, ethnic homogeneity (with a preeminence of European immigrant population), comparatively low levels of rural inequality and well-developed democratic institutions (Huber et al., 2008). Since the last decades of the 19th century, it built a welfare state based on the expansion of the pension system, labour protection legislation and public education provision, which led to a progressive redistribution of income *vis-à-vis* other Latin American countries (Filgueira and Filgueira, 1994). This chapter focuses on the period 1914-1954, when the second leap in primary education development took place, after the initial one of the last quarter of the 19th century. It is also the period for which the earliest reliable electoral data are available at the department level (especially after 1918), and it closes on the verge of the serious economic and political conflicts that characterized the 1960s (Caetano and Rilla, 1996).

There are several reasons why Uruguay is an interesting case-study to understand the relationship between politics and primary schooling diffusion. First, the early social preeminence of state in the country took place under a competitive party-system. In European societies, labour protection and retirement, public health and secular and free education stemmed from the development of an industrial society and a class compromise. Instead, in Uruguay it was the political elite, through the government, that promoted the creation of a modern society. The so-called "traditional parties" were the tool with which the government intermediated between the interests of diverse social groups (Filgueira, 1995). Indeed, one pervasive feature of the Uruguayan party system has been the intertwined links between state bureaucracy and partisan politics (Zurbriggen, 2005: 116).

Second, the action of governments has been influenced not only by the compromises between two strong political parties, but also among their fractions, particularly until the 1960s. The rules concerning government organization and elections are a crucial link in the chain of representative democracy. In Uruguay, they were designed to maintain a bipolar competition between the Colorado Party (main ruling party, that won all presidential elections until 1958) and its contender, the White (or Nationalist) Party. The electoral law contributed sharply to this end. To

our knowledge, Uruguay has been the only country using the "double simultaneous vote" (DSV) system for almost a century. [23] By the DSV, voters could support fractions, yet the totals for all the fractions associated with a party were accumulated to make up the party's representation.

Third, historians and other social scientists have reported the use of public resources by the ruling party to reward its supporters. Under clientelist practices, government offices, favours and privileges were distributed among voters and non-elected candidates as compensation or incentive for their contribution to the electoral outcome (Zurbriggen, 2005). The Parliament was also pervaded by continuous trade-offs to induce cooperation between the executive and the legislature (Lanzaro, 2004; Yaffé et al., 2004). Rewards and compromises to build majorities were addressed towards the opposition party but also to members of parliament attached to the president's party who, due to their fraction adscription, were not subjected to any strong party discipline.

These political practices have been associated to measurable macroeconomic outcomes. Previous research for the period 1920-2000 shows that political fragmentation, legislative composition and the proximity of electoral years have entailed significant changes in fiscal and monetary variables, particularly since the mid-fifties (Aboal and Calvo, 2000). Accordingly, it has been found that the lower the legislative power of the president, the worse the fiscal imbalances (Aboal et al., 2003) and that the higher the president party's fragmentation, the stronger the effect of the political cycle over GDP (Oddone, 2005). Moreover, the partisan channeling of public resources was very distinct in the allocation of funds to social services such as pensions, labour and family protection or health. This has led to a sense of "co-responsibility" between the incumbent party and the opposition in the performance of these social services (Filgueira and Papadópulos, 1997).

However, the historical literature on Uruguay has not attached the allocation of education resources to political reasons. In fact, education has been claimed to be the most universal piece of the public social system, and it is usually assumed that the different ideological and political views were equally committed to its development (Filgueira, 1995). Instead, this chapter argues that if ruling elites have typically influenced the allocation of public resources to their own advantage, it is not strange that political factors could have also affected the distribution of government spending in primary schooling across the territory. In fact, public schools are part of the most visible community infrastructure, which makes them attractive as a political tool.

[23] The DSV system was established by law in 1910 and it was in force until 1994.

Not many references are to be found on this topic in the international literature either. Though originally developed for the US, nowadays there is a wide array of empirical evidence about pork barrel politics in different countries. Some studies provide support to the presence of distributive strategies favouring core districts and the role of powerful senior figures within government to get pork (Levitt and Snyder, 1995; Milligan and Smart, 2005; Golden and Picci, 2008). Others uncover marginal- or swing-district targeting (Denemark, 2000; Case 2001; Dahlberg and Johansson 2002; Veiga and Pinho, 2007, Castells and Solé, 2005).[24] This research often focuses on infrastructure expenditure or general government grants towards municipalities or provinces. To our knowledge, public education spending is only dealt with in Vaishnav and Sicar (2010), who study public school construction in a southern Indian state.[25]

There are few historical analyses of pork-barrel politics. A pioneer one is Wright's study on the distribution of New Deal resources between Western and Southern US states, based on the swing-voter hypothesis (Wright, 1974), which was revised in Wallis (1998). More recently, Curto et al. (2012) examined the effect of government strategies and individual MP's influence on the allocation of public funds for roads during the Spanish Restoration (1880-1914). However, the onset of education provision has not been tackled from this perspective in historical research.

This chapter carries out a panel data fixed effects analysis of the political determinants of public primary schooling expansion, covering 18 Uruguayan departments for a 40 year-period. The estimation uses department-level data of the number of available schools (as a proxy of public spending in school provision), electoral results and legislative composition. The discussion includes all departments but Montevideo, where the capital city is situated. This exclusion is justified by its size disparity and the particular features of its primary education system. In terms of economic and demographic size, during the period Montevideo concentrated from 28 to 40% of the country's population. Canelones, the next department in population size, accounted for just 8%. Montevideo has historically been the economic, cultural and political centre of the country and its biggest consumer market. It exceeded the country's average income per capita by 30%

[24] For an extensive compilation of results, see Golden and Min (2013), who revise more than 150 studies of distributive politics in countries other than the United States.

[25] An alternative approach is provided by the "power resource theory", which deals with other features of the partisan composition of governments, such as ideology and the potential influence of left or right wing parties or party families (in the continuum from liberal to socio-democrats) on education spending. See Garritzmann and Seng (2016) for a revision of the available literature.

during the period and produced almost 60% of Uruguay's total value added (García et al., 2015). Moreover, the primary schooling system was highly influenced by private provision, which was virtually absent in the rest of the country. Montevideo's persistent and marked urban primacy and particular schooling structure makes it an extreme outlier whose consideration would require a specific empirical approach, different from the nation-wide analysis applied here.

In terms of contributions, this study provides new quantitative insights on the development of mass education in the country. On the one hand, it complements the historical qualitative literature and challenges the traditional vision of the neutrality of politicians, generally persuaded about the benefits of promoting public education. On the other hand, it contributes to the ongoing research efforts to understand Uruguayan regional development in historical perspective (García et al., 2015; Martínez et al., 2015) and the impact of political factors on the country's macroeconomic variables (Aboal et al., 2003b).

From a more general perspective, the Uruguayan case provides an interesting example of the tactical allocation of public funds to primary schooling under democratic settings, a topic that has received a limited attention in the available literature. More specifically, it may be useful to understand the historical dynamics of primary education development in other Latin American countries. It has been argued that the primary education systems of the region, consolidated by the mid-20th century, were comparatively backward and low quality (Frankema, 2009). A closer look at the political factors explaining public investment might serve to identify new sources of this underperformance.

The rest of the chapter proceeds as follows. Section 4.2 describes the main features of the expansion of primary education in Uruguay. Section 4.3 is a review of the main characteristics of the Uruguayan political system which would have led to pork barrel tactics. Section 4.4 explains the data and empirical approach and section 4.5 provides the main results. Section 4.6 concludes.

4.2 The expansion of public primary education in Uruguay (1914-1954)

As happened in other Latin American countries such as Argentina, Chile and Costa Rica, primary schooling expanded substantially in Uruguay since the end of the 19th century (Thorp, 1998). The Uruguayan system emerged and grew under the directives of the "Education Reform" led by J.P Varela during L. Latorre's dictatorial government (1876-1879). The project was conceived as a powerful tool to fight barbarism and spread liberal values across the national territory. In Varela's words, *"…primary school (…) mainly aims at developing all [people's] capacities and forces, to*

furnish them with health, strength and aptitudes to put them into action… the knowledge acquisition remains second" (Varela, 1874).

Ever since Varela's reform, its principles became generally accepted in the country, where people continued to consider the development of a liberal and egalitarian culture as the principal objective of basic education (MEC, 2014). The consolidation of this idea was also the merit of the reformist Colorado leader J. Batlle, who was President in two occasions (1903-1907 and 1911-1916) and left a permanent mark not only in his party but mainly in the Uruguayan society.[26] Hence, the Varelian principles of free and publicly-provided schooling (since 1877) were extended to secondary and tertiary education in 1916. The public school system, that had started being operated by secular authorities in the late 19th century, achieved its complete secularization in 1909. In addition, the "Education Reform" and further Batlle's policies made great headway in the professionalization of teaching, the creation of infrastructure and the induction of parents to get their children into the education system (Bralich, 2011). As a result of this founding period, more than 2/3 of the population aged 15 and older was literate by 1930 (Lee and Lee, 2016, see Table A.4.1 in the Appendix).

Different from what happened in US and Europe, the origins of public school expansion in Uruguay were not part of a movement of democratization. It was the head of government, representing strongly liberal and anticlerical parties, who pushed the reforms. This was also the case in Argentina and Chile (Mariscal and Sokoloff, 2000), Brazil (Martinez Fritscher et al., 2010) and Peru (Arroyo, 2016). Hence, electoral reforms did not precede the expansion of government funded schools. Instead, the latter was seen as key to foster men's participation in democracy. In fact, until the 1918 Constitution suffrage was only granted to male citizens meeting wealth and literacy requirements. And schooling expansion was actually a demand by the landholding elites, eager to fight barbarism and civilize masses in order to transform them into a disciplined labour force, thanks partially to the fact that school funding did not involve any cost for those elites (Bralich, 2011).

Schooling, like the rest of government services, was centrally financed and organized. The same happened with the system of fiscal revenues. The growing financial needs of the primary

[26] Batlle's government established a welfare state system in the country within which the intermediate education for women, industrial training and the expansion of secondary education played a central role (Lindhal, 1977).

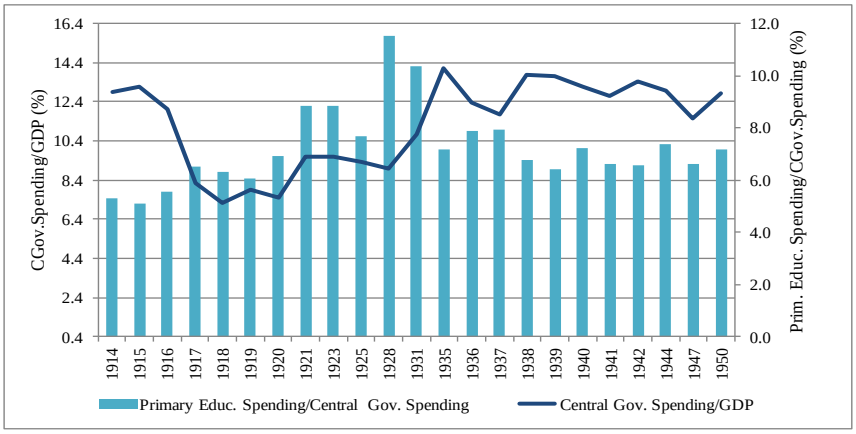
education system were initially covered by funds coming from different tax sources: percentages of taxes on renting, inheritance, trade authorizations, motorcars and various types of basic consumption goods (foodstuff, clothes, etc). The 1934 Constitution changed this system and removed the fixed percentages. Since then, education funding, together with all other items of the national budget, had to be funded by the proceeds of total government revenues (Anselmi and Zaffaroni, 1941).

Within this framework, politicians' incentives to spend on primary education during the period depended on their perception about its benefits, as well as on the availability of fiscal resources. World War I put an end to a period of dynamic export-led growth, damaging the central source of government revenues (foreign trade taxes). However, government expenditure could recover during the 1920s and up to the 1929 crisis sudden stop, increased from 7% of total GDP in 1918 to 11% in 1931. After the mid 1930s, public outlays remained rather stable until the end of the period. Under these budget constraint the expenditure share of primary education raised modestly, from 5.3% in 1914 to 7.4% in 1954 (Azar et al., 2009). Its highest levels were reached during the 1920s, particularly from 1924 to 1930, when primary education captured (on average) 9% of the total budget.[27]

Figure 4.1 shows two phases in the evolution of the primary education expenditure share. From 1917 to 1931 it expanded over a growing public budget. After 1931, both ratios remained rather constant. On the other hand, along with the expansion of funding, the provision of schools clearly increased since 1914, after two early jumps in 1907-1908 and 1911, under Batlle's government. Figure 4.2 shows that the series jumped again in 1926-27 and kept on slowly rising until the mid-1950s. By the end of the period, it had increased by almost 80%. Accordingly, the number of teachers more than doubled, and the percentage of primary enrolment grew steadily from an estimated 29% in 1914 to almost 57% in 1954 (DGEa and DGEb, Table A.4.1).

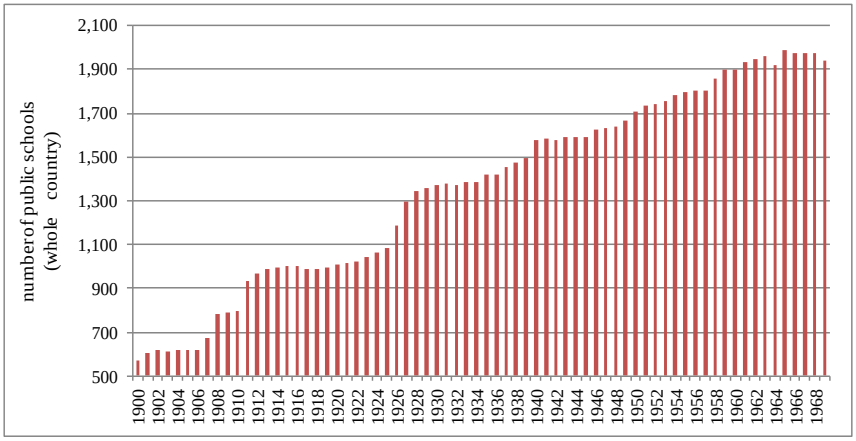
[27] This orientation was supported by a law passed in October 1926 that modified the percentages of tax revenues devoted to primary schooling and widened the range of tax sources applied to this end (Acevedo, 1936).

Figure 4.1 Central Government and primary schooling expenditure shares



Source: Azar et al. (2009)

Figure 4.2 Total number of schools in the country



Source: Based on DGEa (Table A.4.1)

Traditionally, it was assumed that public fund allocation favoured the South (close to Montevideo and the River Plate) and the West (the Uruguay River coastline), which were also regions with high income and welfare indicators in the long term.[28] By contrast, less funds in relative terms would have accrued to the Northern and Eastern regions (by the Brazilian border), which have been described as a poor periphery, with the lowest records in terms of income per capita, infrastructure and social welfare (García et al., 2015; Lombardi and Veiga, 1979).[29] Finally, the central areas of the country were in an intermediate position. The following map portrays the territorial configuration of the country at the department level.

[28] This region includes the departments of San José, Colonia, Soriano, Río Negro and Paysandú.

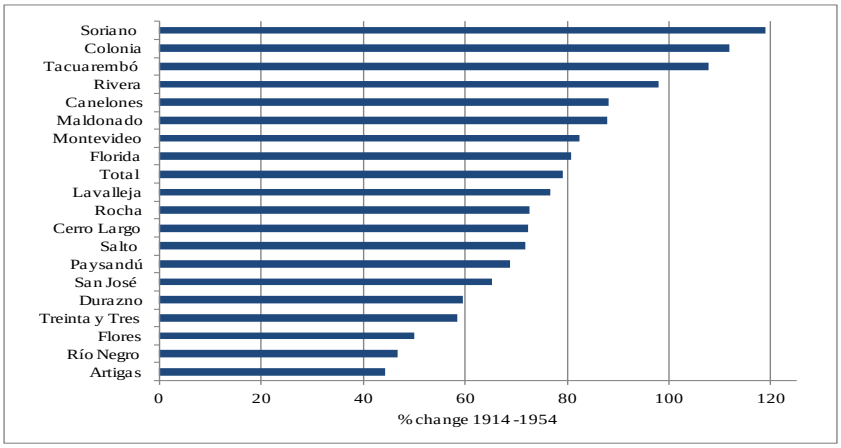
[29] The poorest departments have been Artigas, Rivera, Cerro Largo, Treinta y Tres and Tacuarembó. During the period, also Canelones was in the group.

Map 1. Uruguayan departments

Source: Taken from Martínez et al. (2015) (Table A.4.1)

Figure 4.3 presents the percentage change in the school provision in the 19 Uruguayan departments.

Figure 4.3 Change in the number of public schools across departments (1914-1954)



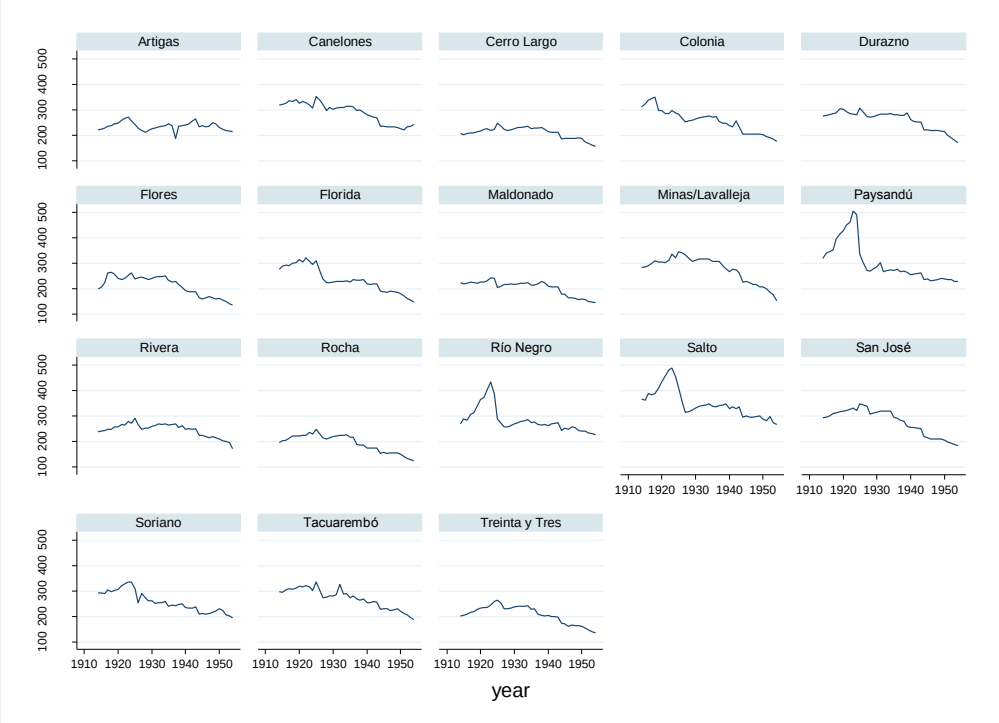
Source: Based on DGEa (Table A.4.1)

The figure shows, however, that the increase in the number of schools was general, and not concentrated in the richest part of the country or Montevideo. In fact, some of the poorest departments, such as Tacuarembó and Rivera, were among those in which the number of schools

grew more between 1914 and 1954. Indeed, one relevant feature of the period is that along with the relevance of the capital-city the government also invested substantially in the rest of the country.[30] This trend would shift in the 1950s, when the regions closer to Montevideo started gaining preeminence in the resource distribution (MEC, 2014).

Figure 4.4 confirms the conclusions drawn from Figure 4.3 by summarizing the evolution of the number of children of school age per school, where school age is *proxied* by Census data on the proportion of 5-14 aged population. The share decreased substantially everywhere, even in the Northern and Eastern regions, thanks to increasing school availability. The levels of the ratio do not seem to have been higher in the poor departments. On the other hand, the figure also makes clear that the evolution of the ratio was not uniform across regions and over time.

Figure 4.4 Children at school age over schools by department



Source: Based on DGEa and DGEb (Table A.4.1)

[30] The idea that Montevideo had already established a proper schooling system under the Varelian Reform and the first Batllist presidency, would explain this spread of education investment (MEC, 2014).

Table 4.1 presents some indicators of primary school development at the department level, as averages for the period 1914-1954. It confirms the variety of situations across the country and, specifically, the distinctive features of Montevideo. The latter concentrated 10% of the country's public funded schools and 60% of the private ones during the period. As a result, the ratio of private over public schools was 70% in Montevideo and 6% in the rest of the country. This justifies the exclusion of Montevideo from our analysis, as well as the focus on the rest of departments, where the public system emerged as the almost exclusive supplier. In this context, this study argues that if public funds were crucial to guarantee access to primary education in the different departments (except for Montevideo) their relevance might have turned them into an opportunity for political manipulation.

Table 4.1 Public primary education indicators by department (average 1914-1954)

Department	Primary enrolment/schools	Primary enrolment/ teacher	School area/pupils (m2)*
Artigas	78.4	41.6	1.34
Canelones	96.0	43.6	1.59
Cerro Largo	75.3	41.4	1.62
Colonia	93.5	41.8	1.48
Durazno	87.4	43.6	1.29
Florida	85.4	41.4	1.42
Flores	74.4	35.2	1.57
Lavalleja	84.5	42.8	1.27
Maldonado	84.2	40.3	1.28
Montevideo	349.6	36.0	1.11
Paysandú	93.0	39.3	1.23
Rivera	100.7	46.5	1.28
Río Negro	92.4	41.7	1.47
Rocha	87.5	42.3	1.31
Salto	102.8	42.4	1.25
San José	81.9	39.6	1.35
Soriano	90.3	41.3	1.29
Tacuarembó	87.9	43.6	1.33
Treinta y Tres	77.5	41.7	1.54
Total	101.2	41.4	1.37

* Data available only for 12 years in the period 1914-1945. CIDE established that the target value of the ratio school area/pupils should be 1.5 m^2.
Source: own computation based on DGEa (Table A.4.1)

So far, this picture about the dynamics of public school expansion reveals just a part of the story. According to several studies, at the end of the 1950s, the minimal conditions to secure an adequate educational performance were not provided, yet. The increase in infrastructure and current expenses was not enough to keep up with enrolment and to retain pupils into the system. Grade repetition, high drop-out rates and late enrolment were among the most important concerns

(Otero, 1969; CIDE, 1965).[31] By 1963, 15% of people over 30 years old were illiterate and less than 40% of the adult population and 47% of the labour force had completed primary education (Otero, 1969). Actually, as in Argentina and Chile, it took at least until the 1970s to achieve acceptable levels of grade promotion and school completion after having achieved full primary school enrolment rates (Frankema, 2009; Bértola and Bertoni, 1999).

From a comparative perspective, the country shares with its regional counterparts the failure to invest enough in public education at least until the 1930s, during the intense growth period associated to primary export expansion. Table 4.2 contains the average level of public primary education spending (as a proportion of GDP) for some middle and high income countries in 1914 and 1950. Uruguay does not stand out by the level of their public resources devoted to public education.

Table 4.2 Public primary education expenditure in selected countries (% GDP)

Countries	1914	1950
Chile	0.89	1.05
France	1.48	1.23
Japan	2.04	1.78
Spain	0.41	0.38
United Kingdom	0.98	0.91
United States	2.33	2.10
Uruguay	0.71	0.85
Total	1.35	1.24

Source: own computation based on UC Davis (Table A.4.1); Azar et al. (2009)

Scholars have already pointed out to the consequences of the "relative denial of tax support for basic education" in the region (Lindert, 2010: 386). The gradual expansion of mass schooling, along with a slow expansion in primary education budgets, resulted in poor educational quality (Frankema, 2009). Uruguay has not been an exception: this has been obvious since the 1960s, but it is probably the result of a long run trend, which would largely explain the country's present disappointing education records (Hanushek and Woessman, 2012).

[31] CIDE stands for "Comisión de Inversión y Desarrollo Económico" (Commission for Investment and Economic Development).

4.3 A look at Uruguayan politics

This chapter aims to assess whether the incumbent government used school provision to persuade the electorate and, particularly, to reinforce its legislative outcomes. Therefore, first it is important to clarify the degree of influence of political parties on the government's decision making process in Uruguay during the period.

The pork-barrel politics literature provides some clues to understand the Uruguayan case. Two main theoretical models account for distortions in resource allocation. Lindbeck and Weibull (1987) and Dixit and Londregan (1998) show that the incumbent purchases votes by distributing money to regions in which there are many "swing voters" (those not specifically attached to any party) and low-income voters (cheaper to attract). Instead, Cox and McCubbins (1986) state that, due to risk aversion, the incumbent government purchases votes by investing in districts where it already has high support.

This line of "electoral targeting" might be combined with a "legislative targeting", as it happens when the distribution of benefits aims at optimizing legislative outcomes. The reason is that after the elections, legislative seats become more important than popular votes. Then, benefits could flow to senior figures in the governing coalition (as with "core" voters) or to pivotal legislators (the analogs of "swing" voters) whose support may be crucial in overcoming majority requirements in the legislative process (Cox, 2009). As a result, distributive benefits may be directed either to persuade the electorate or to bargain intermediate legislative outcomes, even with legislators belonging to the president's own party (Cox and McCubbins, 1986; Evans, 2004). On the other hand, this dynamics would also reflect the higher ability or skills of certain senior representatives to attract resources to their constituencies. As it is shown below, this is the situation that most resembles the Uruguayan case.

The Republic adopted a presidential system and a bicameral organization of the legislative since its inception in 1830. Almost a century later, the 1918 Constitution laid the foundation of a real democratic system. It established universal, direct and secret ballot for all male-citizens and removed any requirement to be elector or elected.[32] It also introduced Proportional Representation (PR) and established a National Administration Council (NAC). Composed by 9 members (6 from the winning Party and 3 from the major opposition party), the NAC would share

[32] These new regulations came into force in 1923. The Constitution also stated that women's citizenship rights could be granted by law. This happened in 1932.

the Executive Power with the President. They would be renewed by thirds every 2 years. The elected president would rule during 4 years and hold the Military power, the Internal Order responsibilities and the country's international representation. The NAC would be in charge of the economy and the rest of domestic policy decisions. NAC members were elected independently from the President and its Chief could belong to a different fraction or even a different party.

This state of affairs lasted until the 1933 *coup d'etat*, which aligned some members of the Colorado Party with the majority of the National party, both seeking changes in the prevailing orientation of the Uruguayan social and economic system. The *de facto* government pushed the creation of a Constitutional Assembly to write down a new Constitution, approved in 1934. It was a mixture of liberalism, corporatism and statism and would influence the main aspects of the country's public policy for the next 40 years (Filgueira, 1995). The new regime did not suspend national elections, which were held in 1934 and 1938, though they were boycotted by important political fractions.[33] The 1934 Constitution removed the NAC, and established that PR would not be applied to the Senate. Since then, the total number of Senators would be equally divided between the election winner and the major opposition party.[34] It also introduced the compulsory vote (though without sanctions), eliminated any difference in political rights of men and women and established that legislatures and executives would be elected at once, every 4 years. These rules would again be revised by the 1951 Constitutional Reform, which brought back a collegial Executive Power since 1952: the National Government Council. It counted on the joint participation of the two main political parties and was in force until 1967.

One long-lasting and fundamental principle common to all electoral regulations since 1910 has been the "double simultaneous vote" (DSV). From 1934 onwards it has been applied to the election of all public officials (legislative and executive, at the national and local level). The DVS implies that voters have the power to choose from different lists within their preferred party: they choose the party as well as a specific group of politicians within it, all at the same time. As a result, the electoral rule could produce a winner who had not won the total popular vote but the majority support within the winning party (Altman et al, 2011; Piñeiro, 2004). Similarly, a legislative majority of the president's party did not necessarily correspond with the preeminence of his political fraction.

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[33] Mainly, the Colorado Batllists and the Independent Nationalists, who emerged from an internal division of the National Party.

[34] This reform has been historically known as the "half-half Senate" or *"senado de medio y medio"* and was in force until 1942.

The collegiate reforms, the PR and the DVS set up strong incentives for party cooperation. Certainly, since the 19th century the Uruguayan history has evolved around the ups and downs of the two strong and statewide parties, Colorados and Nationalists. The Colorado party, inspired by Batlle, dominated the political arena until 1959. They were liberal, anticlerical and tied to urban areas. Instead, the Nationalists have been more conservative and more clearly linked to rural interests. Beyond these general features, differences in ideological background or social composition were negligible and each of those two parties was supported by ca. one -half of the electorate (Zurbriggen, 2005; González, 1990). Indeed, some intraparty ideological differences could be more significant than interparty ones. Other parties, such as Comunists, Socialists, or Christian ones had a minor presence until the 1960s.

The DVS contributed both to create and to organize the so-called "fractionalized bipartism" (Buquet et al., 1998). Both major parties have been riven by policy disputes which made fractions highly visible. These could even be considered as "parties inside parties" (Lindahl, 1977). The Colorados have been divided into batllists and riverists (opposed to the social and economic proposals of President Batlle).[35] Besides, since 1917 the batllists themselves split according to the loyalty to different leaders, situation that got worse after Batlle passed away in 1929. The Nationalists suffered divisions since 1930 due to personal disputes between the most conservative party-leader (L. A. de Herrera) and their opponents (later gathered under the Independent Nationalists).

The impact of the two-party system on electoral competition led to closely disputed results. Uruguay has 19 electoral districts, which coincide with the departments, and vary considerably in the number of representatives (from 2 to 32 or 45 depending on the year). Montevideo (excluded from the analysis) had 30 to 40% of total representation, so it was crucial in the electoral dispute. Nonetheless, given the narrow vote margins and the serious intraparty divisions, the rest of constituencies also became crucial for the electoral competition and post-electoral alliances.

Table 4.3 indicates the electoral occasions in which the vote margin between the main parties was lower than 10% at each constituency. It reveals that during the period, along with strong party loyalties, politics moved in narrow margins in the majority of departments, with the exception of Artigas, Maldonado and Rivera.

[35] The "riverist" fraction takes its name from the Colorado leader Fructuoso Rivera, first constitutional President of the Republic (1830-1834).

Table 4.3 Presence of vote margin under 10% across departments and elections

	Legislative Elections									
Departments	1916	1925	1928	1931	1934	1938	1942	1946	1950	1954
Artigas										
Canelones	yes		yes							
Cerro Largo					yes	yes	yes	yes	yes	yes
Colonia	yes	yes		yes						yes
Durazno	yes				yes	yes		yes	yes	
Flores				yes			yes		yes	
Florida		yes			yes	yes		yes	yes	
Lavalleja	yes	yes	yes	yes	yes	yes		yes		yes
Maldonado										
Paysandú	yes	yes	yes	yes	yes					yes
Río Negro		yes		yes	yes	yes				yes
Rivera										
Rocha	yes	yes	yes	yes						yes
Salto			yes	yes						
San José						yes		yes	yes	yes
Soriano	yes		yes	yes				yes		yes
Tacuarembó	yes	yes	yes	yes	yes	yes				
Treinta y Tres					yes	yes		yes	yes	

Source: own compilation based on Nahum (2007), Nohlen (1993), FSS and Acevedo (Table A.4.1)

Consequently, the Colorados, though being the dominant party, never obtained 3 consecutive majorities in the low Chamber during the period 1918-1933 and only gained one absolute majority (1946) between 1942 and 1954. On the other hand, the high levels of intraparty indiscipline, splits and personality disputes were translated into dissent, bargains and deals among the parliamentary representatives. As a result, coalition partners in the legislative arena changed frequently during government terms. Still, it is true that no matter how close they were, no fraction from one party would have moved to the opponent party (Altman et al, 2011). The same happened to a considerable number of voters who were firmly attached to their party and whose support was out of reach for the other.

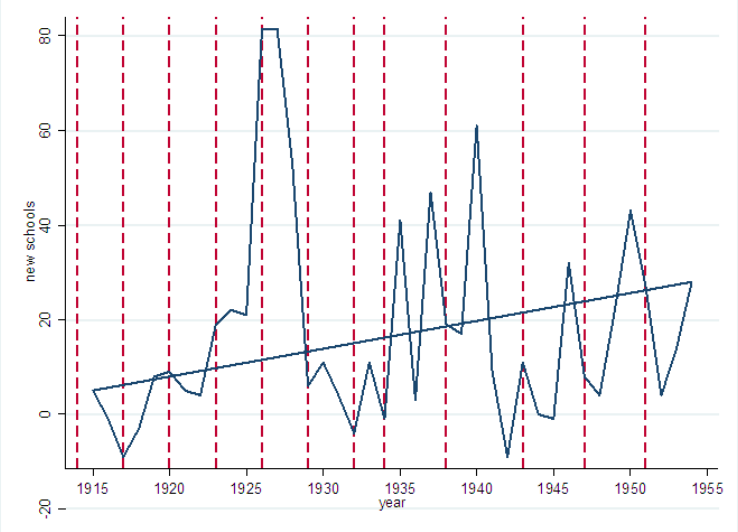
Ultimately, the levels of cooperation and compromise among fractions benefited the working of Parliament by smoothing the decision-making processes and the levels of confrontation and conflict (Caetano and Rilla, 1996). On the other hand, they also brought significant benefits for politicians in terms of patronage and clientelism. These became visible during the 1930s, got worse in the 1940s and reached a maximum in the 1950s, as fraction proliferation increased (Filgueira, 1995, Real de Azúa, 1964). Such was the case that the 1934 Constitution made explicit that "civil servants should serve the nation not the political fractions" (Zurbriggen, 2005: 130).[36]

[36] Article 57 of the 1934 Constitution.

The current study explores primary education spending, which was funded by the central government and disbursed across departments. The role of Parliament was essential, because the national budget was discussed, approved and controlled by the legislative representatives. The present analysis is based on the performance of the members of the low chamber (*Diputados*): they were regulated by the same electoral rules and appointed following a regional proportional representation during the whole period. Moreover, some scholars consider that *diputados* reflect more clearly the high degree of fragmentation of the partisan politics and the relationship with the electorate, being much more responsive to their demands (Monestier, 1999; Buquet, 2003). In addition, as described above, during the period under study the president lacked a strong legislative power and was subject to continuous political bargain at the parliamentary arena.

The extent up to which public school provision might turn into "pork" depends on whether its allocation decision responds to genuine needs or occurs on the basis of partisanship (Stokes et al., 2013). A first approach to the plausibility of the second alternative is given in Figure 4.5. Following Vaishnav and Sicar (2010), it displays the annual variation in the total number of schools across the 18 departments, compared with the succession of legislative terms.

Figure 4.5 Annual variation in the number of schools and legislative election years



Note: variation is computed as the annual difference in the total number of schools available across the 18 departments. The red lines show the legislative election years.
Source: own computation based on DGEa and Asamblea General (2006) (Table A.4.1).

On average, 52% of variations corresponded to the first two years of government. This suggests that they might be rewarding voters or pivotal legislative representatives. Additionally, 32% of

new school establishments took place right before the elections, which could point out to the use of schools to persuade voters.

Overall, this revision of the historical literature about the Uruguayan party system provides evidence on the recurrent need of the incumbent government to reinforce its bargaining position. Thus, it could be expected that the ruling party had rewarded with school provision their core supporters or the more loyal seats in the Parliament. However, as electoral competition and political conflicts became very intense, one might think that the allocation of public education funds could have sought to influence legislative coalition formation, bargaining and swing voters. By testing these different hypotheses, this study aims to better understand whether political factors have conditioned the primary school development during the period.

4.4 Empirical approach

4.1 Data

The empirical analysis is built upon a department-level historical dataset for 18 territorial units for the period 1914-1954. This regional approach had to overcome some data constraints. This is the case of the main outcome variable: public education spending per region is not available for the selected time-span. For this reason, public financial efforts are measured through the number of available schools at each department. This variable stands as a *proxy* for the public resources applied to the current operation of the primary education system across regions (Arroyo, 2016; Gao, 2015; Chaudhary, 2009). Despite being an indirect measure it is suitable since department heterogeneities in terms of school equipment did not seem to be wide according to Table 4.1. Besides, the rapid primary education expansion was mainly covered by renting private buildings (they represented over 70% of establishments), not by school construction. This reduces the importance of potential regional disparities in public infrastructure investment. As a robustness check, we also use the number of teachers hired by public schools as an alternative dependent variable. In all cases, data come from several National Statistics Yearbooks of the years covered by the study (DGEa in Table A.4.1).

Turning to the political factors, the period comprises 12 legislative terms which lasted 3 years until the 1934 Constitution and 4 years from then onwards. We study the political orientation of the *diputados* elected in representation of the different departments. Their total number (including Montevideo) changed from 90 (until 1916) to 123 (between 1917 and 1932) and finally

ranged 99 since 1934. Each department elected at least 2 representatives, which made up a total (average) sample of 70 deputies per election in the 18 departments (Montevideo excluded).

Data on the name, party affiliation, legislative term and department of origin of each one of the legislators have been extracted from the report "Parlamentarios uruguayos 1830-2005" ("Uruguayan Parliamentarians") edited by the Uruguayan Parliament (2006). However, this source does identify each MP's political fraction. From 1925 to 1943 this has been reconstructed on the basis of the electoral ballots of each party by department and election. The information has been published on line by the Uruguayan Electoral Office. The gaps for the rest of the period have been completed with data on elections and parties compiled by the area of Political Sciences of the FSS Databank, Nahum (2007) and Acevedo (1936).

This dataset allows computing the main political indicators to be analysed in the study. As discussed in the previous section, political priorities might have affected spending decisions depending on the intensity of the challenge the incumbent party faced from others and also from intraparty fractions. In order to take into account the crucial role played by these fractions in local politics, we compute the degree of fragmentation of the party system (Laakso and Taafepera, 1979).[37]

Let $\bar{x} = \sum_{i=1}^{n} x_i$ be the total number of parliamentary seats and $s_i = x_i/\bar{x}$ the shares of the seats of party i. Then we define the $Effective\ \ Number\ of\ Parties$ (ENP) as $\frac{1}{\sum_{i=1}^{n}(x_i/\bar{x})^2} = \left(\sum_{i=1}^{n} s_i^2\right)^{-1}$, that is, as the inverse of the sum of squares shares. An increase in the value of ENP corresponds to a reduction in the degree of concentration of the political system. The ENP is simply the inverse of the Hirschman-Herfindahl index. It measures the level of political concentration, where the number of parties in competition is neither dependent on just the largest party's vote $(1/s_i)$ nor distorted by alterations in the numbers or vote shares of very small parties (Taagepera and Shugart, 1989). The same computation applies to party fractions (ENF) by taking $s_i = x_i/\bar{x}$ as the shares of the seats of each political fraction within the party system.

Both ENP and ENF have been estimated for each one of the departments and legislative terms. It is expected that the greater the number of parties or fractions the greater the chances presidents will

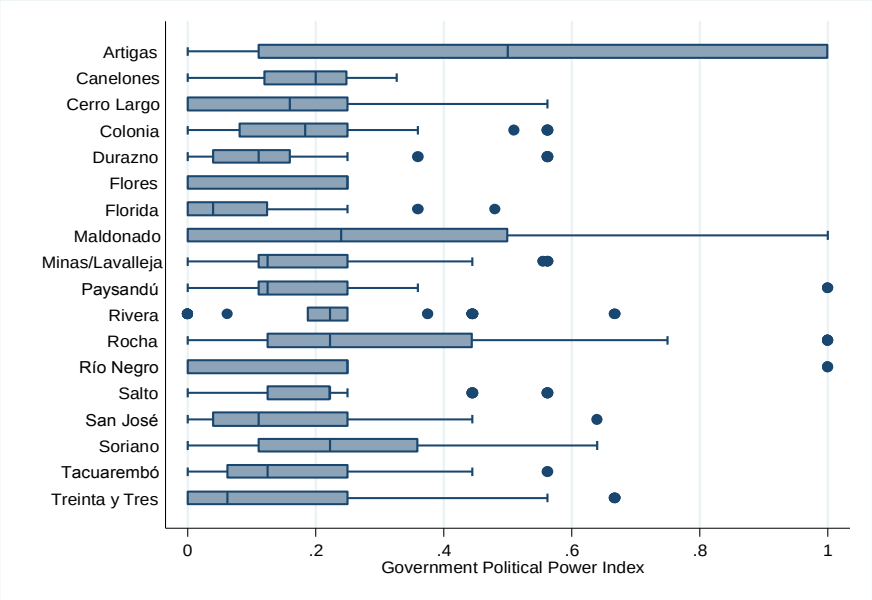
[37] This measure has reached a high degree of consensus among scholars. Despite the drawbacks stressed by some authors suggesting new measures, it remains the most used one when assessing the party-system fragmentation (Caulier, 2011).

not count with a majority support in the legislature (Shugart and Carey, 1992). As previously seen, though the system has produced a fractionalized party scheme, it became markedly more so after the democracy recovery in 1938. On average, the ENF was 2.16 between 1914 and 1930 and rose to an average of 2.85 for the span 1938-1954.

Besides, the distributive politics framework states that government could use schooling provision to induce cooperation between the executive and the legislative. Under the assumption that the extent up to which the president is compelled to seek legislative support hinges upon its legislative power, three variables are used to describe his position in each department. First, the "seat margin" is the difference of seats between the government's party and the maximum of those occupied by an opposition party, as a share of the total available department seats. It is interpreted as an indicator of electoral competition: the higher the seat margin in favour of government, the lower the electoral competition in the department.

The other two indicators explicitly consider the influence of party fractions. The "Government Political Power Index" (GPPI), taken from Aboal et al. (2003a) and Oddone (2005), is obtained by multiplying the proportion of seats aligned with the president's party times the share of seats of his political fraction within the party. The higher the value of the GPPI the stronger is the president's legislative support. The index has been calculated for each department and legislative term. As during the period 1919-1932, the NAC conducted the economy and took the most important domestic policy decisions, it is estimated in reference to the NAC's President. Figure 4.6 shows the degree of variation of GPPI across departments during the legislative terms of the period.

Figure 4.6 Government Political Power Index (GPPI) by department across legislative terms



Source: own computation based on Nahum (2007), CEU, FSS and Acevedo (Table A.4.1)

A second indicator is the share of seats aligned with the president beyond their partisan affiliation (over the total elected at each department level). Different from the previous measure, this "alignment" variable is allowed to change during the legislative term due to coalitions and intraparty conflicts. The required information has been compiled from several historical analyses (Acevedo, 1934 and 1936, Zum Felde, 1967; Caetano and Rilla, 1996; Nohlen, 1993).

A complementary perspective to legislative outcomes focuses on the electoral dispute. In this case, the discussion hinges upon the extent up to which the incumbent government has preferred to reward its core supporters or to maximize the probability of winning the election by allocating resources to swing districts.[38] Hence, following Milligan and Smart (2005) and Vaishnav and Sicar (2010) the electoral pressures on the ruling party are captured by the difference in vote shares between the main party in the central government and its main opponent (expressed in absolute values).[39] A small difference in this vote margin in the last legislative election is assumed to define a "swing" constituency. The necessary data to estimate those differences are taken from Nahum (2007), Nohlen (1993), the FSS Databank and Acevedo (1936). The variable is not available for the whole period, because there is not information about the votes cast by parties at the department level in 3 legislative polls: 1913, 1919 and 1922.

[38] Golden and Min (2013) state that as studies rely on aggregated data they are really comparing core and swing *electoral areas* or districts rather than core and swing voters, as predicted by the theory.
[39] An alternative indicator is given by the votes needed for the incumbent government to gain/lose the majority. Unfortunately, the range of data available at the department level impedes this computation.

Apart from political factors, scholars have suggested that an unequal distribution of land might slow down the expansion of public schooling (Engerman and Sokoloff, 2000; 2001; Galor et al., 2009). Indeed, Engerman and Sokoloff have stated that Argentina, Chile and Uruguay invested more in education than their regional counterparts because landownership inequality was less pronounced. In order to account for this hypothesis, a land Gini index is included in the analysis, which was elaborated by Castro et al. (2012) on the basis of information about the size of rural establishments (Table A.4.1).

Another driver for public schooling investment in Europe and the US has been the extension of political franchise or the "political voice" (Engerman and Sokoloff, 2000, Lindert, 2004). Though in Uruguay, school development preceded democratization, it is relevant to explore whether the electorate enlargement has contributed to foster the demand for primary schooling. The size of the potential electorate to be disputed by the parties is measured by the ratio of registered electors over total population. The indicator takes into account that literacy and wealth vote requirements were effectively removed in 1923 for men aged 18 and over and in 1938 for women. Suffrage has been compulsory since then.

Additionally, the study considers a group of other covariates that aim to proxy the potential demand for public education provision, such as average population size and the birth rate at each department. The former has been constructed by interpolating the 1908 and 1963 Census data while the second has been built upon the total number of births published at several Statistics Yearbooks of the period.[40] On the other hand, the previous local progress of schooling is given by the primary enrolment rate lagged one year (private and public). It was computed from the data on total primary enrolled students (DGEa) and an estimation of the primary-school age children at each department, *proxied* by those aged between 5 and 14 years (DGEb in Table A.4.1). The variable aims to capture the preexisting direct demand on schooling.

Other socio-economic variables that could have affected the demand for education (economic growth, share of total value added, industrial composition, literacy rates, total years of education, etc) are not available at the department level on a yearly basis, so they were captured through several proxies. For instance, secondary enrolment rates are expected to describe the broad

[40] One serious data constraint for the period is that population Censuses were only carried out in 1908 and then in 1963. The information for the long time span between them comes mainly from annual general statistics.

educational standards prevailing at the department but also the local income level and even its distribution. The argument is that, until the late 1920s, secondary education was aimed to prepare students to enter University, so it stood as an exclusive domain of economic elites. Though by 1912, there was at least one public secondary school at almost each department capital, the real democratization of access started in 1935, when secondary institutions were separated from University (MEC, 2014). The variable is taken with a 6 year-lag in order to control for the education and income level of 18-24 year-old people, who may also be potential parents.

Similarly, the share of private primary enrolment over the total describes the potential trade-off between public and private education at the department level, probably influenced by the preferences of the groups belonging to the higher tail of income distribution. The variable is lagged one year. Data come from Nahum (2007), Education Yearbooks and census information for the interpolation of secondary school age population.

The labour force participation rate and the growth rate of the tertiary labour force aims to account for each department economic development. It may also reflect the progress of urbanization. These variables are expected to exert a positive effect on school provision (Lindert, 2004; Mitch, 2013). An additional incentive to foster public education might come from skilled labour demand. Following Cappelli (2016), the share of the labour force employed in agriculture and in secondary activities (in relation to tertiary activities) is used to capture the possible returns to human capital formation, assuming that skilled labour was not a prime request in agricultural societies or for the incipient industry. The information on the labour market has been taken from García et al. (2015) and gaps fulfilled with interpolations.

Finally, the share of school-age children over people aged 55 and older is included to account for the potential generational conflict over public resources. If government tries to maximize its political support by favouring the allocation of funds towards the elderly, there would be a negative effect on school spending (Poterba, 1997; Grob and Walter, 2007). This was a plausible situation in the country, because pensions have historically been the main social transfers. In fact, the first pension rights were recognized in 1829 and consolidated in 1904: before the great mass expansion of public education (Azar et al., 2009).

One limitation of this analytical proposal concerns the treatment of rural schooling, which actually led the expansion of schooling throughout the country (MEC, 2014). However, lack of data on total and school age rural population and distance to urban centers have prevented from focusing on its

specific development. Table A.4.1 summarizes the main data sources and Table A.4.2 reports summary statistics for the baseline variables.

4.2 Methodological approach

The aim of this analysis is to disentangle the contribution of different forces to the number of schools at the department level in order to assess how this relates to political factors. The baseline specification is a panel data fixed effects estimation of the following model:

$$schools_{it} = \beta P_{it} + \gamma X_{it} + \alpha_i + \alpha_t + \mu_{it}$$

where $schools_{it}$ is the number of public schools at each year (t) and department (i); P_{it} includes the political variables; X_{it} stands for the set of control variables; α_i are department fixed effects, α_t are specific year-effects and μ_{it} is an error term.

The model would help to identify the drivers of variations in the number of schools within departments over time. The use of department fixed effects controls for unobserved characteristics of the departments that are constant over time, such as geographic features or differences in rural-urban concentration. Likewise, the year fixed effects capture unobserved external changes over time which may produce similar effects across departments, such as constraints or expansions in national budget which are centrally decided. On the other hand, the potential non-independence of errors within departments is tackled by clustering standard errors at the department level.

The estimation includes the set of controls previously described to avoid the omission of variables that could act as unobservable time-varying factors. Dependent and control variables are taken annually. Political factors (except for the legislative alignment with the president) are defined for each legislative term, so they are the same between elections. The model assumes that the number of schools each year is affected by the legislative configuration or the electoral results emerging from the previous election so that reverse causality problems are avoided. Table A.4.3 shows the statistical correlations between the variables applied to the analysis.

4.5 Results

Table 4.4 presents the first set of results, and it summarizes the influence of the political variables on schooling provision. Column 1 shows a significant and positive relationship between the number of effective fractions and the available schools. So, a highly fragmented political system

seemed to have fostered education spending at the department level. The variable keeps this influence and remains statistically significant across all specifications.

Columns 3 to 5 keep the prevailing intraparty competition variable (ENF) and alternatively add indicators describing government's seat margin, political power index (GPPI) and alignment of MPs. The coefficients of these three variables are negative and significant at 10% level.[41] They suggest that the president's low legislative power benefited school provision across regions. In other words, all else equal, it seems that the incumbent government party did not allocate resources to reinforce the strength of its already loyal legislators. Instead, the fund distribution appears to have been affected by the government's need to bargain with regional opposition representatives.

To complete this information, Columns 5 and 6 show the effect of the electoral margin on schools in order to assess whether public schooling provision was targeted to "core" or "swing" constituencies. The variable has a negative sign, meaning that a reduction in the electoral margin between the main parties (that is, a closer electoral dispute) implied an increase in school provision. Though suggestive, the coefficient is not significant. Still, this result might be affected by the lack of data on 3 elections (1913, 1919 and 1922). Following Milligan and Smart (2005), the vote margin has been interacted with a dummy variable that takes value 1 in those departments held by the government. This is intended to capture possible differences in the effect when the electoral dispute was settled in favour of the president's party. The effect of the electoral margin in government loyal departments is obtained by adding this coefficient (positive and non significant) to the interacted variable, highly significant and negative. The result is a negative sum, suggesting that school provision was positively related to swing regions in which the government won the electoral dispute. The aim would have probably been to enhance its chances of re-election.

[41] This level of statistical significance could stem from the fact that the degree of party support to government is more difficult to assess as competition among political fractions grows (reflected in the highly significant ENF variable).

Table 4.4 Primary schooling, party competition and government legislative powers

Dep. Var. *Nº of public schools*	1	2	3	4	5	6
Effective Nº Fractions (ENF)	0.974***	1.062***	0.909***	0.953***	0.809*	0.386
	(0.298)	(0.277)	(0.310)	(0.298)	(0.404)	(0.392)
Government Seat Margin		-1.327*				
		(0.740)				
Gov. Political Power Index			-1.740*			
			(1.029)			
Alignment with President				-1.412*		
				(0.811)		
Vote Margin (VM)					-1.082	4.527
					(3.902)	(3.525)
VM x Gov. held dept.						-11.561**
						(5.239)
Gov. held dept. (dummy)						0.324
						(1.030)
Land Gini index	-38.723**	-39.632***	-41.244***	-38.735**	-33.096**	-44.496***
	(14.416)	(13.362)	(13.571)	(13.796)	(12.678)	(12.012)
Potential Electorate	18.529*	17.200*	17.884*	18.726*	21.748	21.277
	(9.088)	(8.957)	(8.956)	(9.217)	(20.827)	(19.438)
Population (thousands)	0.778***	0.777***	0.776***	0.777***	0.704***	0.662***
	(0.112)	(0.113)	(0.113)	(0.115)	(0.163)	(0.162)
Birth rate (per thousands)	0.190**	0.203**	0.195**	0.188**	0.089	0.101
	(0.080)	(0.080)	(0.080)	(0.082)	(0.086)	(0.085)
Primary enrolment (lag. 1)	39.942**	41.642**	40.078**	40.456**	29.118*	30.872**
	(15.410)	(15.400)	(15.348)	(15.370)	(14.335)	(13.586)
Priv. school stud./total (lag. 1)	-43.869***	-43.573**	-42.810**	-44.773***	-43.770**	-38.865*
	(15.092)	(15.974)	(15.461)	(15.216)	(19.235)	(18.526)
Secondary enrolment (lag. 6)	-57.105*	-54.030*	-54.823*	-55.441*	-29.413	-25.377
	(31.969)	(28.517)	(30.570)	(30.941)	(37.522)	(30.774)
Labour force participation rate	81.651***	80.646***	80.488***	80.908***	75.032**	61.079*
	(18.970)	(18.748)	(18.712)	(19.047)	(33.697)	(29.254)
Rate of growth of tertiary labourers	863.774**	896.029**	863.591**	853.793**	580.488	494.411
	(311.049)	(312.200)	(320.492)	(313.314)	(456.283)	(437.362)
Active population in primary activities/total	-323.386***	-311.354***	-314.579***	-317.729***	-269.849**	-246.467**
	(104.135)	(101.464)	(104.181)	(101.710)	(103.636)	(87.819)
Active population in secondary activities/total	-331.148***	-309.160**	-322.619***	-326.996***	-274.869**	-257.001**
	(110.973)	(110.927)	(111.194)	(106.194)	(125.144)	(114.024)
School aged/people over 55	20.788***	21.142***	20.680***	20.752***	7.873***	7.687***
	(5.338)	(5.240)	(5.345)	(5.412)	(2.421)	(2.454)
Observations	551	548	549	551	443	443
R^2	0.939	0.940	0.939	0.939	0.902	0.908

Note: All columns include department and time fixed effects and a constant. A total of 18 departments are considered. Cluster robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

What emerges from the results is that school provision during the period seems to have been influenced by government political tactics. These were targeted to persuade swing voters (in

departments at risk of being lost) or opposition legislators, but not to reward party supporters or core constituencies.

Among the control variables, particular attention is given to the land Gini index. As previously mentioned, it has been argued that landownership inequality might have had an adverse effect on primary schooling expansion. Several authors have obtained evidence on this issue by applying an instrumental variable approach to scale down endogeneity problems aroused from omitted variables bias and reverse causality (Galor et al, 2009; Cinnirella and Hornung, 2013).[42] Though the estimation performed in this study precludes the discussion of a causality relationship, the results do indicate that high levels of land inequality within departments were systematically associated with a lower school provision. Therefore, contrary to the traditional belief about the relative neutrality of landowners in the process of education diffusion, the estimation suggests that they had preferences against public schooling which in turn had an effect on the timing of its expansion.

Political voice also affected the commitment to fund schooling across departments. It is possible that the ruling elite perceived that school expansion could be in line with the interests of the extended electorate and this would have contributed to raise primary public schooling. The rest of controls in Table 4.4 play an important role in the variation of the dependent variable: they yield the expected signs and are statistically significant. Hence, total population, birth rates and previous primary enrolment ratios have a positive impact on school expansion. In the same vein, a similar effect is found for the labour force participation and the growth rate of tertiary labour. This is consistent with the idea that urban regions are more prone to demand public education provision.

Another interesting pattern emerges from the negative and significant influence of secondary enrolment rates and the share of private primary school enrolment. They are intended to capture the preferences towards public education of people distributed at middle and high income levels. The evidence suggests that the interests of those who could afford to pay for schooling out of their pocket or had a previous choice in favour of a long educative career held back public primary education spending.

[42] A variable correlated both with landownership and schooling would bias the results. This is the case of the quality of institutions (Sokoloff and Engerman, 2000).

Besides, different occupational groups had different preferences for schooling. A growing share of people at primary and secondary activities *vis-à-vis* those in the tertiary sector (the omitted category) seem to have dampened the support for public schooling. Given the incipient development of manufacturing and the preeminence of agricultural labour during most of the period, a widespread perception about the negligible advantages of acquiring more skills to perform these activities and the high opportunity costs of leaving the jobs to attend schools would account for this result.

A final driver of the schooling provision is the ratio of children to the elderly. The coefficient shows a strong association between school provision and the presence of younger population, indicating that the generational conflict over resources was not visible during the years under analysis.

One important distinction suggested by the historical literature refers to the peculiar dynamics of the years 1917 to 1931. As already noted, there was a significant increase in public education spending during this period (particularly from 1924 to 1930). Besides, the level of party fragmentation was not so pervasive and deep as it would become later. On account of these facts, is it possible that political factors had different effects before and after 1931? In order to identify any changing pattern, a dummy variable for this period has been interacted with the political variables. Results are presented in Table 4.5.

The estimates in the Table confirm the operation of different political forces in those two periods. Columns 1 to 4 show that with the exception of the effect of NEF, which does not seem to vary between periods, the influence of other political variables was clearly positive and significant before 1931 (the effect is obtained from adding the coefficients of the non-interacted and interacted political variables). Furthermore, in the case of vote margins and government held departments, the effect also becomes positive. This means that during this first sub-period, governments would have privileged those districts where they were politically stronger, that is, where they obtained larger positive electoral margins and where their own legislators prevailed.

In other words, during the period of political stability and education budget expansion that preceded the economic and political crisis of the 1930s, funds were allocated to departments where voters were clearly attached to the incumbent party (core supporters). Therefore, there was a preference for parties to reward their core constituencies. Instead, particularly after the dictatorship was over (1934-1938), intense partisanship and polarization would have led to growing party competition. Besides, the available resources for primary education and the

national budget stagnated in relative terms. In this new setting, the use of public education funds to persuade voters and legislators seems to have become more important. Control variables have retained their statistical significance while they have not altered the direction of their influence.

Table 4.5 Political determinants of primary schooling by period

Dep. Var.: *Nº of public schools*	1	2	3	4	5
Effective Nº of Fractions (ENF)	0.895**	1.013***	0.816**	0.805**	0.590
	(0.381)	(0.315)	(0.363)	(0.364)	(0.401)
ENF x period 1917-1931	0.259	-0.119	0.308	0.264	0.207
	(0.624)	(0.547)	(0.533)	(0.595)	(0.731)
Government Seat Margin (GSM)		-2.974**			
		(1.060)			
GSM x period 1917-1931		3.600***			
		(1.102)			
Gov. Political Power Index (GPPI)			-3.374*		
			(1.686)		
GPII x period 1917-1931			4.041*		
			(2.114)		
Alignment with President				-2.873**	
				(1.065)	
Align. Pres. x period 1917-1931				4.679*	
				(2.574)	
Vote Margin (VM)					-0.883
					(4.776)
VM x period 1917-1931					8.039
					(5.637)
Gov. held dept. x period 1917-1931					0.305
					(1.966)
Vm xGov. held dept. x per. 1917-1931					22.085*
					(11.296)
Gov. held dept. (dummy)					-2.048**
					(0.937)
Land Gini index	-39.656**	-47.362***	-45.774***	-45.920***	-47.330***
	(15.099)	(12.920)	(13.481)	(15.197)	(12.920)
Potential Electorate	18.494*	15.106**	16.392*	18.537**	15.333
	(9.174)	(7.135)	(8.175)	(8.673)	(19.493)
Population (thousands)	0.782***	0.755***	0.775***	0.783***	0.614***
	(0.114)	(0.113)	(0.117)	(0.118)	(0.142)
Birth rate (per thousands)	0.192**	0.210***	0.206**	0.192**	0.091
	(0.082)	(0.069)	(0.077)	(0.081)	(0.075)
Primary enroll.(lag. 1)	39.931**	43.239**	40.409**	41.127**	29.844*
	(15.418)	(15.066)	(15.427)	(15.514)	(14.294)
Priv. school stud./total (lag 1)	-43.627***	-40.980**	-40.750**	-43.087***	-41.581**
	(14.832)	(16.183)	(15.671)	(14.653)	(16.448)
Secondary enroll. (lag. 6)	-59.409*	-47.640	-51.975	-50.413	-12.883
	(33.114)	(27.879)	(30.271)	(30.098)	(33.780)
Labour force participation rate	82.928***	74.507***	79.060***	80.658***	59.219**
	(19.256)	(18.383)	(18.751)	(19.128)	(24.999)
Rate of growth of tertiary labourers	876.580**	749.158**	845.693**	878.337**	294.846
	(312.948)	(320.985)	(334.089)	(321.390)	(393.749)
Active pop. in prim. activities/total	-328.592***	-312.916***	-308.434***	-321.047***	-264.128**
	(105.017)	(107.959)	(105.713)	(104.076)	(92.693)
Active pop. in sec. activities/total	-336.444***	-327.266**	-316.626**	-331.511**	-273.319**
	(112.352)	(123.937)	(115.223)	(114.909)	(129.040)
School aged /people over 55	20.909***	21.265***	20.727***	21.798***	6.946***
	(5.284)	(5.055)	(5.344)	(4.915)	(2.112)
Observations	551	548	549	551	443
R^2	0.939	0.942	0.940	0.940	0.913

Note: All columns include department and time fixed effects and a constant. A total of 18 departments are considered. Cluster robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Finally, Table 4.6 explores whether the relationship between political factors and school expansion remains robust when the sample is divided between the rich and middle-income departments and the poor periphery (as described in Section 2). Columns 1 to 6 show that though the direction of the estimated effects does not bear differences with the baseline regressions, they seem to be stronger in the least developed departments. Besides, as previously found, according to the coefficient of the seat margin the government power favoured the core districts in 1917-1931 in both groups of departments (Columns 7 and 8). However, according to the alignment indicator (not presented in this table for the sake of space), this strategy was applied with higher intensity in the poorest regions, i.e. in those departments where public funds were probably more needed.

The effects of control variables are similar to the baseline tables, although the land Gini index is only significant in the rich and middle-income department sample. Thus, in poorer regions, craving for funds, land inequality would not have been so crucial to drive the resource distribution from central government.[43]

[43] The few available observations for the periphery (given that there are no data for 3 electoral instances and this group is the smallest) prevented a robust computation of the vote margin effect.

Table 4.6 Political determinants of schooling provision by economic development of departments

Dep. Var.: *Nº of public schools*	1 Periphery dept.	2 Richer dept.	3 Periphery dept.	4 Richer dept.	5 Periphery dept.	6 Richer dept.	7 Periphery dept.	8 Richer dept.
Effective Nº of Fractions (ENF)	0.976**	1.149**	0.962**	0.998*	0.763*	1.041**	1.425*	1.046*
	(0.340)	(0.433)	(0.328)	(0.466)	(0.312)	(0.456)	(0.626)	(0.531)
ENF x period 1917-1931							-0.510	-0.055
							(0.904)	(0.671)
Government Seat Margin (GSM)	-0.935	-1.398					-2.199*	-3.006*
	(0.582)	(0.973)					(0.994)	(1.425)
GSM x period 1917-1931							2.378**	3.253*
							(0.855)	(1.559)
Gov. Political Power Index (GPPI)			-2.088**	-1.935				
			(0.791)	(1.861)				
Alignment with President					-2.054*	-0.036		
					(0.987)	(1.103)		
Land Gini index	-2.148	-42.470**	-5.405	-44.339**	-5.103	-42.297**	-7.110	-49.394**
	(18.824)	(16.177)	(18.732)	(15.311)	(17.367)	(15.965)	(16.974)	(17.132)
Other control vars.	YES	YES	YES	YES	YES	YES	YES	YES
Observations	179	369	180	369	182	369	179	369
Number of departments	6	12	6	12	6	12	6	12
R^2	0.985	0.935	0.984	0.934	0.985	0.934	0.986	0.936

Note: All columns include department and time fixed effects and a constant. All regressions include electorate, population, birth rate, primary enrolment rates, private/public school students, secondary enrolment rates, labour force participation, growth rate of tertiary labour, active population in primary and secondary activities over total and school aged people over 55.
Cluster robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Some robustness checks of the baseline results are presented in the next tables. In Table 4.7, the dependent variable is replaced by the number of teachers in public schools. This indicator works as a proxy for current public spending. The estimation results suggest that this variable was also affected by political factors. Except for estimates in Column 4, the coefficients show that a greater political fragmentation favoured teacher hiring. In Columns 1-3 the inclusion of factors related to higher government's legislative power are negatively related to the number of teachers, though the coefficient on alignment in Column 3 is not statistically significant. The estimates in Column 4 render non significant results for the vote margin variable. Finally, controlling for the impacts of the political variables over sub-periods the results in Column 5 contrast with those obtained in Table 4.5. Now, the interaction of the incumbent seat margin variable with the first sub-period (1917-1930) has the same net effect as the one found for the entire period. That is, the prevailing government orientation has been to persuade opposition or less "safe" provincial legislators. The result is the same when using the GPII variable.

Note that land inequality across departments exerted a negative influence on the number of teachers (the variable has the expected negative sign). However, the coefficient is not always statistically significant at conventional levels.

Table 4. 7 Number of teachers as dependent variable

Dep. Var: *Nº teachers in public schools*	1	2	3	4	5
Effective Nº Fractions (ENF)	2.109**	1.462*	1.603**	0.286	2.274**
	(0.801)	(0.748)	(0.723)	(0.779)	(0.933)
Government Seat Margin (GSM)	-5.311**				-8.002***
	(1.959)				(2.458)
Government Political Power Index		-4.950*			
		(2.859)			
Alignment with President			-2.334		
			(3.384)		
Vote Margin				13.886	
				(14.004)	
Vote Margin x Gov. held dept				-11.119	
				(15.002)	
Gov. held dept. (dummy)				-5.283	
				(3.381)	
GSM x per. 17-31					6.167**
					(2.870)
Land Gini Index	-67.198	-73.162*	-66.583	-77.394*	-77.302
	(43.993)	(43.698)	(43.421)	(40.533)	(48.373)
Other control vars.	YES	YES	YES	YES	YES
Observations	547	548	550	442	547
R^2	0.959	0.958	0.958	0.944	0.959

Note: All columns include department and time fixed effects and a constant. All regressions include electorate, population, birth rate, primary enrolment rates, private/public school students, secondary enrolment rates, labour force participation, growth rate of tertiary labour, active population in primary and secondary activities over total and school aged people over 55. Cluster robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 4.8 presents a first difference estimation. Similar to the fixed effects (FE) method, it eliminates all unobserved effects correlated with observed variables across departments. However, the assumption in FE is that errors are not serially correlated, while the first difference estimation let them assume a random walk process (Cameron and Trivedi, 2005). The estimations show how the number of schools has changed over time in response to changes in the independent variables. In Columns 1-3 first differences are applied to the annual dataset while in Columns 4-7 regressions have been computed at the legislative term level. The results mirror the findings in Table 4.4 in terms of the direction of the influence they describe. The primary education resource allocation expanded as the number of party fractions grew and the incumbent government obtained lower levels of legislative support at the department level. The estimation strategy provides significant and negative coefficients for the incidence of land inequality when applied to the legislative-term dataset. However, inequality annual data in differences does not provide variation enough to obtain statistically significant coefficients.

Table 4.8 First difference estimation of determinants of public schooling provision

Dep. Var. *Nº of Public Schools*	1	2	3	4	5	6
D. ENF	0.515*	0.466*	0.430	0.358*	0.339*	0.411**
	(0.267)	(0.259)	(0.254)	(0.175)	(0.167)	(0.159)
D. Gov. Seat Margin	-0.535**			-0.929		
	(0.234)			(0.782)		
D. GPPI		-0.412			-1.279**	
		(0.525)			(0.457)	
D. Alignment with President			-1.119***			-0.134
			(0.322)			(0.421)
D. Land Gini Index	-0.859	0.245	-2.538	-22.812***	-23.558***	-20.257**
	(7.293)	(7.013)	(7.116)	(7.394)	(7.540)	(7.565)
Other control vars.	YES	YES	YES	YES	YES	YES
Observations	550	546	546	180	180	180
Dataset	Annual	Annual	Annual	Legis. term	Legis. term	Legis. term
R^2	0.366	0.361	0.357	0.783	0.784	0.781

Note: All columns include department and time fixed effects and a constant. All regressions include electorate, population, birth rate, primary enrolment rates, private/public school students, secondary enrolment rates, labour force participation, growth rate of tertiary labour, active population in primary and secondary activities over total and school aged people over 55. Cluster robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

To sum up, the results show that for the whole period the incumbent government tended to look to swing voter districts and opposition legislators to allocate public school funds. This rationale seemed to hide two distinct patterns when analyzing the school provision though it does not emerge so clear when considering teacher hiring (proxy of current expenditure) over time. Until the 1930s government would have targeted education spending to its core constituencies and to regions dominated by legislators from its own party. However, particularly after 1938, the tactics shifted and the departments more likely to receive education funds, all else equal, were those far apart from the president's party or with higher levels of electoral dispute. In addition, the effect of a closer race in the last election or of legislative bargains with the opposition seemed to have conducted pork barrel politics particularly in poorer regions.

Land inequality emerges as another force shaping public school expansion. The estimations support already established findings about its role on slowing down the public funding effort for primary education. Still, the impact of this variable appeared stronger in middle and high income regions than in poorer ones. In the same line, adding to previous research results, the expansion of political voice acted in favour of the supply of public schools.

Regressions also indicate that local factors were important determinants of publicly funded school provision. Hence, education spending would have been positively associated with population size,

the presence of school aged children or the diffusion of activities linked to the tertiary sector. However, variables connected to the influence of social elites (who did not depend on state to access education and already had a high education background) undermined the regional ability to obtain education resources. Though this group was not strong enough to curb political decision on school expansion (pushed by other factors), the results would reflect that those at the top of income distribution were not prone to lobby in favour of the expansion of mass education in their departments.

4.6 Conclusions

As the initial expansion of primary schooling system is largely a government outcome, it is important to identify whether pork barrel distribution has interfered in its development. Taking the Uruguayan case, this study explores the presence of tactical incentives in the allocation of primary schooling funds at the department level during the period 1914-1954. Drawing on the "distributive politics" literature, it proposes an empirical approach based on indicators about party and electoral competition. To this end, a particular dataset combining historical information about school provision, electoral and political results have been compiled.

Despite its size, Uruguay is an upper-middle income country that has been a regional pioneer in terms of social and economic development, and in the establishment of solid democratic rules. Understanding whether politics shaped the diffusion of primary schooling in this setting becomes a reasonable concern according to the strong partisan biases of local policy-making during the period and the manipulation of public resources in response to electoral competition found by the previous literature.

The results bring on a new perspective about the schooling expansion in the country. The main finding suggests that political factors have played a relevant role in schooling provision across the territory. Influences have come from all the different indicators applied: the level of party-fragmentation, the legislative bargaining process and electoral dispute. This result contends the historical literature claiming that, unlike other matters of social policy, education was not affected by political strategies. Instead, politics seems to have had a distinct impact on the government commitment to fund basic education.

Interestingly, though the incumbent government would have kept a tactical resource allocation throughout the period, the direction of the influence shifted over time. During a first phase, school provision appears as more correlated to core voters and government's party legislators. However,

from 1934 to 1954 opposition or swing voter departments were favoured in the distribution of resources. This coincides with times of higher political conflict and bargaining. In addition, the opposition reward strategy seems to have been more intense in the less developed regions.

Landownership inequality, together with the effect of variables associated to the extant levels of education and wealth, adversely affected school provision. Meanwhile, widespread political voice, the size of population and the importance of tertiary activities in the labour market favoured its expansion. In contrast to the received wisdom, these results reinforce the idea that public school funds at the local level were not evenly distributed following purely children age requirements or the directives of a complete altruistic government.

To be sure, many education policy and budget constraint aspects (not discussed here) might have been pivotal to explain the disappointing primary schooling results by the 1960s (CIDE, 1965; Otero, 1969) and the low quality and educational attainments in upper education levels in Uruguay by the end of the 20th century (Hanushek and Woessman, 2012; Aedo and Walker, 2012). Indeed, it has been posed that Latin American countries (including Uruguay) have overcommitted funds to tertiary schooling at the expense of primary education, thus slowing down the achievement of school completion in the first cycle as well as knowledge acquisition goals (Frankema, 2009; Lindert, 2010). In addition to this established literature, this study drives the attention to the effects of pork barrel politics. The extent up to which funding decisions have been affected by political tactics might well have contributed to a suboptimal provision of basic education. So much worse given that this political agenda appeared to have hit harder on the poorer regions, which were in greatest need of public compensating mechanisms.

Being mass education one of the most relevant engines of development, it is possible that political strategies might have compromised the role of schooling to alleviate persisting territorial inequalities and to gear economic growth. Hence, by introducing a stance on early schooling linked to partisan politics, the evidence provided in this chapter complements the ongoing research lines on regional development disparities in the country and raise new questions on the historical roots of Latin American backwardness. It also brings new evidence useful to think over the experience of similar countries in other world regions.

References

Aboal, D. and Calvo, D. 2000. Política y Macroeconomía en el Uruguay del Siglo XX. Thesis dissertation. Facultad de Ciencias Económicas y de Administración, Universidad de la República, Montevideo.

Aboal, D., Lorenzo, F., Moraes, J. and Oddone, G. 2003a. La Economía Política de los Déficit Fiscales en Uruguay. In Aboal, D. and Moraes, J. (eds), Economía Política en Uruguay: Instituciones y actores políticos en el proceso económico. Ediciones Trilce, Montevideo.

Aboal, D., Lorenzo, F. and Rius, A. 2003b. Política Partidaria y Política Cambiaria: La evidencia para Uruguay desde 1920. In Aboal, D. and Moraes, J. (eds), Economía Política en Uruguay: Instituciones y actores políticos en el proceso económico. Ediciones Trilce, Montevideo.

Acevedo, E.1934; 1936. Anales Históricos del Uruguay. Tomo V and VI. Casa Barreiro y Ramos, Montevideo.

Aedo, C., Walker, I. 2012. Skills for the 21st century in Latin America and the Caribbean. The World Bank, Washington, D.C.

Altman, D. Buquet, D. and Luna, J.P. 2011. Constitutional reforms and political turnover in Uruguay: winning Batlle, losing the war. Documento 2/11, Instituto de Ciencia Política de la Facultad de Ciencias Sociales de la Universidad de la República.

Ansell, B. and Lindvall, J. 2013. The political origins of primary education systems: ideology, institutions, and interdenominational conflict in an era of nation-building. The American Political Science Review 107(3), 505-522.

Anselmi, J. and Zaffaroni, J. 1941. La instrucción primaria y su régimen financiero a través de las distintas etapas de su desarrollo. Ensayo de investigación de finanzas. Facultad de Ciencias Económicas y de Administración, Universidad de la República.

Arroyo, L. 2016. The limits of the estado docente: education and political participation in Peru, 1876-1940. Revista de Historia Económica/Journal of Iberian and Latin American Economic History 34(1), 81-109.

Azar P., Bertino, M., Bertoni, R., Fleitas, S., García, U., Sanguinetti, C., Sienra, M. and Torrelli, M. 2009. ¿De quiénes, para quiénes y para qué? Las finanzas públicas en el Uruguay del siglo XX. Instituto de Economía. Editorial Fin de Siglo, Montevideo.

Beltrán, F. and Martínez, J. 2015. Land access inequality and education in pre-industrial Spain. Discussion Papers in Economic and Social History 137, University of Oxford.

Bértola, L. and Bertoni, R. 1999. Educación y aprendizaje. Su contribución a la definición de escenarios de convergencia y divergencia. Paper presented at Segundas Jornadas de Historia Económica, Montevideo.

Bralich, J. 2011. José Pedro Varela y la gestación de la escuela uruguaya. Revista Historia de la Educación Latinoamericana 13(17), 43-70.

Buquet, D., Chasquetti, D. and Moraes. J. 1998. Fragmentación política y gobierno en Uruguay: ¿un enfermo imaginario? Facultad de Ciencias Sociales: Montevideo.

Caetano, G. and Rilla, J. P. 1996. Relaciones inter-partidarias y gobierno en el Uruguay (1942-1973). Revista Uruguaya de Ciencia Política 8, 15-34.

Cameron, C. and Trivedi, P. 2005. Microeconometrics. Methods and applications. Cambridge University Press, Cambridge.

Cappelli, G. 2016. One size that didn't fit all? Electoral franchise, fiscal capacity and the rise of mass schooling across Italy's provinces, 1870–1911. Cliometrica 10, 311–343.

Case, A. 2001. Election goals and income redistribution: Recent evidence from Albania. European Economic Review 45, 405–23.

Castells, A. and Solé, A. 2005. The regional allocation of infrastructure investment: the role of equity, efficiency and political factors. European Economic Review 49, 1165-1205.

Caulier, J.F. 2011. The interpretation of the Laakso-Taagepera Effective Number of Parties. Documents de travail du Centre d'Economie de la Sorbonne.

Chaudhary, L. 2009. Determinants of Primary Schooling in British India. Journal of Economic History 69, 269–302.

Chaudhary, L. and Garg, M. 2015. Does history matter? Colonial education investments in India. Economic History Review 68(3), 937-961.

Chaudhary, L. Musacchio, A., Nafziger, S. and Yan, S. 2012. Big BRICs, weak foundations: the beginning of public elementary education in Brazil, Russia, India and China. Explorations in Economic History 49, 221-240.

CIDE, 1965. Informe sobre el estado de la educación en Uruguay. Tomo I. Plan Nacional de Desarrollo Económico y Social 1965-74, Montevideo.

Cinnirella, F. and Hornung, E. 2013. Landownership concentration and the expansion of education. Working Paper. Department of Economics, CAGE Online Working Paper Series 175, University of Warwick.

Coatsworth, J. H. 1993. Notes on the Comparative Economic History of Latin America and the United States. In Bernecker, W. and Werner, H. (eds.), Development and underdevelopment in America: contrasts of economic growth in North and Latin America in historical perspective. Walter de Gruyter, New York.

Cox, G. 2009. Swing voters, core voters and distributive politics. Department of Political Science University of California, San Diego. Unpublished manuscript.

Cox, G. and McCubbins, M. 1986. Electoral Politics as a redistributive game. Journal of Politics 48(2), 370–89.

Curto, M., Herranz, A. and Solé, A. 2012. Pork-Barrel Politics in Semi-Democracies: The Spanish "Parliamentary Roads" 1880-1914. The Journal of Economic History 72(3), 771-796.

Dahlberg, M. and Johansson, E. 2002. On the vote-purchasing behavior of incumbent governments. American Political Science Review 96, 27–40.

De la Croix, D. and Doepke, M. 2009. To segregate or to integrate: education politics and democracy. The Review of Economic Studies 76(2), 597-628.

Denemark, D. 2000. Partisan pork barrel in Parliamentary systems: Australian Constituency-Level Grants. Journal of Politics 62, 896-915.

Dixit, A. and Londregan, J. 1998. Ideology, tactics, and efficiency in redistributive politics. The Quarterly Journal of Economics 113,497–529.

Engerman, S. and Sokoloff, K. 2001. The evolution of suffrage institutions in the new world. Working Paper 8512, National Bureau of Economic Research.

----------. 2000. Institutions, factor endowments and path of development in the new world. Journal of Economic Perspectives 14(3), 217-232.

Evans, D. 2004. Greasing the wheels: using pork-barrel projects to build majority coalitions in Congress. Cambridge University Press, Cambridge.

Filgueira, F. 1995. A century of social welfare in Uruguay. Growth to the limit of the Batllista social state. Democracy and Social Policy Series, Working Paper 5. Kellogg Institute.

Filgueira, C. and Filgueira, F. 1994. El largo adiós al país modelo. Ed. Arca, Montevideo.

Filgueira, F. and Papadópulos, J. 1997. Putting conservatism to good use? Long crisis and vetoed alternatives in Uruguay. In Douglas, A., Vilas, C., Hite, K, Martin, S., Piester, K. and Segarra, M. (eds), The new politics of inequality in Latin America. Oxford.

Frankema, E. 2009. The Expansion of Mass Education in Twentieth Century Latin America: A Global Comparative Perspective. Revista de Historia Económica/ Journal of Iberian and Latin American Economic History 27(03), 359–396.

Gallego, F. 2010. Historical origins of schooling: the role of democracy and political decentralization. The Review of Economics and Statistics 92(2), 228-243.

Galor, O., Moav, O. and Vollrath, D. 2009. Inequality in landownership, the emergence of human-capital promoting institutions and the Great Divergence 76(1), 143-179.

García, M., Martínez, J. and Willebald, H. 2015. Crecimiento y estructura productiva regional en Uruguay en la primera mitad del siglo XX. Serie Documentos de Trabajo. Instituto de Economía. Facultad de Ciencias Económicas y de Administración. Universidad de la República, Uruguay.

Garritzmann, J. and Seng, K. 2016. Party politics and education spending: challenging some common wisdom. Journal of European Public Policy 23(4), 510-530.

Gao, P. 2015. Risen from chaos: what drove the spread of modern primary schooling in China in the early 20th century. Unpublished manuscript. London School of Economics and Political Science.

Go, S. and Lindert, P. 2010. The Uneven Rise of American Public Schools to 1850. Journal of Economic History 70, 1–26.

Golden, M. and Min, B. 2013. Distributive politics around the world. Annual Review of Political Sciences 16, 73-99.

Golden, M. and Picci, L. 2008. Pork-barrel politics in postwar Italy, 1953-94. American Journal of Political Science 52(2), 268-289.

González, L. 1990. Legislación electoral y sistemas de partidos: el caso uruguayo. Revista Uruguaya de Ciencia Política 4, 9-27.

Goñi, M. 2016. Landed Elites and Public Education in England and Wales. Evidence from School Boards, 1870-99. Unpublished manuscript.

Grob, U. and Wolter, S. 2007. Demographic change and public education spending: A conflict between young and old? Education Economics 15 (3), 277-292.

Hanushek, E. and Woessmann, L. 2012. Schooling, educational achievement, and the Latin American growth puzzle. Journal of Development Economics 99(2), 497-512.

Huber, E., Pribble, J. and Stephens, J. 2008. The politics of effective and sustainable redistribution. In Estache, A. and Leipziger, D. (eds.), Fiscal Incidence and the middle class: implications for policy, The World Bank, Washington, DC.

Laakso, M. and Taafepera, R. 1979. Effective Number of Parties: a measure with application to West Europe. Comparative Political Studies 12(1), 3-27.

Lanzaro, J. 2004. Fundamentos de la democracia pluralista y estructura política del Estado en el Uruguay. Revista Uruguaya de Ciencia Política 14, 103-135.

Levitt, S. and Snyder, J. 1995. Political Parties and the Distribution of Federal Outlays. American Journal of Political Science 39(4), 958-980.

Lindbeck, A. and Weibull, J. 1987. Balanced budget redistribution and the outcome of political competition. Public Choice 52,273–97.

Lindert, P. 2010. The unequal lag in Latin American schooling since 1900: follow the money. Revista de Historia Económica / Journal of Iberian and Latin American Economic History 28(02), 375-405.

---------- 2004. Growing public: social spending and economic growth since the eighteenth century. Cambridge University Press, Cambridge.

Lindhal, G. 1977. Batlle. La segunda Constitución, 1919-1933. Ed. Arca, Montevideo.

Lombardi, M. and Veiga, D. 1979. Desigualdades internacionales en el Uruguay. Informe Final CLACSO-CIESU, Buenos Aires.

Mariscal, E. and Sokoloff, S. 2000. Schooling, Suffrage, and the Persistence of Inequality in the Americas, 1800–1945. In Haber, S. (ed.), Political Institutions and Economic Growth in Latin America, 159–217. Hoover Institution Press, Stanford.

Martinez Fritscher, A., Musacchio, A., Viarengo, M. 2010. The great leap forward: the political economy of Education in Brazil, 1889–1930. Working Paper 10-075, Harvard Business School.

Martínez, J., Rodríguez, A. and Willebald, H. 2015. Regional income inequality in Uruguay during a century (1908-2008). Did the productive public policy contribute to an equalizing process? Paper presented in XVIIth World Economic History Congress "Diversity and Development", Kyoto.

Milligan, K. and Smart, M. 2005. Regional Grants as Pork-Barrel Politics. CESifo Working Paper 1453.

Mitch, D. 2013. The economic history of education. In: Whaples R. and Parker R. (eds), Routledge handbook of modern economic history: 247–264. Routledge, New York.

Monestier, F. 1999. Partidos por dentro: La fraccionalización de los partidos políticos en el Uruguay (1954-1994). In Fundación de Cultura Universitaria (ed), Los partidos políticos uruguayos en tiempos de cambio, Montevideo.

Nohlen, D. 1993. Enciclopedia electoral latinoamericana y del Caribe. Instituto Interamericano de Derechos Humanos, San José de Costa Rica.

Oddone, G. 2005. El largo declive económico de Uruguay durante el siglo XX. Phd. Thesis. Departament d'Historia i Institucions Econòmiques, Universitat de Barcelona.

Otero, M. 1969. El sistema educativo y la situación nacional. Serie Nuestra Tierra, Montevideo.

Piñeiro, R. 2004. Elección de diputados y fraccionalización partidaria en Uruguay, 1942-1999. Revista Uruguaya de Ciencia Política 14, 15-42.

Poterba, J. 1997. Demographic structure and the political economy of public education. Journal of Policy Analysis and Management 16 (1), 48-66.

Real de Azúa, C. 1964. El impulso y su freno. Ediciones de la Banda Oriental, Montevideo.

Shugart, M. and Carey, J. 1992. Presidents and assemblies. Constitutional design and electoral dynamics. Cambridge University Press, Cambridge.

Stasavage, D. 2010. Democracy and Education Spending in Africa. American Journal of Political Science 49(2), 343-358.

Stokes, S., Dunning, T. and Nazareno, M. 2013. Brokers, voters and clientelism. The puzzle of distributive politics. Cambridge Studies in Comparative Politics. Cambridge University Press.

Thorp, R. 1998. Progress, poverty and exclusion: an Economic History of Latin America in the 20th century. International Development Bank, Washington.

Vaishnav, M. and Sircar, N. 2010. The politics of pork: building schools and rewarding voters in Tamil Nadu. Unpublished manuscript. Dep. Political Sciences, Columbia University.

Varela, J. P. 1874. La Educación del Pueblo. Sociedad de Amigos de la Educación Popular, Montevideo.

Veiga, L. and Pinho, M. 2007. The Political Economy of Intergovernmental Grants: Evidence from a Maturing Democracy. Public Choice 133(3/4), 457-477.

Wallis, J. 1998. The political economy of New Deal spending revisited again: with and without Nevada. Explorations in Economic History 35, 140-170.

Wright, G. 1974. The political economy of New Deal spending. Review of Economics and Statistics 59, 30–38.

Yaffé, J., Filgueira, F. and Garcé, A. 2004. Los dos ciclos del Estado uruguayo en el siglo XX. Instituto de Ciencia Política, Ediciones de la Banda Oriental, Montevideo.

Zum Felde, A. 1967. Proceso histórico del Uruguay. Arca, Montevideo.

Zurbriggen, C. 2005. Estado, empresarios y redes rentistas durante el proceso sustitutivo de importaciones en Uruguay. El path-dependence de las reformas actuales. Phd. Thesis in Political Sciences. Universität Tübingen.

Appendix

Tabla A.4.1 Data sources

Variables (department level)	Data sources
Nº of schools (private and public) Nº of teachers (private and public) Enrolment in primary schools (public and private) Enrolment in secondary institutions (public and private)	MEC, Ministerio de Educación y Cultura. 2014. 140 años de la educación del pueblo: aportes para la reflexión sobre la educación en Uruguay. Tomo I. MEC, Montevideo. DGEa- Dirección General Estadísticas, (various years). National Statistics Yearbook, Montevideo
Births per department	
Parliament representatives by party and fraction	Asamblea General. 2006. Parlamentarios uruguayos 1830-2005, Montevideo.
Votes casts and electorate	CEU- Corte Electoral Uruguay. Data retrieved from http://www.corteelectoral.gub.uy/historial hojas de votación. Acevedo, E.1934; 1936. Anales Históricos del Uruguay. Tomo V and VI. Casa Barreiro y Ramos, Montevideo. FSS-Faculty of Social Sciences Databank. Data retrieved from http://cienciassociales.edu.uy/bancosdedatos. Nahum, B. (coord). 2007. Estadísticas Históricas del Uruguay 1900-1950. Tomo I. Departamento de Publicaciones, Universidad de la República, Montevideo. Nohlen, D. 1993. Enciclopedia electoral latinoamericana y del Caribe. Instituto Interamericano de Derechos Humanos, San José de Costa Rica.
Total Population Population by age bracket	DGEb- Dirección General de Estadística. Population and Household Census 1908 and 1963. Nahum, B. (coord). 2007. Estadísticas Históricas del Uruguay 1900-1950. Tomo I. Departamento de Publicaciones, Universidad de la República, Montevideo.
Gini Land Index	Castro, P., Pradines, V. and Riestra, V. 2012. Los determinantes del precio de la tierra en el largo plazo. Thesis dissertation. Facultad de Ciencias Económicas y de Administración, Universidad de la República, Montevideo..
Population by economic activity Labour force participation	García, M., Martínez, J. and Willebald, H. 2015. Crecimiento y estructura productiva regional en Uruguay en la primera mitad del siglo XX. Serie Documentos de Trabajo. Instituto de Economía.. Universidad de la República, Uruguay Martínez, J., Rodríguez, A. and Willebald, H. 2015. Regional income inequality in Uruguay during a century. Paper presented in the XVIIth World Economic History Congress "Diversity and Development", Kyoto.
Public primary education expenditure (countries)	UC Davis. Global price and income history group. Data retrieved from http://gpih.ucdavis.edu/Government.htm.
Total schooling years (countries)	Lee, J. and Lee, H. 2016. Human Capital in the Long Run. Journal of Development Economics 122: 147-169.

Table A.4.2. Descriptive variables

Variable		Mean	Std. Dev.	Min	Max	Observations
Nº of public schools	overall	68	25.31	21	168	N = 738
	between		21.47	30	128	n = 18
	within		14.31	25	108	T = 41
Nº of teachers in public schools	overall	152	78.90	35	483	N = 737
	between		51.08	67	300	n = 18
	within		61.28	-23	335	T-bar = 40.9
Effective Nº Political Fractions (ENF)	overall	2.39	0.80	1.00	6.00	N = 738
	between		0.37	1.81	3.12	n = 18
	within		0.71	0.85	5.27	T = 41
Alignment with President	overall	0.54	0.32	0.00	1.00	N = 738
	between		0.05	0.45	0.68	n = 18
	within		0.31	-0.13	1.09	T = 41
Government Political Power Index	overall	0.21	0.22	0.00	1.00	N = 736
(GPPI)	between		0.09	0.08	0.50	n = 18
	within		0.20	-0.29	1.04	T-bar = 40.8
Government Seat Margin	overall	0.09	0.42	-1.00	1.00	N = 735
	between		0.26	-0.32	0.61	n = 18
	within		0.33	-1.02	1.29	T-bar = 40.8
Vote margin	overall	0.16	0.12	0.003	0.60	N = 574
	between		0.082	0.057	0.35	n = 18
	within		0.093	-0.023	0.50	T = 31.8
Potential Electorate	overall	0.38	0.21	0.02	2.22	N = 738
	between		0.03	0.32	0.43	n = 18
	within		0.21	-0.01	2.17	T = 41
Population (thousands)	overall	77.78	32.55	12.44	210.32	N = 738
	between		29.66	30.38	165.40	n = 18
	within		15.08	-75.18	122.69	T = 41
School aged /people over 55	overall	2.37	0.83	0.90	5.25	N = 738
	between		0.51	1.82	3.48	n = 18
	within		0.66	1.16	4.24	T = 41
Land Gini index	overall	0.69	0.14	0.16	0.84	N = 666
	between		0.14	0.22	0.81	n = 18
	within		0.02	0.60	0.75	T = 37
Birth rate (per thousands)	overall	22.10	10.25	8.84	259.04	N = 738
	between		2.12	18.60	26.52	n = 18
	within		10.04	9.88	256.63	T = 41
Private school students/total	overall	0.06	0.04	0.00	0.20	N = 702
	between		0.04	0.01	0.14	n = 18
	within		0.02	0.01	0.16	T = 39
Secondary enrolment	overall	0.03	0.02	0.00	0.14	N = 644
	between		0.01	0.02	0.05	n = 18
	within		0.02	0.00	0.14	T = 35.7
Primary enrolment rate	overall	0.38	0.09	0.20	0.70	N = 738
	between		0.04	0.33	0.48	n = 18

Variable (cont.)		Mean	Std. Dev.	Min	Max	Observations
Primary enrolment rate	overall	0.38	0.09	0.20	0.70	N = 738
	between		0.04	0.33	0.48	n = 18
	within		0.09	0.22	0.63	T = 41
Active population in primary	overall	0.44	0.07	0.23	0.60	N = 738
activities/total	between		0.05	0.33	0.52	n = 18
	within		0.04	0.32	0.61	T = 41
Active population in secondary	overall	0.22	0.04	0.15	0.33	N = 738
activities/total	between		0.04	0.17	0.29	n = 18
	within		0.01	0.17	0.27	T = 41
Labour force participation rate	overall	0.40	0.08	0.25	0.60	N = 738
	between		0.06	0.32	0.55	n = 18
	within		0.05	0.28	0.57	T = 41
Rate of growth of tertiary labourers	overall	0.02	0.01	0.01	0.08	N = 738
	between		0.01	0.01	0.04	n = 18
	within		0.01	0.00	0.06	T = 41

Source: Table A.4.1

Table A.4.3 Panel correlations of variables

	Nº pub. schools	Nº teach.	ENF	GSM	GPPI	Alignment	Electorate	Pop.
Nº public schools	1							
Nº teach. pub schools	0.7579*	1						
Effective Nº Fractions (ENF)	0.5951*	0.4915*	1					
Government Seat Margin (GSM)	0.1139*	0.1242*	0.1618*	1				
Gov. Political Power Index (GPPI)	-0.0383	0.0123	-0.1696*	0.6239*	1			
Alignment with President	0.1318*	0.0666*	0.0114	0.3519*	0.4611*	1		
Potential electorate	0.3786*	0.1701*	0.3774*	0.1201*	-0.1087*	0.2132*	1	
Population	0.7633*	0.9739*	0.5246*	0.0944*	0.0036	0.0552	0.0970*	1
Schoold aged/people over 55	-0.3811*	-0.0796*	-0.2649*	0.1161*	0.2015*	-0.2114*	-0.7360*	-0.1024*
Gini Land Index	-0.5533*	-0.4574*	-0.2888*	-0.0697*	0.0203	0.0039	-0.1078*	-0.5773*
Birth rate	-0.1339*	-0.0274	-0.0919*	0.0690*	0.0655*	-0.1448*	-0.0264	-0.0574
Priv. School stud./total	0.2245*	0.4902*	0.3310*	0.0157	-0.046	-0.0123	0.0102	0.5498*
Sec. enrolment rate	0.4694*	0.6611*	0.3872*	0.1811*	-0.0284	0.1926*	0.5283*	0.5793*
Prim. enrolment rate	0.5370*	0.4781*	0.3399*	0.2041*	-0.0272	0.2235*	0.6485*	0.3715*
Pop. prim. act./total	-0.5726*	-0.7883*	-0.4420*	-0.2648*	-0.0442	-0.1464*	-0.2268*	-0.7460*
Pop. sec. act./total	0.4170*	0.6355*	0.3274*	0.2197*	0.0805*	0.033	-0.0824*	0.6294*
Labour force participation rate	0.3612*	0.6297*	0.2168*	0.2385*	0.1325*	-0.0676*	-0.2489*	0.5518*
Rate of growth of tertiary labour	-0.1047*	-0.0275	-0.1324*	0.1038*	0.1374*	-0.1800*	-0.5379*	0.0062
Vote Margin	0.1281*	0.2454*	0.1838*	0.4558*	0.3036*	0.0951*	0.1426*	0.1942*

* indicates significance at 10% level and lower.

Table A.4.3 Panel correlations of variables (cont)

	School aged /+ 55	Gini Index	Birth rate	Priv. sch/. total	Sec. enroll. rate	Prim. enroll. rate	Pop. prim. act./total	Pop. sec. act./total	Labour force part. rate	Growth tert. labour
School aged/people over 55	1									
Gini Land Index	0.2840*	1								
Birth rate	0.3832*	0.0225	1							
Priv. school stud./total	0.038	-0.0441	-0.0075	1						
Sec. enrolment rate	-0.3635*	0.1740*	-0.0785*	0.4166*	1					
Prim. enrolment rate	-0.5851*	-0.0512	-0.2143*	0.2322*	0.7295*	1				
Pop. prim. act./total	0.2348*	-0.0981*	0.0841*	-0.6986*	-0.7010*	-0.6110*	1			
Pop. sec. act./total	0.0496	-0.1335*	0.0058	0.7650*	0.3610*	0.2957*	-0.8385*	1		
Labour force part. rate	0.5425*	-0.2112*	0.2534*	0.6385*	0.2524*	0.0878*	-0.4308*	0.6299*	1	
Growth tert. labour	0.5096*	-0.4009*	0.3267*	0.1000*	-0.4214*	-0.3369*	0.1708*	0.1624*	0.4558*	1
Vote Margin	0.1119*	-0.0761*	0.1040*	0.1275*	0.3583*	0.2730*	-0.3674*	0.2967*	0.3564*	0.0106

* indicates significance at 10% level and lower

Chapter 5

Conclusions

"If you are planning for a year, sow rice; if you are planning for a decade, plant trees; if you are planning for a lifetime, educate people."
Chinese proverb

This dissertation examines public education spending and its outcomes from different perspectives. It considers the efficiency with which public outlays are translated into educational results (Chapter 2); the economic impacts of tertiary education attainments given the structure of the resource allocation and of skills (Chapter 3) and finally, the effects of the tactical distribution of spending on schooling provision (Chapter 4). This concluding chapter summarizes the main findings of the three studies and the implications gathered from the thesis

Over these three chapters the research work delved into questions like: how (and why) public resources are translated into valued educational outputs? Why do some countries obtain more benefits from education spending than others? What drives policy makers to prioritize education spending? Hopefully, the results obtained in this thesis can provide some hints to build up answers to those questions.

The efficient allocation of resources in education has received an increasing attention during the last years. The idea that there is substantial room to improve education performance without expanding resources has often emerged as a recurring argument. However, Chapter 2 finds that the risks of a resource misuse in relation to education attainments have tended to decrease over the period 1970-2010. In fact, considering both developed economies and LACs, spending inefficiencies appear to have been high until 1990 but not so much thereafter. This result is in line with the progress of economic globalization that emerges as one of the most important determinants of spending efficiency. Conversely, more democratic settings have tended to harm the efficiency achievements.

Furthermore, by the end of the period, the most efficient countries are found among the Latin American members of the sample, which are also the lowest spenders. In their case, being the best performers would be associated to a "squeezing efficiency" pattern, which implies that they were able to make the most from relatively low education outlays.

In Chapter 3 the focus turns to the productivity impacts from higher education attainments in developed and upper-middle income countries. It considers the skill profiles that higher education produces and the resources it absorbs at the expense of primary education. Despite the theoretical consensus about the benefits from tertiary education, it is also identified as an elitist and regressive outlay. Contesting this view, this study finds tertiary educated significant to accelerate economic growth and technical change and to account for cross-country differences in the level of income. However, this positive effect on income and technological progress is reduced when the budget resource allocations are too skewed towards tertiary education, something that is particularly serious in LACs.

On the other hand, the politics of skill formation also affects the macroeconomic returns from tertiary education. The estimations presented in the chapter suggest that there are good reasons to promote the rise in the share of students enrolled in the fields of sciences and technology, which has remained around 9% in the countries analysed. Their positive effects on economic growth and output emerge even though the sample includes LACs, where the quality of tertiary education appears as comparatively lower.

Finally, Chapter 4 assesses the extent up to which political factors affects the spatial distribution of public primary education spending, taking Uruguay during the first half of the 20th century as case study. The research relies on the "pork barrel" literature about the tactics of the incumbent government. The results of the analysis contradict the national rooted belief about the immunity of education policies to any misallocation of public resources due to electoral goals. According to the estimates, the main impacts of politics on spending allocation have come from the need of governments to persuade legislators from the opposition or from swing-voter departments. This influence seemed to have been particularly intense in periods of higher political conflict.

Together with political motivations, the expansion of primary education was also favored by the extension of political voice and an increasing share of tertiary labor market activities. In contrast, social and wealth inequality adversely affected school provision, even in the self-conceived "highly egalitarian" Uruguayan society. From a regional perspective, the results point to a possible source of long-term distortions in LACs' education spending.

So far, this set of results bear some significant implications, particularly when thinking about the development puzzle of LACs *vis-à-vis* other countries at the beginning of the 21st century. First, there are reasons to contend claims about the effectiveness of efficiency improvements if they are pursued in low spending settings. In these countries, policies oriented to expand the access to formal education keeping budgets unchanged might lie behind serious deficits in

quality records. Besides, inefficiency is not necessarily linked to spending increases, as shown by some of the richest European countries.

Secondly, beyond budget constraints, the resource distribution among education levels also matters for economic growth. The productivity opportunities lost due to low investment at basic education levels are not made up for with more tertiary spending. On the other hand, the type of higher education skills promoted by this public outlay critically affect the size of higher education positive spillovers, both at countries that generate the new technologies and at those which adapt them. Finally, it is important to consider the degree to which public policy decisions on education are exposed to partisan politics. Political factors might be an important piece to understand why education spending decisions lead to suboptimal educational outcomes.

As a whole, all these different policy implications share one common feature. Hence, consolidating a virtuous cycle between efficiency and spending levels, getting a more balanced education resource structure and limiting the political use of education funding, are finally linked to a better quality of government institutions. In particular, reforms aimed to improve public accountability mechanisms, generate information transparency and ease the disclosure of financial data, are critical for a good operation of educational policies.

Many issues related to the three studies presented here are left for further research. Education efficiency might be computed at different academic levels (particularly at the tertiary level) and can help to explain measures of education quality or attainment. Besides, much needs to be learnt about the characteristics of the political elite involved in the decisions on education budget allocation. The literature has suggested that high quality policymakers are more likely to implement growth-promoting macroeconomic policies (Besley, 2005). The underlying assumption is that highly educated leaders are more prone to act in the public benefit (Besley and Coate, 1997; Osborne and Slivinski, 1996; Besley et al., 2011). On the other hand, inefficient public spending or a suboptimal distribution of educational expenditure can also be attributed to the characteristics of public employees (Bai and Wei, 2001). It would be interesting to explore to what extent the quality of bureaucracy can influence the efficiency of education resource allocation. Lastly, a deeper analysis into the historical patterns of schooling diffusion across the Uruguayan territory might provide new insights to understand important development challenges of the country like its current educational outcomes, the persistence of inequality in regional development or its productivity performance (Maloney and Valencia, 2014; Chaudhary and Garg, 2015).

References

Bai, C.E. and Wei, S. 2001. The quality of bureaucracy and capital account policies. World Bank Working Paper Series 2575, Washington.

Besley, T. 2005. Political Selection. Journal of Economic Perspectives 19(3), 43-60.

---------- 2004. Paying Politicians: Theory and Evidence. Journal of the European Economic Association 2(2), 193-215.

Besley, T. and Coate, S. 1997. An Economic Model of Representative Democracy. The Quarterly Journal of Economics 112, 85–114.

Besley, T., Montalvo, J. and Reynal.Querol, M. 2011. Do educated leaders matter? The Economic Journal 121, F205-F227.

Chaudhary, L. and Garg, M. 2015. Does history matter? Colonial education investments in India. Economic History Review 68(3), 937-961.

Maloney, W. and Valencia, F. 2014. Engineers, innovative capacity and development in the Americas. IZA Discussion Paper 8271.

Osborne, M. J., and Slivinski, A. 1996. A Model of Political Competition with Citizen- Candidates. The Quarterly Journal of Economics 88, 2423–2445.