Redistribution Through Education: The Value of Public Education Spending

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ABSTRACT

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JEL Codes: I26, I28, I22, J31

Keywords: Public Spending, Education, Incidence Analysis, Inequality.

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The Value of Public Education Spending

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Abstract

This chapter assesses how publicly funded education affects the income distribution. It discusses and compares different approaches to measuring the consequences of government education spending. The empirical quantification of the private returns to education, the estimation of the elasticity of school enrollment to public spending in the sector, and the identification of age-earnings profiles are the building blocks of the analysis. The methods are implemented using aggregate level data and cross-sectional household surveys from Chile and Ghana. Real-world data limitations are taken into account. From the country comparison, we identify differences in how families demand education, how labor markets "value" human capital, and how public initiatives might shape income inequality and poverty. The analysis illustrates the extent to which conventional incidence analysis informs about the distributional effects of fiscal expenditure on education.

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1 Introduction

Education can be a powerful policy instrument to redistribute resources. On the one hand, by equipping individuals with relevant abilities and skills, human capital policies affect future poverty and inequality (Heckman and Krueger, 2005). On the other, as an in-kind benefit or monetary transfer (voucher), education shapes the way in which governments mold income distribution in the short-run (Lustig and Higgins, 2017). This explains the fiscal relevance of the sector all around the world. OECD countries spend on average more than 6 percent of gross domestic product on education services and their global contribution to government expenditure has risen steadily during the last decades (4.9 percent in 2014 relative to the 3.9 percent reported in 2000). The potential redistribution effects of these efforts are the result of a simple and general economic logic: governments collect revenues from taxes, which are then allocated to different spending categories including in kind-transfers such as education.

The conventional fiscal incidence analysis assesses the point-in-time impact of these actions. In particular, by comparing the pre- and post-fiscal income distributions a long-standing literature in public economics has characterized the impacts of the fisc (Musgrave, 1959). For example, using this approach, Lustig (2015) documents the contribution of public spending on education (and health) to the reduction in inequality across countries in Africa, Asia and Latin America. Likewise, Younger et al. (2017) show for Ghana that two-thirds of the reduction in the Gini from consumable to final income, a comparison highlighting the effects of public expenditures, can be attributed to education benefits. Acerenza and Gandelman (2017) report large Gini coefficients for household private educational spending for 12 Latin American and Caribbean countries (2003-2014). However, once public spending on education is considered, the Gini coefficients in educational spending fall significantly.

This chapter presents a general fiscal incidence analysis of public education spending. In doing so, the text makes several contributions. First, it describes and compares two methodologies for the estimation of the economic impact of public spending. Second, when it comes to empirical implementation, it takes into account some of the real-world data limitations that

characterize the evidence in this field. Third, it goes beyond the static "accounting" approach, which adds/subtracts to pre-fiscal income the transfers/taxes each individual or household receives/pays at a specific time, and investigate the potential behavior and dynamic responses to public spending. Finally, it implements the methods and presents new empirical evidence for Chile and Ghana.

The selection of Chile and Ghana is not incidental. While the south american country is the region's most successful case of economic and social development, the african nation has consolidated its democracy becoming one of the most promising economies in its continent. Nonetheless, when it comes to continuing and extending socio-economic progress both countries face significant challenges. With a per capita GDP of US$22,707 (2016, PPP in constant 2011 international dollars), a poverty headcount ratio at $1.90 a day (2011 PPP) of 1.3% (as proportion of population), gross enrollment rates in primary and secondary education reaching 100%, Chile has been actively promoting access to higher education as a mechanism to reduce its high and stable income inequality. On the other hand, with a per capita GDP of US$3,980 (2016), and enrollment rates in secondary and tertiary education of 60% and 16%, respectively, and gross enrollment rates in primary schooling in excess of 100%; Ghana has continued strengthening efforts towards improving schooling attainment starting with secondary schooling. Thus, the cross country comparison allows us to identify differences in how families demand education, how labor markets value human capital, and how public initiatives might shape income inequality and poverty given different levels of economic and social development.

Despite the advantages of a general framework, this chapter does not circumvent the natural complexities of educational systems. They adjust and evolve with political and socioeconomic conditions as well as societal needs, altering the impact of government spending. As such, understanding and quantifying the allocation of public resources within the education sector becomes critical. For instance, it has been largely argued that investing in early stages, i.e. pre-school, pays off more in the long-run than, for example, expanding coverage of other levels of education (García et al., 2016). Indeed, the recent evidence analyzing the association between education spending and individuals' long-term outcomes confirms this ra-

tionale (Chetty et al., 2011). In this context, the conventional fiscal incidence analysis must be extended to fully characterize the impacts of these efforts.

To shed light on this matter, this chapter investigates the potential returns of public investments on human capital formation considering three interconnected elements: the impact of fiscal spending in education on redistribution, the relative efficiency in the use of sectoral resources across schooling levels, and the effects of different education policies on individuals' future income. These elements also constitute the building blocks of the new evidence presented herein, which relies on the estimation of the effect of public spending on educational attainment, the estimation of the elasticity of school enrollment to public spending, and the identification of age-earnings profiles.

On empirical grounds, the text explores the extent to which conventional sources of information provide a conducive landscape for carrying out fiscal incidence analysis of education spending. To this end, we exploit cross-sectional household surveys and aggregate oficial data for the two above-mentioned countries. The evidence generated from the three approaches is then critically examined in light of the data available.

The first methodology mimics the conventional accounting framework. It utilizes the monetary value of education services at different schooling levels as inputs for estimating the redistributive effect of public spending. In the spirit of the literature, this approach abstracts from potential behavioral responses and dynamic considerations. This is not true, however, of the other two alternatives. They both incorporate the effect of public spending on enrollment rates at different schooling levels, providing a different perspective to the incidence analysis. The second method relies on aggregate information, whereas the third one uses individual-level data to estimate the effect of an increase in public spending on education through a direct cash transfer to families. We estimate the effect of additional financial resources on student progression through the education system. In the context of the third method, using estimated age-earnings profiles associated with different schooling levels, we simulate the impact of a permanent income shock (e.g. government subsidy) on schooling attainment and income. In this way, we define the long-term effects of public policies aimed at increasing school attainment

and expanding education coverage on poverty and inequality.

The paper is organized as follows. Section 2 introduces the conceptual framework and describes the empirical strategy and the sources of information. Section 3 motivates the empirical analysis, highlighting the differences and similarities between Chile and Ghana. Section 4 presents the main results and Section 6 concludes.

2 Conceptual Framework

This section introduces some considerations and basic concepts regarding the incidence analysis of education spending. Let's begin by assuming individuals can either study or work, but cannot do both activities at the same time. As a student, each individual receives non-labor income Y_0, pays taxes T, and receives monetary transfers from the government B. To a large extent, primary, secondary and even tertiary students do not directly bear the private costs of education. School supplies, books, co-payments and tuition-fees are commonly paid for using resources from working parents or other relatives. Thus, her disposable income Y_D is defined as $Y_0 - T + B$, while her final income, Y_F, includes the monetary value of in-kind transfers from the government (E_G) or private sources (E_F).

For workers, on the other hand, market income Y_M combines net labor income $Y_L(1-s)$, where s denotes the social security contribution rate, and non-labor income Y_0.[1] In this case, disposable income is defined as Y_M plus monetary transfers B minus taxes T. Finally, assuming the absence of other in-kind transfers and abstracting from consumption subsidies and taxes, final income Y_F equals disposable income minus private contributions to education τ. Table 1 defines market, disposable and final income for students and workers.

What are the re-distributional benefits of in-kind publicly-funded education? Lambert's *fundamental equation of the redistributive effect* comes in handy to address this question (Lambert, 1993). His formulation delivers a mathematical expression linking the changes in the distributions of income resulting from general fiscal efforts with the redistributive effects of

[1] Consistent with the CEQ Assessment, s can include contributions to old-age pensions if contributory pensions are treated as transfers.

taxes and transfers. In particular, using Lambert's original notation, the net fiscal incidence progressivity (Π_N) arising from the comparison of the distributions of market and final income can be expressed as:

$$\Pi_N = \frac{(1-g)\Pi_T + (1+b)\rho_B}{(1+b-g)}, \tag{1}$$

where Π_T and ρ_B measure the progressivity/regressivity for T and B when applied separately to the original income, respectively; g is the total tax ratio (total taxes over original income) and b is the total benefit ratio (total benefits over original income). Thus, regardless of whether progressive or regressive taxes are in place to fund education, it is intuitive to think of E_G as a progressive transfers shaping ρ_B such as it benefits more poor and middle-income households, particularly when the alternative of 'free' public education is available.[2] This chapter explores this framework but taking into considerations the features that make public spending in education distinctive relative to other fiscal efforts.

Individuals invest in human capital to build a better future. Thus, the full economic and social impacts of one dollar spent on education are only realized many periods in the future. This inter-temporal connection represents a challenge for the standard fiscal incidence analysis formulation as it is usually carried out at a point-in-time rather than over the lifecycle (Lustig and Higgins, 2017). We revisit this issue throughout the text.

3 The Value of Public Education Spending to Its Beneficiaries

At least two approaches have been pursued in the economic literature to quantify the value to the beneficiaries of public subsidies assisting the consumption of in-kind services. The first one uses the market value (prices) to directly capture the individual's own valuation (Aaron and McGuire, 1970). The second alternative, known as benefit incidence analysis, is more closely

[2] This expression implies that, given the dominant role of ρ_B (its associated weight is greater than one), even with regressive taxes ($\Pi_T < 0$), "the net system exhibits more progressivity than regressive benefits alone ($\Pi_N > \rho_B > 0$)" (see Lambert, 1993, pp. 259). This result highlights the inherent association between redistribution, taxes and benefits.

connected to the analysis of this paper. By combining information on costs and utilization of the goods (Selowsky, 1979), the benefit incidence approach imputes the value of the unit subsidy (provision cost) to the relevant consumers (who receive in effect an in-kind transfer) and, in this way, seeks to estimate the total subsidy as share of household expenditures. Castro-Leal et al. (1999) have followed this approach for example to provide insights into the historical problems faced by African governments in delivering essential social services, including education, to vulnerable households. Using data from Brazil, Soares (2018) compares the distribute impact of education as captured by the cost of provision and market approaches, reporting that both yield similar estimates.

From a static perspective, identifying the source of educational funding plays an important role in understanding the incidence of education spending within the income distribution. The main consideration in the static framework is the importance of discounting out-of-pocket fees and tuition expenses from the income of families contributing to the education of their children beyond mandatory taxes for funding public education. While the conventional benefit incidence analysis is both empirically appealing and informative, it needs to be extended to estimate the overall value of public spending, which depends on the costs and private rates of returns to education, and, of course, the demand for the service. We first study the latter ingredient from two different angles.

3.1 Cost of provision as a proxy for benefits

The cost of public provision approach is the simplest method to approximate the monetary value of education services. Let Δ_s be the cost to the state of providing publicly-funded education in school level s with $s = \{1, ..., S\}$. Information leading to the estimation of Δ_s is commonly available at different aggregation levels (e.g. municipality-level per student public expenditure).[3]

In the spirit of this framework, total final income within the household becomes $Y_F =$

[3] An alternative strategy for estimating Δ_s could exploit information on tuition costs from private schools. In this case, however, the analysis must control for potential differences in the production function of education services across provider types (Soares, 2018).

$Y_D + \sum_s \delta_s \times n_s$, where n_s denotes the total number of students in level s attending public schools. Thus, the direct comparison of distribute statistics obtained under Y_F and Y_D (e.g., the Gini coefficient or ρ_B) could inform about the fiscal incidence of education.

As Soares (2018) discusses, despite its conceptual simplicity and modest data requirements, the cost of provision approach deflects some of the complexities associated with standard welfare analysis. For instance, the obvious concerns regarding the distributional consequences of its sources of funding (taxes) are dismissed. In addition, it does not allow for the creation or destruction of welfare, behavioral responses or general equilibrium effects. In addition, whether Δ_s reflects marginal or average costs might be critical for the analysis. This comes as a no surprise as this strategy does not aim at constructing the true counterfactual distribution of final income but instead is sought to provide a first-order approximation to the incidence of in-kind transfers (Younger, 2018). However, as we show next, addressing the shortcomings of the cost of provision approach is not an easy task.

3.2 The market value of education

Governments promote school enrollment by increasing funding allocated to the education sector. Families, in turn, respond by sending more children to schools and keeping them enrolled in school for a longer time period. For individuals, the benefits of this efforts become apparent years later. This section introduces an strategy for the estimation of the value of public education services and its fiscal incidence allowing for behavioral responses to in-kind education transfers in a dynamic context. Conceptually, its two core ingredients are the elasticity of human capital investments with respect to the value of the public transfer (the demand for education) and the long-term impact of education on labor market outcomes.

Behavioral responses to public education. Let p_s be the probability of enrolling in schooling level s given that $s-1$ was completed, and E_s represents the value of publicly-funded education for level s. Given the sequential nature of education, the probability of attending at least schooling level $s+1$ (or the survival function), ξ_{s+1}, and the probability of reaching $s+1$

(and stopping there), q_{s+1}, can be defined as:

$$\xi_{s+1} = \prod_{j=0}^{s+1} p_j, \tag{2}$$

$$q_{s+1} = (1 - p_{s+1}) \prod_{j=0}^{S} p_j. \tag{3}$$

Using this definition, we can approximate the impact of public spending on the demand for education. Specifically, from the empirical assessment of these two probabilities, we can estimate the behavioral response to education spending.

Since behavioral responses drive the empirical association between enrollment levels and public expenditure over time, $\left\{ \frac{\partial p_j}{\partial E_j} \right\}_{j=0}^{s+1}$ can be identified from aggregate time series data. Fortunately, the microeconomic foundations of discrete decision models extents the empirical frontiers. To see this, let's assume schooling decisions are made considering the relative benefits and costs of the different alternatives. Thus, if we let U_s be the associated indirect utility of schooling level s given that $s-1$ is completed, an individual should enroll/complete s as long as $U_s \geq 0$, which implies that $p_s = \Pr[U_s \geq 0]$ for all s.

In general, a large set of observed and unobserved characteristics can determine I_s, including the value of the transfers E_s.[4] This would be consistent with an economic framework in which public education spending determines individual or collective budget sets (e.g., via direct monetary or in-kind transfers to families). And despite the fact that the functions U_s and $\Pr[\cdot]$ are ex-ante unknown, standard parametric specifications, in combination with individual-level information, can be imposed for practical purposes leading to their estimation and construction of the expression:

$$\frac{\partial q_{s+1}}{\partial E_{s'}} = \frac{\partial \Big[(1 - \Pr[U_{s+1}(E_{s+1}) \geq 0]) \prod_{j=0}^{s} \Pr[U_j(E_j) \geq 0] \Big]}{\partial E_{s'}},$$

[4] The set of dimensions to be controlled for when modeling this probability should include variables characterizing individual's preferences for education (tastes) (Keane and Wolpin, 1997a) as well as controls capturing labor market prospects (Willis and Rosen, 1979) and financial constraints (Becker, 1962).

where $s+1 \geq s'$. This expression captures the strategic responses of individuals to educational spending, which can be linked to individual-level willingness to pay for education (as public spending increases). It can be easily extended to allow for heterogeneous responses to changes in E_s. This might be particularly important if, for example, the objective is to identify those who benefit the most from policy efforts in a specific schooling level.

Education and labor markets. In a dynamic context, a careful analysis of the association between human capital accumulation and labor income should lie at the core of the fiscal incidence of education spending. Higher levels of human capital produce better future labor market outcomes. This empirical regularity should lean parents towards more and better education services today. However, if the supply of such services is not guaranteed, upward socio-economic mobility would be limited and income distribution of future generations transformed. Second, to the extent that public provision of education depends upon taxes and transfers across generations, a comprehensive analysis of the its incidence should include inter-generational considerations.

Figure 1 shows the causal chain of a dollar that enters the education system. In a nutshell, economic resources allocated to schooling level s, E_s, can be conceptualized as inputs determining investment levels, $I(s)$, which then affect individuals' attained human capital and future labor market opportunities. This is the logic outlined in the previous section. In what follows we discuss the long-term economic impact of an extra fiscal dollar spent in schooling level on labor income.

As is standard in the literature, we first let labor income $Y_L(\cdot)$ be determined by the stock of human capital (e.g., years of education or s) and labor market experience (t). The present value of income stream (given s), $V(s)$, which encapsulates the sequence of earnings through retirement T, is a construct commonly used to approximate the monetary value associated with schooling level s. Formally,

$$V(s) = \int_s^T Y_L(s, \tau - s) d\tau$$

where $Y_L(s, \tau - s)$ includes the discount factor. From this expression we can define the benefits of an increase in education spending, which as described in Figure 1, should operate through two interconnected channels: extra human capital investments and a boost on labor market productivity. Hence, from (4) we obtain:

$$\frac{\partial V(s)}{\partial E_s} = \int_s^T \frac{\partial Y_L(s, \tau - s)}{\partial s} \times \frac{\partial s}{\partial E_s} d\tau - Y_L(s, 0) \frac{\partial s}{\partial E_s}, \tag{4}$$

where $\partial Y_L(s, \tau - s)/\partial E_s$ represents the effect of human capital on earnings, $\partial s/\partial E_s$ captures how schooling decisions depend on public transfers, while the last term comes from the impact on the age at first employment. The estimation of these terms represent a heavy burden to bear as it involves modeling the underlying schooling decision problem letting to expressions (2) and (3). In spite of the fact the econometric tools for doing this exist, data limitations usually prevent it. Section 4 below describes a feasible alternative.

But of course, the accumulation of human capital involves monetary and non-monetary (psychic) costs, which must be considered when defining the value of education. Importantly, some of these can be alleviated by public spending. Thus, if $C(s)$ denotes the total costs, the net value of schooling level s is $\widetilde{V}(s) = V(s) - C(s)$, where $\partial C(s)/\partial E_s \neq 0$.

The inter-temporal distributional effects of public spending in education. From the general definition of the economic net benefits attached to s we can assess the dynamic distributional consequences of public spending in education.

Let $G[\cdot]$ be the inequality indicator of interest. Thus, for a given population of N individuals with idiosyncratic net values of education $\left\{\widetilde{V}_i(s)\right\}_{i=1}^N$, we can construct:

$$G = G\Big[\left\{\widetilde{V}_i(s)\right\}_{i=1}^N\Big].$$

By combining this expression and equation (4), we can quantify the inter-temporal impact of changes in educational spending on income inequality from $\partial G/\partial E_s$. Notice this generalizes the static approach based on the study of $G\Big[\{Y_{D,i}(s)\}_{i=1}^N\Big]$.

This analysis, however, does not consider the fact that schooling decisions are made under uncertainty and that, at any point in time, future labor market outcomes are unknown to the agent. To incorporate this into the framework, we define $\mathbb{E}[\widetilde{V}]$ and $\mathbb{E}[\widetilde{V}(s)|s]$ as the unconditional and conditional (on s) expectations of $\widetilde{V}(s)$, respectively. Thus,

$$\mathbb{E}[\widetilde{V}(s)] \quad = \quad \sum_{j=0}^{S} \mathbb{E}\left[\widetilde{V}(j)\Big| j \text{ is selected}\right] \times q_j. \tag{5}$$

where q_j is defined in (3). Equipped with proper data, econometric models can deliver each of the elements of this expression. In that case, we could construct $G\Big[\left\{\mathbb{E}[\widetilde{V}_i(s)]\right\}_{i=1}^{N}\Big]$ and its derivative with respect to E_s, which would now characterize the impact of public education spending on inequality under uncertainty.

Empirical caveats. Despite its theoretical simplicity, the empirical implementation of this framework conveys multiple challenges. First, the setting implicitly assumes the availability of rich longitudinal information containing data on earnings (lifetime), schooling progression, monetary and non-monetary costs of education by schooling level, among other variables. Such data is rarely available.

Second, and now on econometric grounds, constructing (5) (and any of its special cases) would involve the estimation of earnings profiles taking into account the self-selection of individuals across different schooling levels. Although there is a long-standing literature dealing with the estimation of the hedonic models in education controlling for its endogeneity, the vast majority of those efforts comes from reduced-form strategies, which omit the dynamic nature of the schooling decision process.

The empirical approach described next overcomes some of these difficulties. It is designed for settings in which longitudinal information is not available, but the researcher has access to cross-sectional data from a population-based study. This information is complemented with information on monetary costs of education and taxes. The strategy to generate individual-level streams of future earnings uses flexible versions of the Mincer model (Mincer, 1974). The next sections describe this framework, which is applied to Chile and Ghana.

4 Why Chile and Ghana?

Africa and South America are at different levels of economic and social developments. As Figure 2 shows, the average GDP per capita in Africa in 2014 was just above US$5,000 (PPP), the average for South America in 1990. However, despite the differences, both regions have heavily bet on human capital formation as a determinant of sustainable economic progress. This explains the upward trends in government expenditure on education observed during the last decades. According to UNESCO, from 1999 to 2013, government expenditure on education as percentage of GDP increased from 3.4% to 4.5% in Sub Saharan Africa (it reached 4.47% in Middle and East Africa), while in Latin America and the Caribbean went from 3.84% to 5.21% during the same period. These efforts have significant effects on school enrollment. For instance, between 1999 and 2016, gross enrollment in primary education in Ghana increased from 81% to 108%, and in secondary education from 35% to 62%. Likewise, gross enrollment in secondary education during this period in Chile went from 83% to 100%, whereas enrollment in tertiary education increased from 37% to 88%. Thus, during the last two decades, public efforts in the education sector resulted in higher enrollment rates throughout the whole schooling system.[5]

The high correlation between labor income and years of education have played a key role supporting the political and economic agenda. Figure 3 presents the Mincerian return to an extra year of education for countries from Africa and Latin America during the period 1990-2012 as reported by Montenegro and Patrinos (2014) (see Section 3 for a description of Mincer model). In both cases the estimated returns are high, reaching averages of 10% and 13% per year of education over the period for Latin America and Africa, respectively. Interestingly, while the returns are almost constant in the former, the figure suggests an upward trend for the latter region.

But focusing on the average association between years of education and labor income might overlook potential non-linearities describing the economic consequences of human capital formation on labor market productivity. Heterogeneity in the population (e.g., preferences

[5] According to UNESCO, Government expenditure on education in Chile increased from 2.6% (1994) to 4.6% (2013). For Ghana, it went from 4.1% (1999) to 6.1% (2013).

or endowments), direct and indirect costs, human capital depreciation, the economics of skill formation, signaling mechanisms, are all factors that could explain why, for example, one extra-year of education in primary, secondary or tertiary school impact labor market outcomes in different ways (Heckman et al., 2006) Figure 4 examines this hypothesis. It decomposes the returns to education on labor income by schooling level (primary, secondary and tertiary) for the period 1997-2012. Panels A and B presents the results for Africa and Latin America, respectively. For both region, the largest economic benefits are associated with tertiary education, whereas secondary and primary education "produce" relatively lower contributions.[6]

Table 2 displays the Mincerian returns to education by schooling level in Chile and Ghana for 1991, 2005 and 2011. In the case of primary education, they decreased during the last decade in both countries. For secondary and tertiary education, the returns increased in Ghana and, although remained high, both decreased in Chile. Overall, these results could justify the notion that public efforts should largely concentrate on promoting access to tertiary education. This, however, would represent a limited perspective. Perhaps in countries with already high enrollment rates in primary education, focusing on secondary and tertiary education might be economically appealing. Nonetheless, it is not obvious that expanding access to schooling levels which exhibit lower enrollment is socially optimal. For example, a number of papers in developing economies have shown that the returns to tertiary education may be low, or even negative, if the expansion does not come along with proper quality standards, nor takes into account the costs and dynamic consequences of the process (Urzúa, 2012; Espinoza and Urzúa, 2016; González-Velosa et al., 2015).

The evidence described next sheds lights on this reasoning. By comparing the cost of providing education with the earning trajectories of students that benefit from a higher spending, we assess the impact of public spending at different education levels. The analysis exploits the differences between Chile and Ghana.

[6]The results also suggest that behind the constant average return to a year of schooling presented in Figure 3, Latin America experienced during this period a downward trend in the average returns to tertiary education. For an analysis of the factors explaining the decreasing returns to tertiary education in Latin America and the Caribbean see Ferreyra et al. (2017). For Africa, Montenegro and Patrinos (2014) reports unstable returns to primary education and increasing returns to tertiary education.

4.1 Data Sources

The implementation of the conceptual frameworks described above require micro-level information on multiple dimensions, ranging from variables describing individuals schooling background to labor market outcomes. In addition, this information must be complemented with data on, for example, public costs of education across different schooling levels.

Our main sources of information are household surveys in Chile and Ghana. We rely as much as possible on these sources in order to facilitate the replicability of the methodology in other countries where similar surveys are available (for Brazil see Soares, 2018). More detailed information, for instance, on the duration or tuition of different academic programs comes at the cost of replicability. Given the highly heterogeneous quality of data sources across countries, household surveys provide a more unified and consistent source to compare the results across different economies. We also use the UNESCO Education database, which contains aggregated data on a number of education indicators, such as public spending in education, enrollment rates and learning indicators.

Chile. The primary dataset we use for Chile is the household survey CASEN 2013. CASEN is a nationally representative household survey run by the Chilean Ministry of Social Development, covering 66,725 households. CASEN has been extensively used to monitor and evaluate the impact of social policies and to measure outcomes such as poverty, inequality as well as issues related to health and dwelling conditions. It contains education and labor modules that provide information on the highest level of education attained, the type of institution attended (private or public), labor market experience and earnings. The survey is taken every two years. We use its 2013 version, which coincides with the year of the household survey from Ghana. We also gather data from the OECD (OECD, 2013) on average cost of attending primary, secondary and tertiary education in Chile, as well as the fraction of the cost that is shared by the state and families.

Ghana. Our main data source in Ghana is the Ghana Living Standards Survey (GLSS) 2012-2013 (round 6). The GLSS is part of an international project, the Living Standard Measurement

Study (LSMS), which was initiated in 1980 by the Policy Research Division of the World Bank. We use the sixth version of the GLSS, which was run by the Ghana Statistical Service agency and covers 18,000 households. This sample is the same utilized by Younger et al. (2017) in their investigation of the fiscal incidence in this country. The GLSS is nationally representative and provides household information on a number of relevant issues, including household consumption, educational attainment, access to financial services, economic activity, and migration, among others. The GLSS education module provides information on the educational history and final attainment of respondents, and also on private expenditures in education, including fees as well as other expenses. We also use data on aggregate education statistics, such as number of schools and total enrollment across different levels from the Ministry of Education of Ghana.

Educational Attainment Levels. Optimally, the analysis should be carried out by year of additional education. However, given the sample sizes, this would put too much weight on the empirical strategy. Therefore, we classify instead the levels of education according the following criteria:

1. Primary: In Chile, primary education comprises eight grades and a representative student enrolls at age 6. Pre-primary education (before age 6) was not mandatory in 2013. In Ghana, primary education lasts eleven years and students typically are enrolled from age 4 to 15. Primary education formally includes 2 years of pre-primary education, 6 years of primary school, and 3 years of Junior Secondary School (JHS). To make the analysis between Chile and Ghana more comparable, we exclude pre-primary education.

2. Secondary: Secondary education lasts 4 and 3 years in Chile and Ghana, respectively.

3. Tertiary Education: In both countries, we define tertiary education by any degree granted by a University. We assume an average duration of 4 years, and post-graduate education, such as master degrees or PhDs is excluded from the analysis.

Throughout most of the analysis we use "less than primary education" (no formal education) as the baseline. Each individual in our sample belongs to one of the above-defined

levels based on his/her highest degree attained. For instance, a student that dropped-out from primary school will belong the "No Formal Education" group, whereas one who dropped-out from secondary will belong to the "Primary Education" groups.

All levels of education are sequential (primary level completed is required to go to secondary school, and a secondary education is required to attend a university). This sequential ordering will define the way we define the economic value of education. For example, the internal rate of return (IRR) is defined as the relative value of pursuing the next level of education compared to the counterfactual of not pursuing it and remaining at the current level.

Costs of Education For Ghana, we use data from the GLSS to estimate the average cost of education at each schooling level. The education module of the GLSS contains information on actual household spending per person in each level. The data includes information on tuition fees as well as other expenses, including transportation costs, materials and lodging. By averaging the total expenditure across the population in the sample, we compute the average private costs of education at each level. For Chile, we use data from the OECD (OECD, 2013) on the costs of education. OECD (2013) reports total spending by education level, as well an estimate of the fraction of the cost that is borne by families. For both countries, we complement the data on public spending using UNESCO's Education Dataset, which contains information on public expenditure and enrollment rates for multiple countries and years.[7].

We present descriptive statistics in Table 3. We find significant differences in government expenditure in primary education across both countries, with the Chilean government spending upwards of $2,000 USD per pupil, and its Ghanian counterpart $160 USD per student. While the Chilean government spends slightly more in secondary education, increasing its outlays to around $2,400 USD per student, the government of Ghana almost triples its spending for its secondary students, reaching $500 USD. At the same time, while Chilean families bear an additional cost equivalent to one-third of government expenditures in these two levels, expenditures by Ghanian households account for at 35-40% of total spending in primary and secondary education. Finally, there is a significant change in the finance of tertiary education

[7]See http://data.uis.unesco.org

(Panel C): while governmental expenditure on this level in Chile far exceeds that of Ghana's government, Chilean households account for two-thirds of total spending at this level, relative to less than 40 percent for their counterparts in Ghana.

We also examine how enrollment rates vary across educational levels in these two countries. Despite the large differences in educational expenditures in primary schooling in these two countries, there are no observed differences in gross enrollment at this level. In fact, the gross enrollment rate in Ghana exceeds that of Chile, possibly reflecting a larger share of students who have fallen behind in their education.[8] Nonetheless, significant differences appear as early as secondary school. For instance, while the gross enrollment rate in secondary education in Chile is 100%, the corresponding value in Ghana is only 61%. Similarly, there are vast differences in tertiary education, such that upwards of 80 percent of Chilean students reach this level, compared to just 14 percent of students in Ghana. This comparative analysis suggests there is a large scope to increase access to both secondary and tertiary education in Ghana.

The differences in enrollment rates further translate into contrasting patterns in schooling transition probabilities. Table 4 present these results. The chances of completing a tertiary degree for a student attending primary education are almost 30% in Chile but just 4.5% in Ghana. Among those attending secondary education, the proportions increase significantly, up to 45.5% and 19%, respectively, yet large differences remain. As we show below, these differences are critical for understanding the differential effects of public spending on enrollment rates in each country.

5 Main Results

In this section, we present empirical evidence from the different components of the two frameworks.

[8]The gross enrollment rates is defined as the ratio between the net enrollment and the total population in the age of being enrolled in a certain level of education. For this reason, the gross enrollment rate can take values greater than one.

5.1 The Cost of Provision Approach

Table 5 displays the values associated with the public provision of education services in Chile and Ghana by schooling level. For Chile, it reports two sets: The figures reported by UNESCO and those obtained from official sources (Ministry of Education), which take into account the value of the fiscal transfers to schools depending on their type (e.g., conventional or technical high schools) and shift (half- or full-day schools).

Using the empirical strategy described in Section 3, Table 6 presents the results obtained for the cost of provision approach. The outcome of interest in Panel A is the Gini coefficient obtained using disposable per-capita income within the household to which, depending on the number of students attending publicly subsidized institutions, the value of the subsidy is added.

Column (1) contains the results for Ghana, whereas column (N) reports the number of individuals for whom the monetary value of the in-kind transfer is allocated. The largest decline in inequality is reported for primary education (0.395 relative to the original 0.423), where more than 4 million individuals receive a boost in their income. For the other groups the simulated effects are negligible.

Columns (3) (UNESCO) and (4) (official figures) display the results for Chile. As for Ghana, the largest decline in inequality comes from education services in primary education (0.523 versus 0.53). It is worth mentioning that for both countries, the marginal contribution of tertiary education implies a small increase in the Gini coefficients, which might be the result of a regressive access to publicly funded higher education institutions. Finally, Panel B repeats the analysis but now assuming all students, regardless of wether they attend publicly subsidized institutions, internalize the monetary value associated with the provision of public education. As expected, the effects are similar to those reported in Panel Abut larger in magnitude.

5.2 The market value of education

Following our conceptual framework, two different methods can be used to estimate the behavioral responses of individuals to additional government spending in education. Both assume

access to limited data.

Aggregate enrollment and public spending. In order to estimate the aggregate elasticity of enrollment with respect to educational spending, we need data on enrollment rates and spending for students in all grades. Unfortunately, as previously mentioned, the sample sizes in the household surveys for Chile and Ghana do not provide sufficient variation to carry out this analysis. As a result, we supplement this data by incorporating information on enrollment rates and educational expenses for all Latin American and African countries as reported by UNESCO.

Provided with aggregate information on enrollment and public spending by schooling level over time, one could consider the following empirical association:

$$T_{l,t} = \alpha_l + \theta_l G_t + \varepsilon_{l,t}, \quad l = \{1, ..., L\} \text{ and } t = \{1, ..., T\} \tag{6}$$

where G_t defines government spending on education in year t, $T_{l,t}$ captures enrollment rates for educational level l and θ_l embeds the correlation between public expenditure and the enrollment rate in education level l (for those eligible to attend it). A positive θ_l implies that increases in G_t will increase the probability that a student goes ahead and enrolls in that level. A higher enrollment rate in level l will imply that the cohort of students who have benefited from the policy may attain further education. For instance, if government spending increases primary level enrollment, a fraction of these new students will also go to secondary school, and finally some will pursue tertiary education. Therefore, increasing enrollment at any particular level will also affect attainment at higher education levels. Therefore, provided with the sequence of these parameters, $(\theta_2, ..., \theta_L)$, the analyst could evaluate the aggregate and dynamic effects on enrollment due to changes in G_t on the overall distribution of final schooling levels in the population. Lastly, since different schooling levels exhibit different expected earning profiles, we can then estimate the economic impact of public expenditure in education by calculating the change in labor market outcomes induced by an increase in public expenditure both through its direct and indirect channels.

We carry out this estimation separately in the two regions using data for the period 1976-2016. We impute the estimated correlation among Latin American countries to Chile and the corresponding elasticity for Africa to Ghana. Tables 9 and 10 present the estimated elasticities for Africa and Latin America, respectively.

The results for Africa suggest a clear association between schooling spending and enrollment in primary and secondary education. These results fit in with those presented earlier, as governmental expenditures in Ghana across these two levels is small compared to private expenditures. As a result, a modest increase in public spending could go a large way towards increasing both primary schooling and more critically, secondary schooling. On the other, the estimated elasticity for tertiary education is small and non-statistically significant. This result may be explained by the low enrollment levels in tertiary education observed in the region during the period of analysis. The findings presented in Table 9 indicate that enrolling an additional student in primary and secondary education requires approximately $2,500 and $1,100 dollars of government financing per year, respectively.[9] Meanwhile, Table 10 shows positive and statistically significant enrollment-expenditure elasticities for secondary and tertiary education. However, in the case of primary education the estimated parameter is small and non-significant. These results may be explained by large baseline enrollment rates in primary schooling during 1976-2016, such that additional governmental funding would not further increase enrollment. On the other hand, we find that Latin American governments could increase student enrollment in secondary and tertiary education by increasing spending at these levels. In fact, the estimated elasticities suggest that enrolling extra student in secondary and tertiary education would cost governments an approximate $30,000 and $10,000 USD per year, respectively.

Individual-level analysys. We can study schooling decisions in a micro-economic analysis using household survey data, as is common in the literature. Following the notation introduced in Section 3, if we assume a linear and separable model for the net utility associated with schooling level s after completing schooling level $s-1$, $I_{s^*}(Z,\varepsilon)$, we can use standard discrete choice models to characterize the sequence of schooling decisions. In particular, given a set

[9] We note that these estimates do not take into account capacity constraints.

of observed characteristics, Z, we define the transition probability across schooling levels as a function of the expected utility in these levels as follows:

$$\begin{aligned} p_s &= \Pr(I_{s*}(Z_i, \varepsilon_i) \geq 0 | Z) \\ &= \Pr(\varphi_s(Z_{s,i}) \geq \varepsilon_{s,i} | Z) \\ &= F_\varepsilon(\varphi_s(Z_i)) \end{aligned}$$

where $\varepsilon(i)$ is the error term, $F_{\varepsilon_s}(\cdot)$ is its cumulative density function and $\varphi_s(\cdot)$ is an general function of $Z_{s,i}$.[10] Under the assumption of normally distributed error terms at each step of the decision process (i.e., $\varepsilon \sim N(0, \sigma^2_{\varepsilon_s})$), and linear in parameters specifications for $\varphi_s(\cdot)$, we can estimate the sequence of probabilities using a sequence of probit models.[11]

Tables 11 and 12 present the results for the discrete choice models characterizing the sequence of schooling decisions. For both cases, the empirical analysis is carried out using household survey data. As discussed in our conceptual framework, it is important to include the correct set of observable characteristics in Z_i to correctly capture the factors determining transition probabilities. In Z_i, we include a polynomial of family income which allows us to capture flexible responses of schooling decisions to income. We also include a person's gender, a dummy variable for residence in a rural area and parents' educational attainment, separately for mothers and fathers.

Earnings profiles by schooling level. In the context of the market value approach, the second step in the empirical analysis of the economic impact of public spending in education has to do with the estimation of earnings profiles. Let s denote the schooling level attained by the individual i, with $s = 1, ..., S$. Formally, if we let Y be the outcome of interest (e.g., log annual earnings), s denote years of education, and X labor market experience, the Mincer

[10] $Z(i)$ and ε_i are assumed to be independent. Furthermore, $\varepsilon_{s,i}$ and $\varepsilon_{s',j}$ are assumed independent for all j and i where $i \neq j$ for any s, s'.

[11] The structure mimics a dynamic decision model model (Cameron and Heckman, 1998). The empirical caveats of implementing this framework using cross-sectional information are discussed below.

model delivers the following regression equation:

$$Y = \pi_0 + \pi_1 S + \beta_1 X + \beta_2 X^2 + \varepsilon, \tag{7}$$

where ε is an idiosyncratic error term and π_1 captures $\partial E[Y|S, X]/\partial S$, that is, the average difference in the expected value of Y between individuals with S and $S-1$ year of education, after controlling for the effect of labor market experience.

This model can be trivially extended to allow for level-specific returns. Let s denote the final schooling level attained by the individual with $s = 1, ..., S$, and let D_s be a dummy variable such that $D_s = 1$ if the individual reaches schooling level s, and 0 otherwise. Thus, we can write (7) as follows:

$$Y = \pi_0 + \sum_{s=1}^{S} \pi_s D_s + \beta_1 X + \beta_2 X^2 + \varepsilon.$$

The coefficient π_s is typically interpreted as the economic return to schooling level s, where the baseline category is no formal education. However, this expression still imposes linear separability between education and labor market experience. To relax this assumption, using the sample of individuals reporting each schooling level D, we can estimate:

$$Y = \pi_D + \beta_{1,D} X + \beta_{2,D} X^2 + \varepsilon_D. \tag{8}$$

From this regression, we can generate series of labor earnings until a given age of retirement. [12]

[12] However, conventional estimates based on earnings regressions are subject to important qualifications (Heckman et al., 2006). The potential endogeneity of education, a result of its correlation with the unobserved component, ε_i, is a source of econometric concerns vastly discussed in the literature (Card, 2001). The exact specification of the equation has been a subject of much debate as well (Heckman et al., 2006). And another important drawback of this approach is that it does not take into account the cost that students and their families face when investing in education. Educational attainment implies monetary and non-monetary costs that impact the decision of investing in human capital. First, there is an opportunity cost of studying. People could join the labor market instead, and earnings foregone during the study period can be an important factor driving the education decision. Second, there are monetary expenses of acquiring education. In some cases, there is tuition to be paid to educational institutions. Even if education is tuition-free, there are often other expenses, such as transportation costs, lodging or materials that people have to incur. Finally, there are non-pecuniary

We estimate earnings profiles following the Mincer regression specified in equation (8) using cross-section data from the household surveys. The left-hand side of (8) measures the natural logarithm of net annual earnings. Net earnings are calculated after subtracting the prevailing income tax rates in Chile and Ghana shown in Table 7 (Panel A for Chile and B for Ghana). Years of labor market experience are calculated as follows: we subtract the total number of years of formal education to the current worker's age. We limit the minimum working age to 15, which is the minimum legal age to work in both countries. Moreover, we only include workers who are not currently studying or pursuing any degree. As is well-known in this literature, educational attainment is endogenous to individual's unobserved characteristics, which affect both attainment and labor market outcomes. To address this endogeneity, we complement our OLS estimates with an instrumental variables approach, for which we use reported family income and parental education as instruments for educational attainment.[13]

Table 8 displays the estimated coefficients from the Mincer regression for Chile (columns (1) and (2)) and Ghana ((4) and (5)), respectively. The first OLS column in each country includes the full sample of respondents over 15, whereas in the second one, we restrict our attention to 15-35 year old dependents. OLS estimates show significant returns to an additional year of education for students who have not gone beyond secondary school in both countries. For Chile, an extra year of education is associated with an increase in annual earnings in the range of 9-11 percent, which is in line with previous estimates by Montenegro (2001). Despite the difference in enrollment and financing patterns in Ghana, we also find large and significant returns in this country, in the range of 7-8 percent. These results are largely in line with previous findings by Duflo et al. (2017), who find a return of 13% for secondary school students in Ghana enrolled in a vocational track and Peet et al. (2015), who find an estimated return of 4.7% to an additional year of education in Ghana using LSMS data between 1982 and 2012.[14]

costs, such as psychological costs, of pursuing education. Despite these empirical difficulties, expression (**??**) represents another critical building block for the estimation of the value of education.

[13] Various empirical approaches have been proposed to account for the endogeneity of educational attainment. (Card 1992, Carneiro et al. 2003, Heckman et al. 2006, 2008, among others). We note that data limitations in household surveys in both Chile and Ghana limit our ability to follow recent econometric approaches designed to address this issue. This topic remains a promising avenue for future research once better data becomes available.

[14] For a review of estimated Mincerian returns by level of education in Africa, see Barouni and Broecke (2014).

We note, however, that the IV estimates, presented in columns 3 and 6 deliver significantly lower, and non-significant point estimates. The discrepancy between our OLS and IV estimates may be due to the lack of an appropriate instrument, so we note further work is needed in this area. At the same time, we find significantly larger estimates to completing tertiary education in both countries, and these results are significant in both OLS and IV specifications, exceeding 150 percent in the two OLS regressions and 200 percent in instrumental variable estimations.

The Mincerian regression also allows us to examine the returns to experience as well as the concavity of the returns to education. The first OLS regression indicates that the returns to experience tend to be higher in Ghana than in Chile, reaching 8 percent in the former compared to just 5 percent in the latter. These results become larger as we move across columns, though they become insignificant in the IV specification due to the large standard errors. We find that in both countries, and across all levels of education, earnings profiles are concave. Figures 5 and 6 show the post-tax age-earning profiles for different levels of education. These profiles are estimated using the estimated coefficients reported in Tables 5 and 6 and illustrate the significant differences between the age-earnings profiles associated with tertiary versus other levels of educations. In Chile, the concave pattern is starker for students who have attained a tertiary degree, where a clear peak is observed at around 27 years of experience, which corresponds to adults in their early fifties. While there is a concave pattern for Chileans with lower levels of attainment, the relationship is less clear. Nonetheless, we note that the earnings peak occurs at a higher level of experience, which corresponds with the fact that less educated individuals enter the labor force at earlier ages. We find similar patterns in Ghana: there are concave earnings patterns across all educational levels, though the pattern is starker for the highest achieving individuals, whose earnings peak at 23-25 years of experience. Finally, we note that Table 8 shows larger returns to experience for less educated students, as the coefficient on the education and experience interaction is negative across all specifications (although not significant in a few of them). These results indicate the importance of relaxing the conventional Mincer model.

We use the results in Table 8 to estimate the earnings profiles from labor market entry

through retirement. We follow equation (8), which defines the average growth rate of earnings at each level of experience. We use earnings after 5 years of working experience as the as starting point (instead of $exp = 0$) to extrapolate the rest of the earnings profile, as this allows a more representative sample of workers. [15] Thus, given $Y_{i,D,5}$ in the data (average), we use the estimates of $\beta_{1,D}$ and $\beta_{1,D}$ to compute $\hat{Y}_{i,D,t}$, for $t = \{6, .., T\}$.

In this context, the estimation of internal rates of returns (IRR) to education for individuals in both countries can be used to understand the potential effect of increased educational spending. Table 13 presents the internal rates of returns and the net private returns for different pairwise comparisons of schooling levels computed using the cost of education from Section 5.2 and age-earnings profile estimates from Section 5.1. We note that the unit cost for government-supported expansion of education in Chile across the three levels equals US$2270 for primary education, US$2417 for secondary schooling, and US$2755 at the tertiary level per pupil. For Ghana, the respective costs reach US$161 (primary), US$499 (secondary) and US$1390 (tertiary) per student.

Our estimates consider the direct costs and benefits of more schooling (to be paid by the government), the opportunity costs (foregone earnings), but also the option value of reaching a higher education level (Heckman et al., 2007). [16]

For example, increasing schooling attainment from primary to secondary not only de-

[15] For example, the number of 15 year-old full-time workers with nor formal education is typically low in the sample

[16] Formally, we use the generated sequences of earnings, $\left\{\hat{Y}^0_{s,i}, \hat{Y}^1_{s,i}, ..., \hat{Y}^R_{s,i}\right\}$ for $s = \{1, .., S\}$, jointly with discrete-time versions of $\widetilde{V}_s$ to calculate the net present value (NPV) of earnings for individuals reaching different education levels. We define $\widetilde{V}^{soc}_s$ as:

$$\widetilde{V}(s,r)^{soc} = \sum_{t=a+d_s}^{T} \frac{Y(s,t)}{(1+r)^t} - \sum_{t=1}^{d_s} \frac{C(s,t)}{(1+r)^t} \tag{9}$$

where, as in (5), $C(s,t)$ is the annual private cost of attending level s, d_s its duration, r the discount rate, T, and the retirement age. Notice that labor income in (9) is pre-tax income. Therefore, $\widetilde{V}(s,r)^{soc}$ embeds "social gains" from achieving level of education s, since it includes the taxes that will collected by the government. In this setting, when the government increases public expenditure, say in primary education (s_1), $E(s_1)$, enrollment will increase at a per-student cost equals to κ_1. Given the cumulative effect of education, a new enrollee will achieve complete primary education with probability $p(s_1, s_0)$ where s_0 represents the alternative of no formal education, will pursue and complete secondary education with probability $p(s_2, s_1)$ and will complete tertiary education with probability $p(s_3, s_2)$. Since each of these paths is associated with a corresponding earnings stream (or NPV at a given discount rate r), $\widetilde{V}(s_1, r)$, $\widetilde{V}(s_2, r)$, $\widetilde{V}(s_3, r)$, we define the return to educational spending

livers a direct benefit through higher wages associated with the wage premium of secondary to primary schooling, but it also provides individuals with the opportunity of reaching a higher schooling level. For instance, students who have completed secondary schooling are able to further enroll in tertiary education and capture its corresponding benefits. This is not the case for secondary school dropouts. We carry out this analysis using baseline enrollment rates at each education level along with the estimated transition probabilities from one level to the next. In other words, we simply estimate the probability of reaching a higher schooling level by computing the unconditional probability that can be inferred from enrollment rates.

We present two empirical estimates. First, we analyze the economic returns of achieving further education for a representative student who has completed a primary school degree. We carry out this analysis by estimating the costs and benefits of attaining an additional four years of schooling, which corresponds to secondary school completion. We also estimate the returns to achieving further education for a secondary school graduate. In this case, we analyze the benefits and costs associated with obtaining a tertiary education degree, which we assume to take four years to complete in both countries.

Table 13 presents the results. Within this simple framework, the internal return of completing a secondary degree for a student who has completed a primary degree is large in Chile, reaching upwards of 7 percent. On the other hand, the estimated return to a comparable student is significantly smaller in Ghana, remaining below 1 percent. These results fit in with the estimated returns to schooling found in the Mincer regressions presented above. , we find that the private net present value of finishing this level of education is large in Chile, exceeding $2,000 per person. On the other hand, the equivalent internal value in Ghana is negative and large, yielding a loss larger than $2,200 USD per person. We note that we assume

for an individual selecting schooling level s^* as:

$$\frac{\partial \Delta_{s^*,s^*-1}}{\partial E(s_1)} = \frac{\partial \left[V_{s^*,s^*-1} - V(s^*-1,r)\right]}{\partial E(s_1)} \tag{10}$$

The effect of educational spending on educational attainment depends directly on an individual's value associated with education levels s and $s-1$. Furthermore, the implicit costs C_{s^*,s^*-1} now include the additional obligations associated with κ_s. This measure can be complemented with the estimation of internal rate of return, which is defined as the discount rate that would equate the net present values of the baseline (no extra funding for primary education) and resulting (extra funding) schooling levels.

a 7 percent discount rate in the calculation of these values.[17]. The low returns in Ghana are partly explained by the large opportunity cost associated with schooling (due to the small wage premium in secondary schooling) and by the low probability of completing a secondary degree (see transition matrix in Table 4). The results for tertiary education are similar. We find that completing a degree at this level for a secondary school graduate would yield significant returns in Chile, in excess of $400 USD per person (the corresponding internal rate of return exceeds 7 percent). In Ghana, however, the small IRR, which is not different from zero, implies a negative benefit associated with completing a degree at this level, in excess of $5,000 USD. We note that the benefits associated with completing a tertiary degree are smaller than those for a secondary degree due to the larger cost associated with education at this level. We next carry out simulation exercises to analyze how an increase in public spending in both countries would affect the income distribution in the future generation. This analysis presents one of the key points of our conceptual framework, in which we highlighted the difference in the fiscal incidence of educational spending when viewed through a static lens vis-a-vis a dynamic analysis.

5.3 Policy exercises

The conceptual framework presented above indicates that public spending on education affects long-term outcomes, including labor market outcomes and income inequality, through various mechanisms, in particular through its effect on educational transitions and final schooling attainment. To estimate the impact of public spending in education, we consider three different exercises: A public subsidy equivalent to 10%, 30% and 80% of the annual average costs per schooling level. The 10% increase corresponds a per student increase in financing of US$1,894 in Chile and of US$163 in Ghana — corresponding to 2.2% and 1.8% of GDP, respectively. We assume that these resources are transferred directly to each student and explore their impact on a sample of twelve different generations of students (all attending school today). Within

[17] We have explored whether our results are sensitive to the choice of discount rate in both countries, as individuals may discount the future differentially in these contexts. While the estimates vary in magnitude, the sign of the estimated returns is the same. The results are available upon request.

each cohort, we also control for the quintile of family income.

Table 14 reports the effects of each scenario on the transition probabilities for Chile (Panel A) and Ghana (Panel B) for the generation of individuals attending second, sixth and twelfth graders. Across both countries, we find limited impacts of the 10% increase in spending on educational attainment, though the effects are larger in Chile than in Ghana. This result holds for the three cohorts, as well as across the income distribution. This policy would increase the probability of attaining tertiary education for a low-income child in Chile by 2 percentage points, yet the equivalent effect for a child in Ghana would result in an effect of 0.4 percentage points. An 80% increase in spending, on the other hand, would deliver sizable effects on tertiary enrollment in both countries, with larger effects in Chile vis-a-vis Ghana. For instance, enrollment rates in tertiary education for a middle-income 12^{th} grader in Chile would increase from 74.2 percent to 83.7 percent under the simulated policy. Meanwhile, enrollment rates would increase from 49.8 percent to 52.9 percent for the equivalent child in Ghana. Interestingly, Panel B shows that an 80% effect would have non-linear effects on enrollment vis-a-vis a smaller sized policy. For instance, Panel B.3 clearly shows that while neither the 10% nor the 30% increase in spending would affect tertiary school enrollment, the largest policy would have a sizable impact across the income distribution.

Table 15 reports the estimated effects of increased spending on education on individuals' expected value of tertiary schooling, $V(s)$. Recall that equation (5) indicates that the value associated with each education level depends on both the earnings streams associated with these levels as well as the costs. Panel A shows the results for Chile. We find that each of the three simulated increases in educational spending would result in significant increases in the net present value associated with tertiary education. For instance, a 10% increase in spending would yield a $776 USD increase in this expected value measure for a second grade student. A similar reform in Ghana, presented in Panel B, would only increase the expected value by $10 USD. These results hold across the three cohorts and for all simulated policies: the increase in the expected value of tertiary schooling would be significantly larger in Chile than in Ghana. These results are in line with our previous findings presented in Table 14, which had shown

that increases in educational spending would have smaller impacts on tertiary enrollment in Ghana than in Chile. While increased spending would still increase enrollment, we note that this policy may not be necessarily efficient. In the second column of Table 15, it is clear that the investment associated with the increased public expenditures would far exceed the gain in individuals' expected value of tertiary schooling. As a result, policymakers may be interested in analyzing whether alternative policy designs could deliver the same effects on tertiary school enrollment through other channels.

Figures 7, 8 and 9 display the predicted distribution of annual earnings for the current generations of second, sixth and twelfth graders in Chile and Ghana. The distributions are generated 20, 30 and 40 years after the intervention. Figure 10 complements the results showing the distribution of labor income during adulthood (30 years after the reform) for individuals who belong to the bottom 20% of the distribution of family income while in school.

6 Conclusions

The quantification of the net benefits of education has fueled the economic research for decades (Becker, 1962; Card, 2001; Heckman et al., 2017). A greater stock of human capital should lead to better labor market prospects, including more stable occupations and higher future earnings (Heckman et al., 2014). But, of course, accumulating human capital also involves costs (Keane and Wolpin, 1997a; Rodriguez et al., 2015). Uncertainty and the intrinsic dynamic learning value of schooling must also be factored in (Levhari and Weiss, 1974; Keane and Wolpin, 1997b; Weisbrod, 1962; Altonji, 1993; Arcidiacono, 2004). In this context, rational individuals should weigh the expected long-term costs and benefits when deciding whether or not to invest in education (Willis and Rosen, 1979). This illustrates why estimating the impact of public education spending on any outcome represents a complex task.

When governments subsidize the provision of education services, prices cannot be used to yield measures of benefit incidence as they do not necessarily reflect the marginal willingness to

pay across consumers (Castro-Leal et al., 1999).[18] This chapter introduces two methodologies for assessing the impact of public spending in the education sector when the researcher has access to limited data. The empirical analysis is carried out using micro-level data from Chile and Ghana.

Our results suggest substantial heterogeneity across countries and schooling levels. For example, the returns to investing in primary education in Ghana are low. This is not surprising as gross enrollment rates in this level are already high, so the expansion comes at a large cost. However, when it comes to secondary education, Ghana exhibits large returns. For Chile, the results indicate positive economic values to education. Finally, we use these estimates to simulate the returns to government expenditure in education. We find positive but heterogeneous effects at all levels of education in both countries. More importantly, our findings not only highlight the differences between the methods, but empirically document the contrast between conventional estimates and the returns to public spending in the education sector.

Appendices

A Dynamic fiscal incidence of public spending in education

This appendix extends the conceptual framework of Section 3 to a general dynamic economic setting with uncertainty.

The recursive problem. By its very nature, and as illustrated by expressions (2) and (3), the accumulation of human capital throughout the schooling system involves sequential decision processes. Enrollment in schooling level s requires the completion of schooling level $s-1$, with $s = \{1, ..., S\}$. As before, let p_{s+1} be the probability of attending schooling $s+1$ given that level s is completed. The provision of education services is costly. Let $C(s+1)$ be the cost associated with schooling level s. Thus, the expected private net benefit of attending level $s+1$

[18] Experimental evidence exists (Muralidharan and Sundararaman, 2011), but it is rare and hard to extrapolate to different settings, making comparative policy analysis within and across countries difficult. Observational students (quasi-experimental designs) are similarly affected by data limitations and natural difficulties to establish proper identification strategies (Rosenbaum, 2002, 2010). Nevertheless, despite these issues, carefully implemented observational studies can offer insights into the mechanisms through which public spending in education could alter income inequality and promote poverty reduction in the long-run.

as perceived by an individual reporting s, $V_{s+1,s}$, can be written as:

$$V_{s+1,s} = p_{s+2} \times [V_{s+2,s+1}] + (1 - p_{s+2}) \times V(s+1) - C(s+1) \text{ for } s = \{0, ..., S-1\}, \quad \text{(A.1)}$$

where $V(s+1)$ represents the economic value associated with the alternative 'reaching schooling level $s+1$ and not continuing the accumulation of human capital after that'. This recursive system captures the dynamic effects of investing in education, which must be taken into account when defining its returns. In particular, for an individual who has completed schooling level s, the decision to continue (or not) her formal education process might depend on whether $V_{s+1,s}$ is larger (or smaller) than $V(s)$.[19]

Thus, the relevant economic indicator of the value associated with schooling level $s+1$ becomes:

$$\Delta_{s+1,s} = V_{s+1,s} - V(s), \quad \text{(A.2)}$$

with associated expected overall costs, $C_{s+1,s}$, equal to:

$$C_{s+1,s} = p_{s+2} \times C_{s+2,s+1} + C(s+1) \text{ for } s = \{0, ..., S-1\}. \quad \text{(A.3)}$$

This last expression highlights the fact that effective public efforts promoting the accumulation of human capital throughout formal education must alleviate more than the contemporaneous costs of the process, as educational attainment depends on the sum of costs across all decisions. The empirical applications discussed bellow consider this insight. As a result, in order for an increase in spending $E(s)$ to affect final attainment, enough resources are required to modify at least some of the probabilities in the set $\{p_{s+1}\}_{s=1}^{S}$. The identification of the parameter of interest, $\frac{\partial \Delta_{s+1,s}}{\partial E(s)}$, critically depends on how the sequence of probabilities $\{p_{s+1}\}_{s=1}^{S}$ are affected by the change in public spending. In what follows we propose two simple empirical methods to estimate the private returns to education in a dynamic settings with uncertainty, each with a distinctive logic and interpretation. One approach follows aggregate level information, whereas the other one exploits individual-level data.

Inter-temporal fiscal incidence analysis. Conceptually, the provision of public education

[19] This approach provides us with a mechanism to evaluate the decision of pursuing higher levels of education. For example, we can rationalize the decision of a student with a secondary degree deciding whether or not to pursue a tertiary education degree. We can also estimate the economic benefits associated with pursuing secondary education versus remaining with primary education. Thus, for any two final schooling levels $s-1$ and s, e.g. secondary and tertiary education, $r_{s,s-1} = V(s) - V(s-1)$ represents the extra (discounted) net dollars an individual would obtain in the event of completing schooling level s (and not pursuing additional education) versus $s-1$. In particular, Willis and Rosen (1979) study to what extent individuals compare $V(s)$ and $V(s-1)$ when deciding whether to pursue a college degree after graduating from high school. The economic consequences of this decision can be rationalized in at least two different ways. First, by directly comparing $V(s)$ with $V(s-1)$. For a given discount rate r, the difference between the two discounted net present values can be interpreted as the differential benefit of pursuing s. Thus, we can define the returns to s relative to $s-1$ as $\rho_s = \frac{V(s)-V(s-1)}{V(s-1)}$. A main drawback of this approach is that we need to specify a discount rate, which may differ across individuals, and may not be easy to define. Instead, one could use an alternative approach based on the estimation of the internal rate of return (IRR) of pursuing schooling level s. Specifically, IRR_s is defined as the discount rate that makes the two streams equal in present value, $V(s, IRR_s) = V(s-1, IRR_{s-1})$. Therefore, at any discount rate r, if $r < IRR_s$, pursuing s will be a better financial investment.

services must be understood as an in-kind transfer, but a particular one. It shares the obvious complexities associated with the valuation of any benefit of its type, but since its goal is to boost the skills and abilities of the "beneficiaries", one cannot abstract from its middle- and long-term consequences even when carrying out a static fiscal incidence of public spending in the sector. To see this, we must first acknowledge the economic forces linking past public efforts in education and present income (Mincer, 1993). In particular, there is a long-standing literature documenting the causal association between investment in human capital and labor market outcomes (Mincer, 1958, 1974). Thus, if we denote by $Y'_M(t)$ the contemporaneous labor income of workers and by $E_F(t-1)$ the monetary value of education-related transfers in-kind for the previous generation, any past public action generating the incentives for yesterday's children (today's adults) to attend and/or stay in school, should lead to a structural association from $E_F(t-1)$ to $Y'_M(t)$. In other words, transfers in one period affect the distribution of next period original income. Importantly, this association is not deterministic as investments in education involves uncertainty about their future effects.

Understanding the implications of the inter-temporal association between transfers and market income impels the static fiscal incidence analysis beyond the conventional framework. And this is not because public spending in education might re-rank households according to per capita income once the taxes to pay for or benefits associated with it are taken into account, but due to the time dependence now affecting Π_N. In particular, by adding a time dimension t to the terms in expression (1) and assuming stable total tax and benefit ratios, we can use Lambert's equations over two time periods to write:

$$\Pi_N(t) - \Pi_N(t-1) = \frac{(1-g)\left[\Pi_T(t) - \Pi_T(t-1)\right] + (1+b)\left[\rho_B(t) - \rho_B(t-1)\right]}{(1+b-g)}, \qquad \text{(A.4)}$$

where $\Pi_T(t)$ depends on $\rho_B(t-1)$ as taxes and benefits are connected throughout the effects of education. Two interesting results emerge from this expression. First, the progress in redistribution can be faster than the advances in regressive benefits (i.e., $\Pi_N(t) - \Pi_N(t-1) > \rho_B(t) - \rho_B(t-1) > 0$) even under a deterioration of the progressivity of taxes ($0 > \Pi_T(t-1) > \Pi_T(t)$).[20] Second, even if the redistributive effects of benefits when applied to the original income are constant over time, i.e. $\rho_B(t) = \rho_B(t-1)$, the net fiscal system can increase its progressivity as education can lead to $\Pi_N(t) - \Pi_N(t-1) > 0$ even if $\Pi_N(t) < 0$.

The precise identification of these dynamics go beyond this chapter's scopes. However, they illustrate how by studying not only the long-term economic returns to education but also the individuals' responses to human capital investments throughout the lifetime one could provide new insights into the challenges of the fiscal incidence analysis of public spending in education.

[20] The condition is $\frac{(g-1)}{g}\left[\Pi_T(t) - \Pi_T(t-1)\right] < \left[\rho_B(t) - \rho_B(t-1)\right]$.

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Keane, Michael P and Kenneth I Wolpin, "The Career Decisions of Young Men," *Journal of political Economy*, 1997, *105* (3), 473–522.

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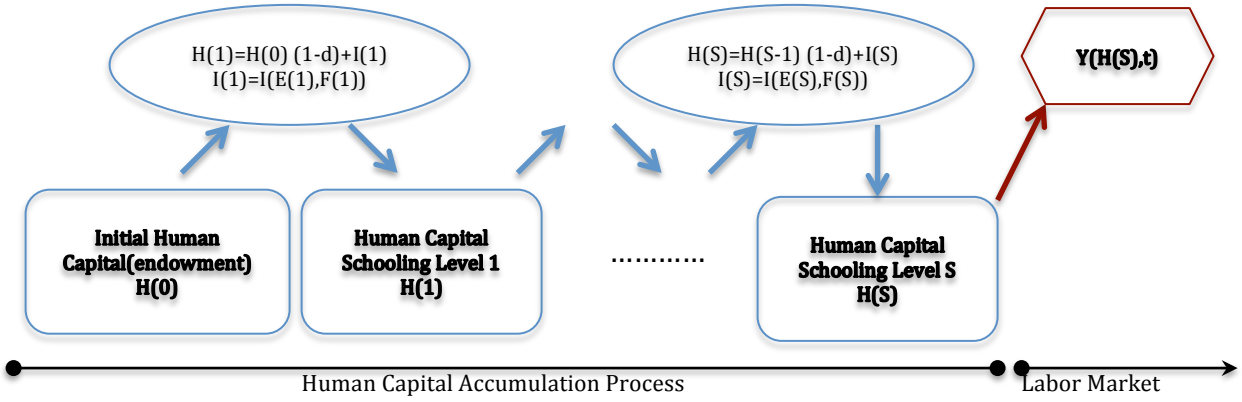
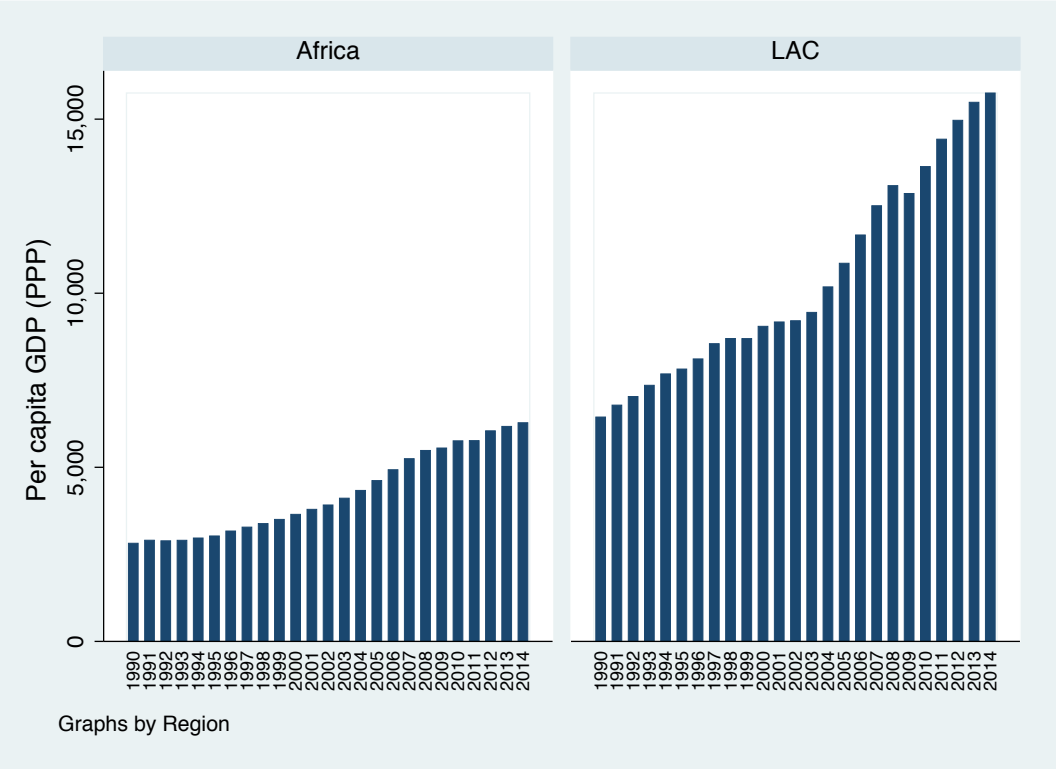
Figure 1: The Causal Chain of Resources allocated to Education Systems



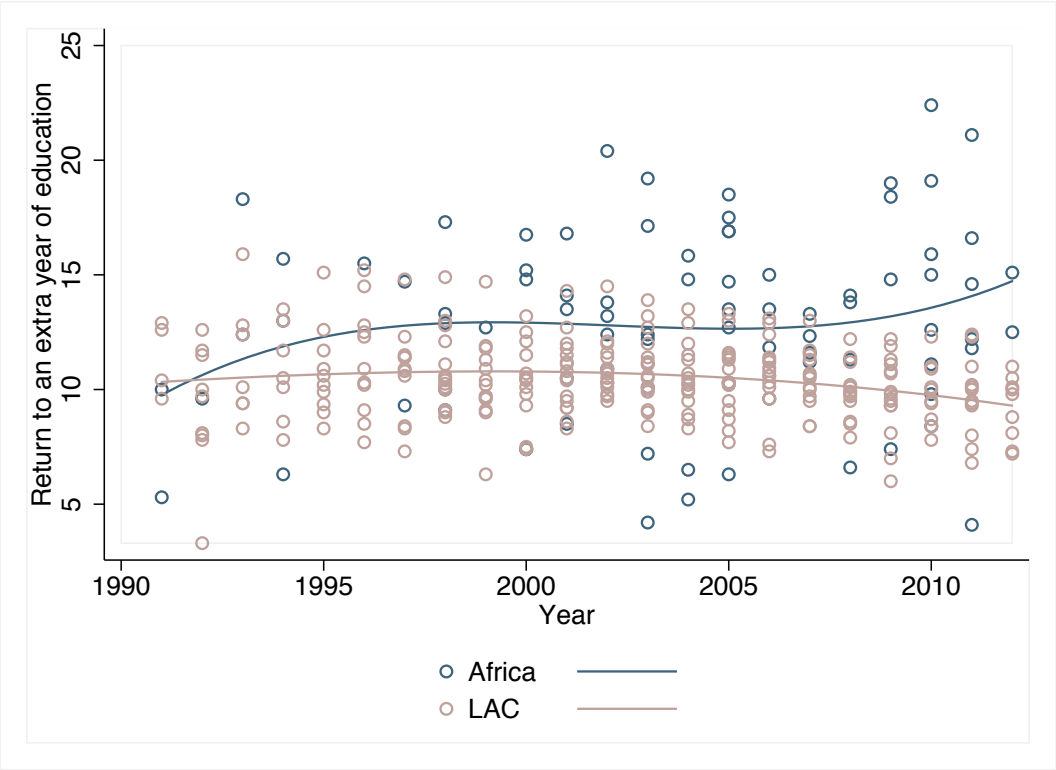
Note: $E(s)$ denotes the economic resources allocated to the schooling level s, $F(s)$ denotes parental inputs, $I(s)$ denotes investments levels in schooling level s, $H(s)$ denotes human capital levels at the end of schooling level s, d denotes depreciation, $Y(H(S), t)$ denotes period t income levels of an individual with human capital $H(S)$.

Figure 2: GDP per capita: 1990-2014 Africa vs. Latin America and the Caribbean



Source: Author's calculations based on data from the World Bank.

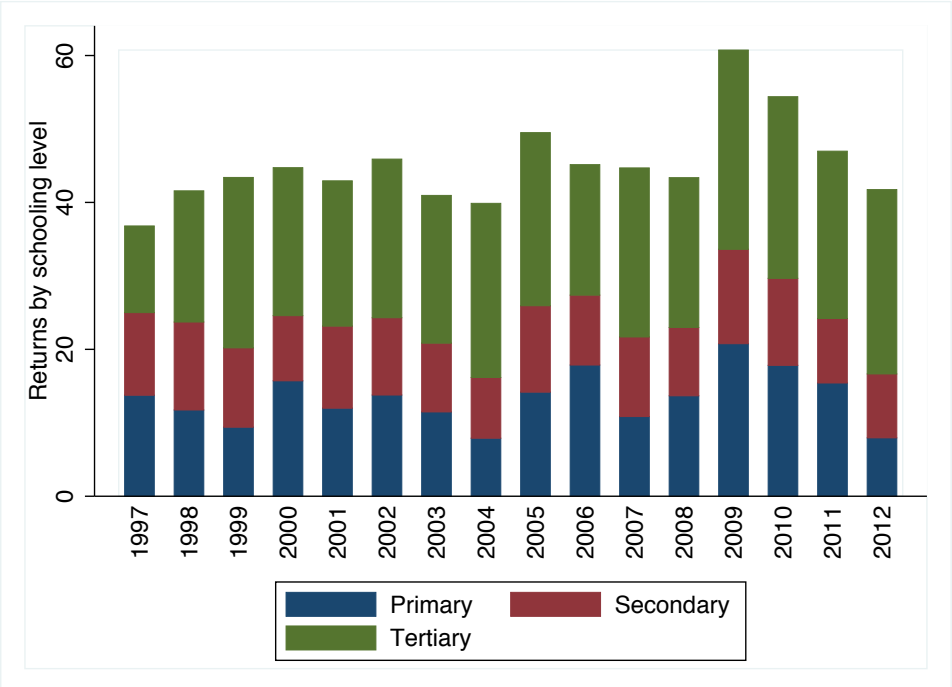
Figure 3: The Evolution of the Returns to an additional Year of Education: 1990-2013
Africa vs. Latin America and the Caribbean



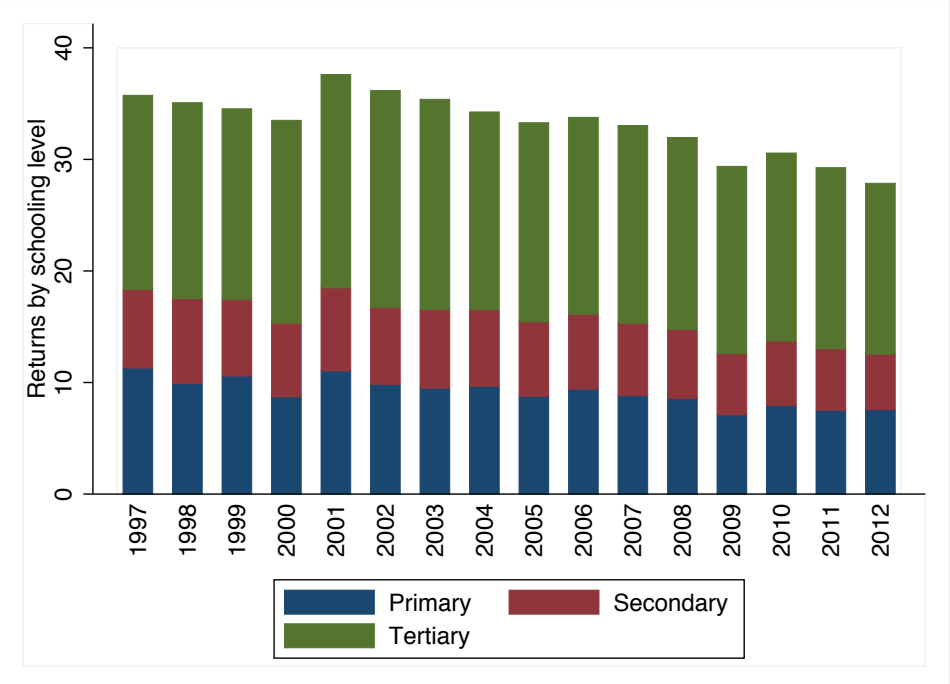
Source: Author's calculations based on Montenegro and Patrinos (2014).

Figure 4: Evolution of Mincerian Returns to Education: 2000-2014 by schooling level

Panel A. Africa

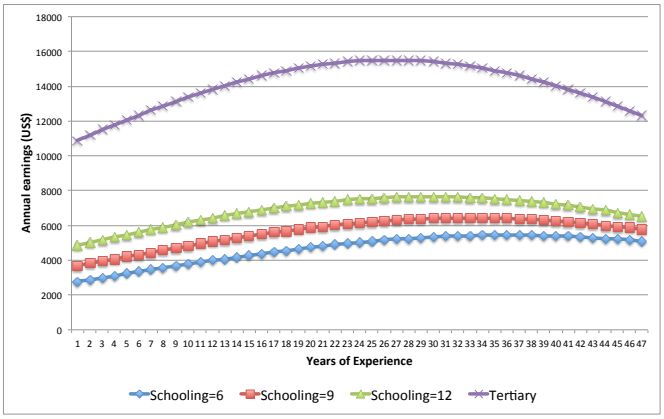


Panel B. Latin America



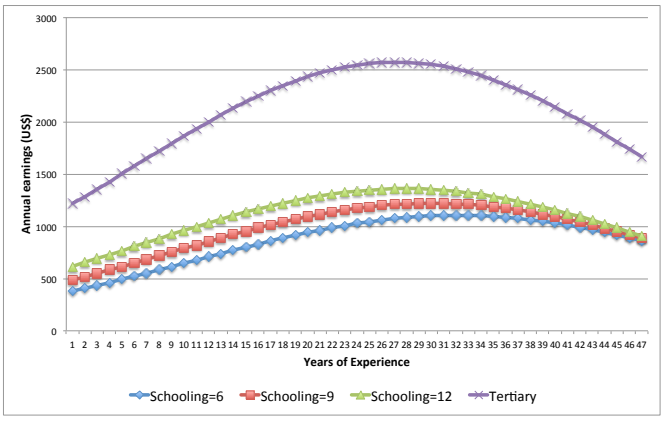
Source: Author's calculations based on Montenegro and Patrinos (2014).

Figure 5: Earnings Profiles in Chile (2013)



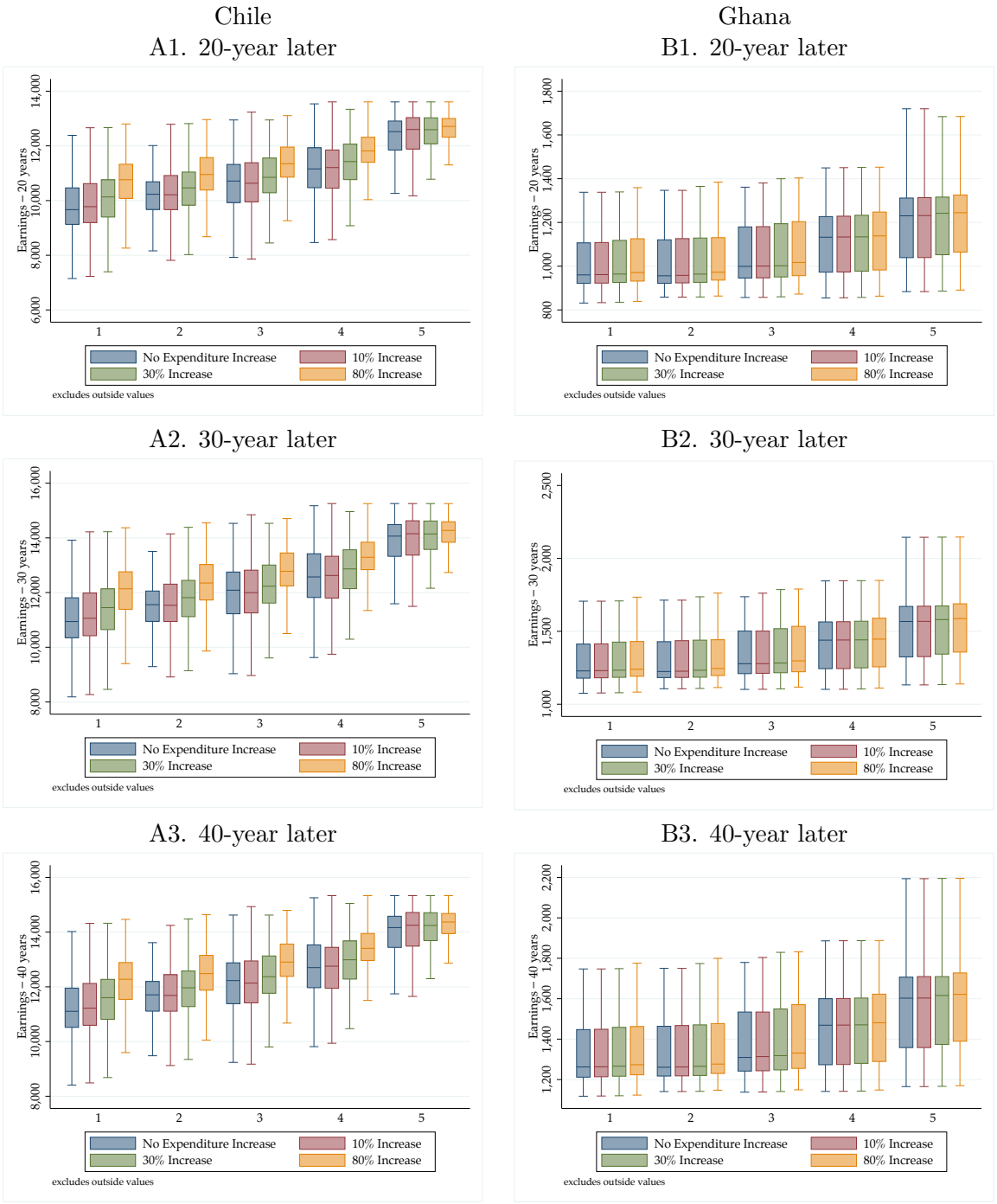
Source: Author's calculations using data from the CASEN 2013 and results from earnings regressions. Annual earnings in 2013 Chilean Pesos on vertical axis .

Figure 6: Earnings Profiles in Ghana (2013)



Source: Author's calculations using data from the GLSS 6 and results from earnings regressions. Annual earnings in 2013 Ghanaian Cedis on vertical axis.

Figure 7: Annual Earnings during adulthood of current second graders after Increases in average annual expenditure in education per student

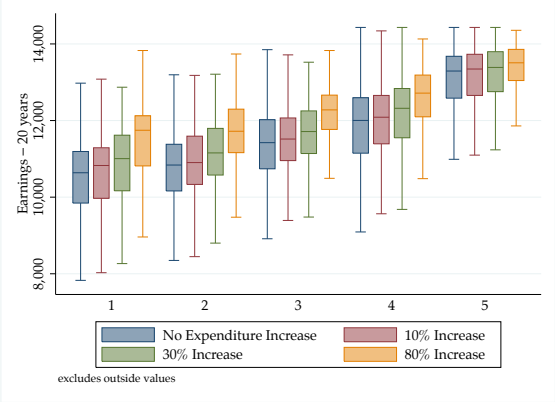


Note: Implicit rate of return to education: 3.9% (30 years of labor market experience).

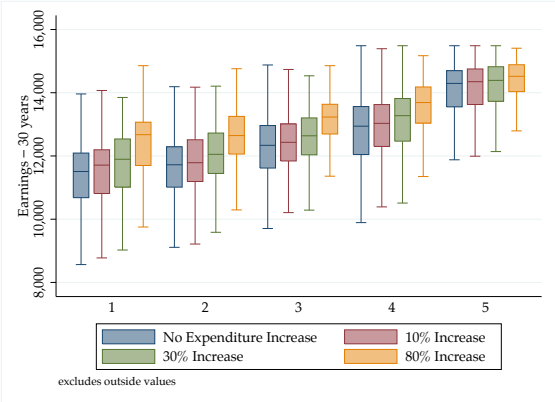
Figure 8: Annual Earnings during adulthood of current sixth graders after Increases in average annual expenditure in education per student

Chile

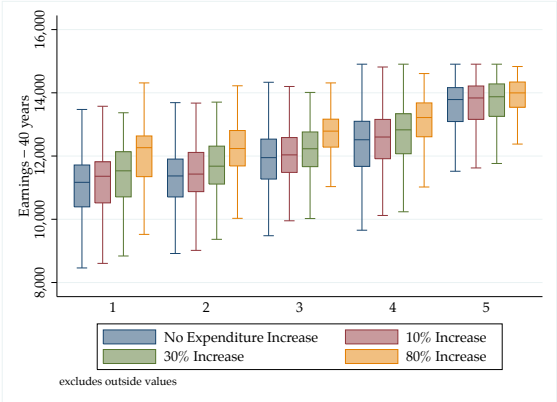
A1. 20-year later



A2. 30-year later

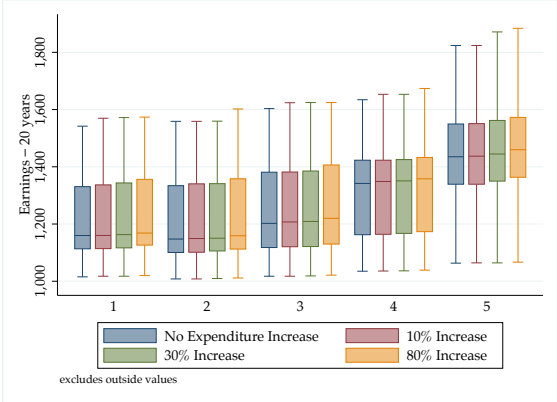


A3. 40-year later

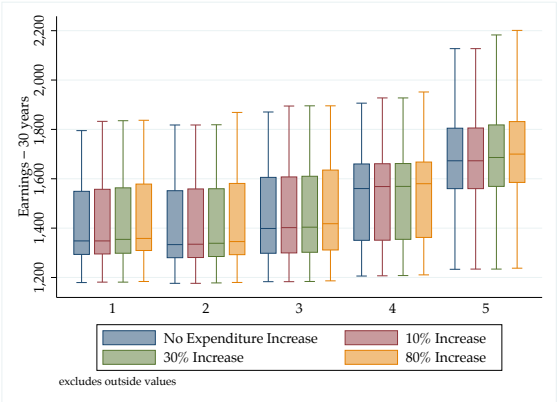


Ghana

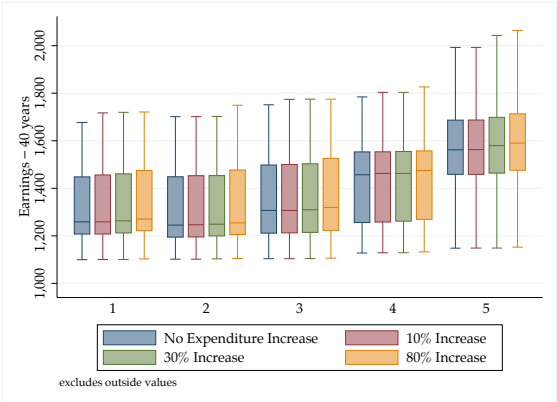
B1. 20-year later



B2. 30-year later



B3. 40-year later

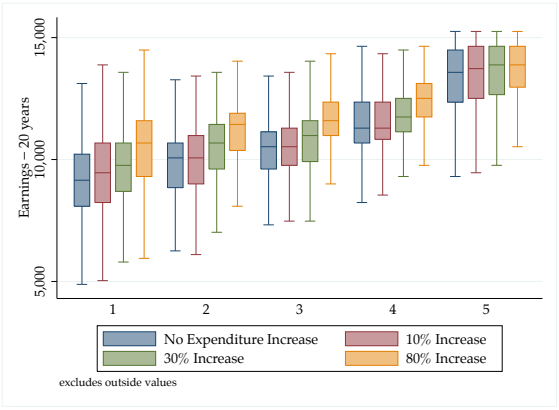


Note: Implicit rate of return to education: 3.9% (30 years of labor market experience).

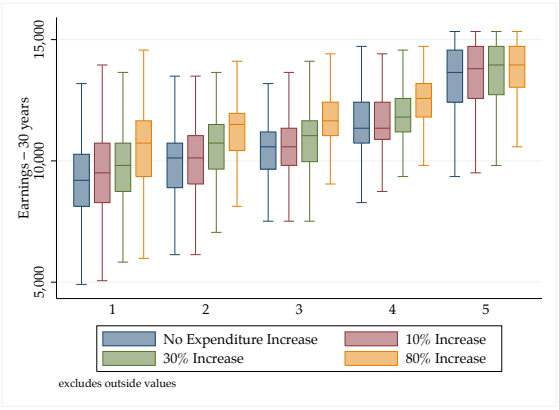
Figure 9: Annual Earnings during adulthood of current twelfth graders after Increases in average annual expenditure in education per student

Chile

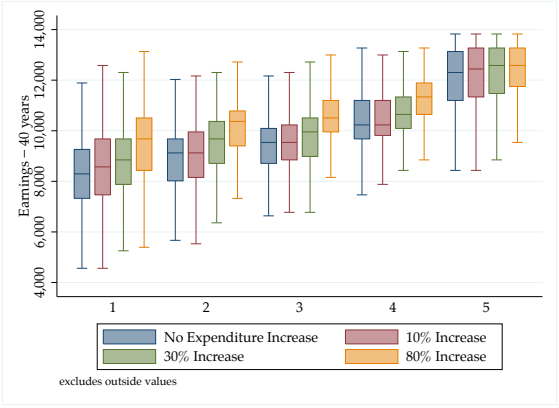
A1. 20-year later



A2. 30-year later

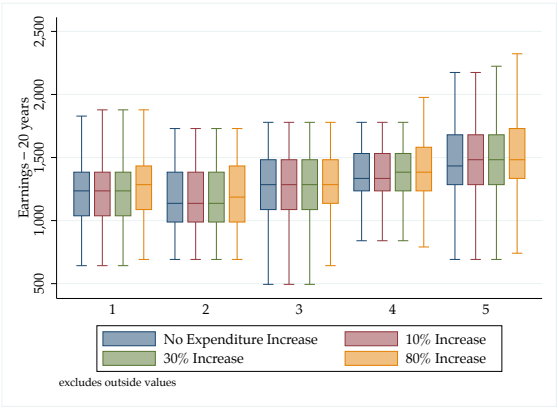


A3. 40-year later

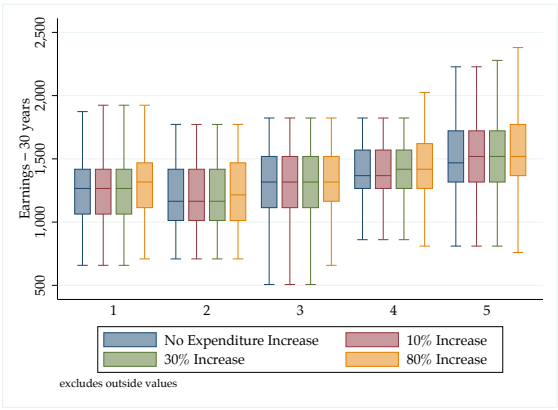


Ghana

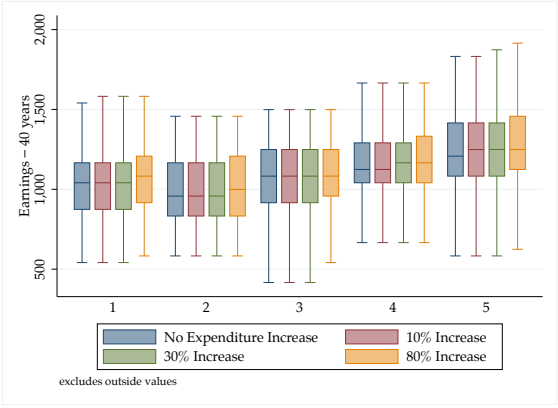
B1. 20-year later



B2. 30-year later



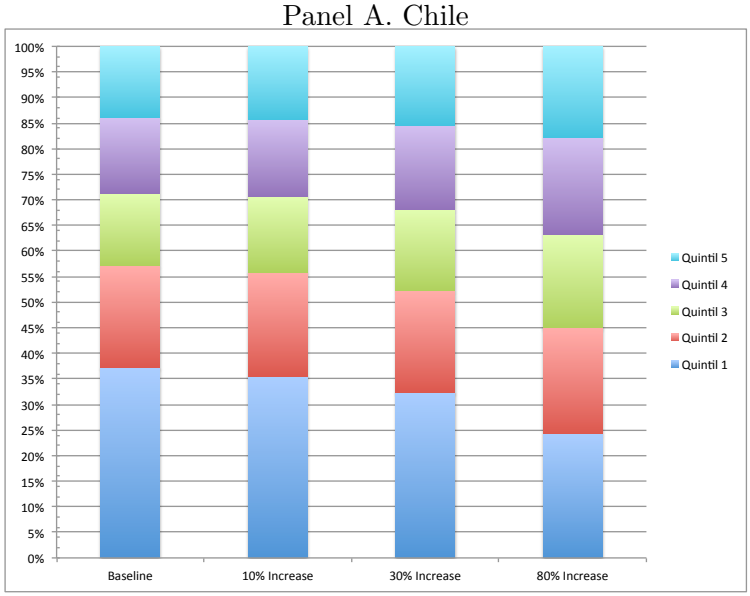
B3. 40-year later



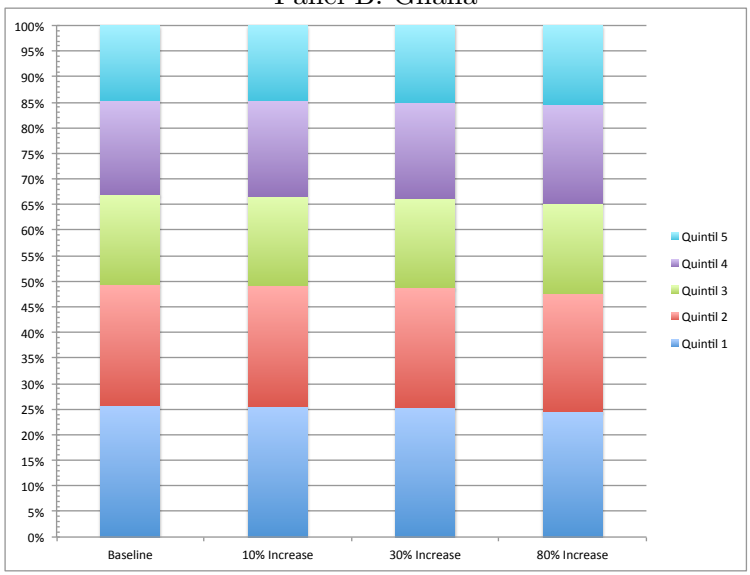
Note: Implicit rate of return to education: 3.9% (30 years of labor market experience).

Figure 10: Distribution of labor income during adulthood (30 year-later) for those individuals with family income while in school at the bottom 20%
Baseline vs. Transfers (10%, 30% and 80% of public expenditure per student)

Panel A. Chile



Panel B. Ghana



Note: Both panels are simulated using the results from the models of labor market income as a function of years of education, and the empirical framework examinug the association between transition probabilities and family income. Public transfers are assumed to increase per capita family income when the individual was deciding whether or not to continue her education.

Table 1: Fiscal Incidence Analysis of Education Spending

	Market Income	Disposable Income	Final Income
	Y_M	Y_D	Y_F
Students	Y_0	$Y_0 - T + B$	$Y_D + E_F + E_G$
Workers	$Y_0 + Y_L(1-s)$	$Y_M - T + B$	$Y_D - \tau$

Note: Y_0 denotes non-labor income, T denotes taxes and B monetary transfers from the government. E_G and E_F represent monetary value of in-kind transfers from the government and private sources, respectively; and Y_L is labor income. τ captures the private contributions to education.

Table 2: Returns to education by schooling level
Chile and Ghana: 1990-2012

Country	Year	Primary	Secondary	Tertiary
Ghana	1991	1.4%	7.9%	12.2%
	2005	4.7%	7.8%	23.2%
	2012	2.7%	8.8%	28.7%
Chile	1992	6.2%	7.2%	10.5%
	2003	6.8%	7.2%	19.3%
	2011	3%	5 .6%	17.6%

Source: Montenegro and Patrinos (2014). The returns to education are obtained from linear regression models of (log) earnings on a series of dummy variables denoting the maximum schooling level achieved. Empirical analysis is carried out using household surveys.

Table 3: Education systems in Chile and Ghana (2013)

	Chile	**Ghana**
Panel A. Primary Education		
Gross Enrollment rate (%)	100.18	108.47
# of students	1472348	4062026
Compulsory	YES	YES
Length (years)	8	9
Gov. expenditure per student in constant US $	2270.1	161.4
Annual Tuition (avg. US$)	-	31.65
Other expenses (avg. US$)	-	69.71
Total Cost (avg. US$)	706.414	101.36
Panel B. Secondary Education		
Enrollment rate (%)	100.45	61.08
# of students	1571374	2356686
Compulsory	YES	YES
Length (years)	4	3
Gov. expenditure per student in constant US $	2417.2	499.8
Annual Tuition (avg. US$)	-	163.16
Other expenses (avg. US$)	-	133.85
Total Cost (avg. US$)	665.54	297.01
Panel C. Tertiary Education		
Enrollment rate (%)	83.81	14.3
# of students (ISCED 6)	755508	201536
Compulsory	NO	NO
Length (years)	4 - 7	4
Gov. expenditure per student in constant US $	2755.7	1390.8
Annual Tuition (avg. US$)	-	558.52
Other expenses (avg. US$)	-	264.83
Total Cost (avg. US$)	5531.68	823.35

Note: Information on the costs of education for Chile (all levels) were obtained from OECD (2013). Costs of education in Ghana were obtained directly from household survey GLSS6. Enrollment rates are reported by UNESCO.

Table 4: Schooling Transition Probabilities

A. Ghana			
	Increase in enrollment		
Attainment	Primary (a)	Secondary (b)	Tertiary (c)
Primary	0.611	-	-
Secondary	0.344	0.810	-
Tertiary	0.045	0.190	1.000
B. Chile			
	Increase in enrollment		
Attainment	Primary (a)	Secondary (b)	Tertiary (c)
Primary	0.352	-	-
Secondary	0.353	0.545	-
Tertiary	0.295	0.455	1.000

Note: The table presents how changes in enrollment levels affects final schooling attainment. In particular, each column shows the distribution of schooling levels associated with an increase in enrollment in primary (column a), secondary (b) and tertiary (c) education.

Table 5: Cost of Provision Approach: Value of in-kind transfer by schooling level

		Ghana	**Chile**	**Chile**
	Schooling Level	(1)	(2)	(3)
Value of one year of publicly funded schooling (Annual US$)	Pre-primary	105	2,770	1,162-1,414
	Primary	161	2,270	1,104-1,414
	Secondary	499	2,417	-
	Conventional	-	-	1,244-1,689
	Technical/Vocational	-	-	1,511-1,917
	Tertiary	1,390	2,755	2,755

Notes: Columns (1) and (2): The monetary value of an extra year of publicly funded schooling across schooling levels is obtained from http://data.uis.unesco.org (UNESCO). Column (3): The values correspond to the official per student transfers. The smallest transfer values are associated with half-day schools. The largest transfer values are associated with full-day schools. Gini coefficients are computed using household level full income. Marginal and cumulative effects are computed after adding to total income the respective value of one year of publicly funded education for each school-age children attending school.

Table 6: The Cost of Provision Approach: The Impact of Education Spending on Inequality

		Ghana		Chile		
Gini	**Original**	**0.423**		**0.530**		
		(1)	(N)	(3)	(4)	(N)
A. Only those enrolled in publicly-subsided institutions						
Marginal Effects	Pre-primary	0.419	(735,632)	0.524	0.527	(637,009)
	Primary	0.395	(4,260,708)	0.518	0.523	(1,312,752)
	Secondary	0.423	(392,061)	0.525	0.526	(549,088)
	Tertiary	0.427	(131,860)	0.529	0.528	(213,977)
Cumulative Effects	Pre-primary	0.419		0.524	0.527	
	+Primary	0.392		0.512	0.519	
	+Secondary	0.392		0.507	0.516	
	+Tertiary	0.396		0.505	0.514	
B. All those enrolled						
Marginal Effects	Pre-primary	0.420	(1,180,199)	0.523	0.526	(836,200)
	Primary	0.391	(5,956,728)	0.516	0.522	(1,967,008)
	Secondary	0.424	(500,235)	0.522	0.523	(995,207)
	Tertiary	0.431	(171,092)	0.527	0.525	(1,100,704)
Cumulative Effects	Pre-primary			0.523	0.526	
	+Primary	0.386		0.509	0.518	
	+Secondary	0.387		0.502	0.513	
	+Tertiary	0.394		0.498	0.508	

Notes: The monetary values of an extra year of publicly funded schooling across schooling levels are reported in Table 5. For Chile, the numbers under (3) are obtained using the values reported in http://data.uis.unesco.org (UNESCO). Column (4) uses the official public per student transfers. These consider whether the individuals are enrolled in half- or full-day schools. Gini coefficients are computed using household level disposable income. Marginal and cumulative effects are computed after adding to total income the respective value of one year of publicly funded education for each school-age children. For both countries, column (N) reports the number of individuals for which the monetary value of the in-kind transfer is imposed.

Table 7: Montly Income Tax rate in Chile (Chilean Pesos)

A. Chile (in Pesos)

From	To	Tax Rate
0	$1,111.29	0.0%
$1,111.29	$2,469.53	4.0%
$2,469.53	$4,115.89	8.0%
$4,115.89	$5,762.25	13.5%
$5,762.25	$7,408.60	23.0%
$7,408.60	$9,878.13	30.4%
$9,878.13	$12,347.67	35.5%
$12,347.67	or more	40.0%

B. Ghana (in Ghanaian Cedis)

From	To	Tax Rate
0	$216.00	0.0%
$216.00	$324.00	5.0%
$324.00	$475.00	10.0%
$475.00	$3,240.00	17.5%
$3,240.00	or more	25.0%

Source: Chilean Tax Revenue Authority (*Servicio de Impuestos Internos*) and Ghana Revenue Authority.

Table 8: Results from Mincer Regressions

Variable	Chile			Ghana		
	OLS	OLS	IV	OLS	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)
Years of Education (≤12)	0.114***	0.091***	0.092	0.080***	0.072**	0.209
	(0.004)	(0.009)	(0.089)	(0.008)	(0.029)	(0.167)
Tertiary	2.198***	1.800***	2.703**	1.640***	1.452***	3.811*
	(0.043)	(0.104)	(1.066)	(0.105)	(0.383)	(2.062)
Experience	0.050***	0.067***	0.124	0.078***	0.065*	0.237
	(0.002)	(0.007)	(0.081)	(0.006)	(0.035)	(0.195)
Experience^2	-0.001***	-0.001***	-0.003**	-0.001***	-0.001	-0.004
	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.004)
Education (≤12) × Exp.	-0.002***	-0.002***	-0.002	-0.002***	-0.002	-0.011
	(0.000)	(0.000)	(0.005)	(0.000)	(0.002)	(0.012)
Tertiary × Experience	-0.022***	-0.035***	-0.110*	-0.020***	-0.004	-0.139
	(0.001)	(0.006)	(0.065)	(0.004)	(0.027)	(0.185)
Rural	-0.227***	-0.050**	-0.003	-0.351***	-0.328***	-0.221**
	(0.009)	(0.021)	(0.029)	(0.024)	(0.082)	(0.095)
Female	-0.500***	-0.167***	-0.281***	-0.446***	-0.268***	-0.282***
	(0.005)	(0.015)	(0.023)	(0.022)	(0.080)	(0.084)
R^2	0.30	0.22	0.11	0.19	0.22	0.16
N	90,339	11,689	7,163	16,073	1,354	1,354
Sample	Full	15-35 y/o	15-35 y/o	Full	15-35 y/o	15-35 y/o

Note: We only include workers whose age is above 15 years-old and that are not currently studying or pursuing any degree. Parental education is used as source of instruments for both countries . Source: For Chile CASEN 2013. For Ghana GLSS round 6.

Table 9: Elasticities: Cross-Country Regressions in Africa

Controls	Enrollment in		
	Primary	Secondary	Tertiary
Expenditure Primary	4.497***		
	(1.216)		
Expenditure Secondary		18.208***	
		(2.255)	
Expenditure Tertiary			-0.358
			(0.831)
Constant	92.965***	19.595***	7.797***
	(2.750)	(3.517)	(0.885)
R^2	0.05	0.25	0.00
N	263	202	182

Note: The table presents the estimated elasticities of gross enrollment rates on public expenditure. The sample includes available data from 48 Sub-Saharan countries for the period 1976-2016.

Table 10: Elasticities: Cross-Country Regressions in LAC

Controls	Enrollment in		
	Primary	Secondary	Tertiary
Expenditure Primary	-0.958		
	(0.974)		
Expenditure Secondary		8.207***	
		(1.193)	
Expenditure Tertiary			22.106***
			(3.015)
Constant	113.118***	74.604***	19.238***
	(1.783)	(1.976)	(2.844)
R^2	0.00	0.16	0.24
N	245	244	169

Note: The table presents the estimated elasticities of gross enrollment rates on public expenditure. The sample includes available data from 41 countries in Latin America and the Caribbean for the period 1976-2016.

Table 11: Transition Probabilities for Chile
Results from Probit models

	p_3	p_4	p_5	p_6	p_7	p_8	p_9	p_{10}	p_{11}	p_{12}	p_{13+}
Income	0.0148***	0.1288***	0.0185***	0.0733***	0.0249***	0.1217***	0.0548***	0.0596***	0.0548***	0.0611***	0.0858***
	(0.0056)	(0.0082)	(0.0028)	(0.0052)	(0.0025)	(0.0046)	(0.0017)	(0.0023)	(0.0017)	(0.0021)	(0.0008)
	[0.0000]	[0.0001]	[0.0001]	[0.0002]	[0.0002]	[0.0005]	[0.0014]	[0.0009]	[0.0017]	[0.0014]	[0.0224]
	<0.0000>	<0.0000>	<0.0000>	<0.0000>	<0.0000>	<0.0000>	<0.0000>	<0.0000>	<0.0000>	<0.0000>	<0.0002>
Female	0.3837***	-0.0239*	0.0617***	0.4290***	0.3551***	0.2065***	0.5131***	0.5039***	0.5941***	0.5201***	0.5793***
	(0.0216)	(0.0145)	(0.0101)	(0.0135)	(0.0084)	(0.0093)	(0.0057)	(0.0073)	(0.0061)	(0.0077)	(0.0032)
	[0.0004]	[-0.0000]	[0.0004]	[0.0009]	[0.0031]	[0.0007]	[0.0123]	[0.0077]	[0.0180]	[0.0113]	[0.1446]
	<0.0000>	<0.0000>	<0.0001>	<0.0000>	<0.0001>	<0.0000>	<0.0001>	<0.0001>	<0.0002>	<0.0002>	<0.0008>
Rural	-0.0311	0.0607***	-0.2317***	0.1139***	-0.0037	0.0180*	-0.1585***	-0.0227***	0.0272***	0.1165***	-0.1650***
	(0.0194)	(0.0168)	(0.0114)	(0.0128)	(0.0088)	(0.0100)	(0.0056)	(0.0075)	(0.0066)	(0.0093)	(0.0047)
	[-0.0000]	[0.0001]	[-0.0017]	[0.0002]	[-0.0000]	[0.0001]	[-0.0046]	[-0.0004]	[0.0008]	[0.0024]	[-0.0456]
	<0.0000>	<0.0000>	<0.0001>	<0.0000>	<0.0001>	<0.0000>	<0.0002>	<0.0001>	<0.0002>	<0.0002>	<0.0014>
Father's Ed.	0.0500***	0.0882***	0.0092***	0.0459***	0.0452***	0.0520***	0.0421***	0.0348***	0.0315***	0.0274***	0.0629***
	(0.0026)	(0.0021)	(0.0016)	(0.0016)	(0.0011)	(0.0013)	(0.0008)	(0.0010)	(0.0008)	(0.0010)	(0.0005)
	[0.0001]	[0.0001]	[0.0001]	[0.0001]	[0.0004]	[0.0002]	[0.0011]	[0.0006]	[0.0010]	[0.0006]	[0.0164]
	<0.0000>	<0.0000>	<0.0000>	<0.0000>	<0.0000>	<0.0000>	<0.0000>	<0.0000>	<0.0000>	<0.0000>	<0.0001>
Mother's Ed.	0.0388***	0.0064***	0.0515***	0.0824***	0.0666***	0.0666***	0.0791***	0.0691***	0.0738***	0.0385***	0.0819***
	(0.0027)	(0.0022)	(0.0016)	(0.0017)	(0.0012)	(0.0014)	(0.0008)	(0.0010)	(0.0008)	(0.0011)	(0.0006)
	[0.0000]	[0.0000]	[0.0003]	[0.0002]	[0.0006]	[0.0003]	[0.0020]	[0.0011]	[0.0023]	[0.0009]	[0.0213]
	<0.0000>	<0.0000>	<0.0000>	<0.0000>	<0.0000>	<0.0000>	<0.0000>	<0.0000>	<0.0000>	<0.0000>	<0.0001>
Mean p	.0.988	0.977	0.973	0.980	0.946	0.980	0.911	0.967	0.944	0.967	0.668
N	1,806,780	1,805,345	1,803,183	1,798,347	1,793,526	1,771,659	1,740,845	1,591,351	1,403,423	1,224,055	977,926

Notes: Per capita family income in thousand dollars. (standard errors), [associated marginal effect at the means), <marginal effect's standard errors>.
*** p¡0.01, ** p¡0.05, * p¡0.1.

Table 12: Transition Probabilities for Ghana
Results from Probit models including controls for parent education

	p_3	p_4	p_5	p_6	p_7	p_8	p_9	p_{10}	p_{11}	p_{12}	p_{13+}
Income	0.1143	0.1810	0.0256	0.1590	0.0918	0.1965**	0.2117**	0.1366	0.0339	0.0790	0.1118
	(0.1680)	(0.1255)	(0.0521)	(0.1149)	(0.0629)	(0.0799)	(0.1024)	(0.0959)	(0.0508)	(0.1257)	(0.0991)
	[0.0018]	[0.0064]	[0.0014]	[0.0165]	[0.0153]	[0.0382]	[0.0359]	[0.0455]	[0.0066]	[0.0117]	[0.0441]
	<0.0026>	<0.0044>	<0.0028>	<0.0118>	<0.0105>	<0.0155>	<0.0171>	<0.0318>	<0.0098>	<0.0185>	<0.0391>
Female	-0.0228	0.0046	0.0660	0.0012	0.0587	-0.0899*	0.0774	-0.1186*	0.0564	0.1312	-0.1450
	(0.0994)	(0.0765)	(0.0697)	(0.0586)	(0.0533)	(0.0542)	(0.0619)	(0.0621)	(0.1085)	(0.1183)	(0.1192)
	[-0.0004]	[0.0002]	[0.0035]	[0.0001]	[0.0098]	[-0.0175]	[0.0131]	[-0.0395]	[0.0109]	[0.0194]	[-0.0572]
	<0.0016>	<0.0027>	<0.0037>	<0.0061>	<0.0089>	<0.0106>	<0.0105>	<0.0207>	<0.0209>	<0.0176>	<0.0470>
Rural	-0.2905**	-0.3397***	-0.3730***	-0.2577***	-0.3035***	-0.3028***	-0.2742***	-0.5515***	-0.2946***	-0.3600***	-0.3466***
	(0.1133)	(0.0889)	(0.0789)	(0.0649)	(0.0572)	(0.0577)	(0.0674)	(0.0653)	(0.1067)	(0.1166)	(0.1292)
	[-0.0047]	[-0.0125]	[-0.0208]	[-0.0272]	[-0.0519]	[-0.0606]	[-0.0484]	[-0.1894]	[-0.0616]	[-0.0602]	[-0.1374]
	<0.0020>	<0.0035>	<0.0050>	<0.0069>	<0.0097>	<0.0117>	<0.0120>	<0.0224>	<0.0224>	<0.0209>	<0.0509>
Father's Ed.	0.0427***	0.0342***	0.0459***	0.0384***	0.0371***	0.0366***	0.0251***	0.0412***	0.0371***	0.0378***	0.0351***
	(0.0130)	(0.0080)	(0.0069)	(0.0072)	(0.0060)	(0.0061)	(0.0076)	(0.0066)	(0.0113)	(0.0146)	(0.0127)
	[0.0007]	[0.0012]	[0.0025]	[0.0040]	[0.0062]	[0.0071]	[0.0043]	[0.0137]	[0.0072]	[0.0056]	[0.0139]
	<0.0002>	<0.0003>	<0.0004>	<0.0008>	<0.0010>	<0.0012>	<0.0013>	<0.0022>	<0.0022>	<0.0021>	<0.0050>
Mother's Ed.	0.0395**	0.0413***	0.0299***	0.0348***	0.0246***	0.0192***	0.0380***	0.0249***	0.0150	0.0188	0.0098
	(0.0161)	(0.0108)	(0.0090)	(0.0083)	(0.0072)	(0.0071)	(0.0087)	(0.0079)	(0.0117)	(0.0142)	(0.0128)
	[0.0006]	[0.0015]	[0.0016]	[0.0036]	[0.0041]	[0.0037]	[0.0065]	[0.0083]	[0.0029]	[0.0028]	[0.0039]
	<0.0003>	<0.0004>	<0.0004>	<0.0008>	<0.0012>	<0.0014>	<0.0015>	<0.0026>	<0.0023>	<0.0021>	<0.0051>
Mean p	.9455	0.9263	0.9258	0.917	0.896	0.855	0.868	0.657	0.884	0.914	0.647
N	7,686	7,587	7,350	7,027	6,495	5,423	4,235	3,128	1,838	1,353	821

Notes: Income in thousand dollars. (standard errors), [associated marginal effect at the means), <marginal effect's standard errors>. *** p¡0.01, ** p¡0.05, * p¡0.1.

Table 13: Returns to Education

		Chile	Ghana
Panel A. IRR			
Level	Counterfactual		
Secondary	Primary	7.67%	0.454%
Tertiary	Secondary	7.12%	0.101%
Panel B. Net Present Value			
Level	Counterfactual		
Primary	Secondary	US$2,080.2	-US$2.265.9
Secondary	Tertiary	US$427.5	-US$5.222.2

Source: Author's calculations. IRRs in Panel A are measured with respect to the previous level of education. Net Present Values are presented in Panel B.

Table 14: The effects of public spending in education on the probability of attaining tertiary education by family income

Scenario	Quintiles of Family Income				
	1	2	3	4	5
A.1 Generation of Second Graders - Chile:					
Baseline - No Intervention	0.542	0.596	0.673	0.770	0.925
10% Increase	0.562	0.614	0.689	0.783	0.931
30% Increase	0.599	0.650	0.722	0.809	0.941
80%Increase	0.688	0.732	0.793	0.864	0.961
A2. Generation of Sixth Graders - Chile:					
Baseline - No Intervention	0.564	0.625	0.685	0.766	0.917
10% Increase	0.583	0.643	0.701	0.780	0.923
30% Increase	0.619	0.677	0.732	0.805	0.934
80%Increase	0.704	0.754	0.801	0.861	0.956
A3. Generation of Twelfth Graders - Chile:					
Baseline - No Intervention	0.633	0.701	0.742	0.802	0.937
10% Increase	0.648	0.715	0.755	0.814	0.941
30% Increase	0.678	0.742	0.780	0.835	0.950
80%Increase	0.748	0.804	0.837	0.881	0.967
B.1 Generation of Second Graders - Ghana:					
Baseline - No Intervention	0.139	0.155	0.200	0.238	0.318
10% Increase	0.143	0.160	0.205	0.244	0.324
30% Increase	0.152	0.170	0.216	0.255	0.335
80%Increase	0.175	0.194	0.243	0.285	0.361
B2. Generation of Sixth Graders - Ghana:					
Baseline - No Intervention	0.146	0.173	0.212	0.247	0.325
10% Increase	0.149	0.178	0.217	0.252	0.330
30% Increase	0.157	0.187	0.228	0.264	0.341
80%Increase	0.178	0.212	0.256	0.294	0.368
B3. Generation of Twelfth Graders - Ghana:					
Baseline - No Intervention	0.470	0.501	0.498	0.512	0.581
10% Increase	0.470	0.502	0.500	0.515	0.586
30% Increase	0.472	0.507	0.507	0.523	0.596
80%Increase	0.485	0.527	0.529	0.548	0.621

Note: Information on the costs of education for Chile (all levels) were obtained from OECD (2013). Costs of education in Ghana were obtained directly from household survey GLSS6. Average family income is obtained from Household Surveys.

Table 15: The effects of public spending in education by Generation
Net Prevent Value (NPV, US$)

Scenario	NPV	Investment	Δ NPV
	1	2	3
A.1 Generation of Second Graders - Chile:			
Baseline - No Intervention	80,317.7	-	-
10% Increase	81,095.3	1,476.0	777.6
30% Increase	82,563.1	4,449.8	2,245.4
80% Increase	85,735.2	11,979.3	5,417.5
A.2 Generation of Sixth Graders - Chile:			
Baseline - No Intervention	107,861.9	-	-
10% Increase	108,814.0	1,088.3	952.1
30% Increase	110,778.1	3,288.7	2,916.2
80% Increase	115,015.6	8,901.1	7,153.7
A.3 Generation of Twelfth Graders - Chile:			
Baseline - No Intervention	137,934.0	-	-
10% Increase	140,050.5	308.2	2,116.5
30% Increase	144,314.7	936.3	6,380.7
80% Increase	154,132.0	2,568.6	16,198.0
B.1 Generation of Second Graders - Ghana:			
Baseline - No Intervention	8,248.4	-	-
10% Increase	8,258.8	105.5	10.5
30% Increase	8,284.1	317.6	35.8
80% Increase	8,340.5	853.8	92.1
B.2 Generation of Sixth Graders - Ghana:			
Baseline - No Intervention	11,533.5	-	-
10% Increase	11,547.7	69.1	14.2
30% Increase	11,575.0	208.2	41.6
80% Increase	11,645.9	561.5	112.4
B.3 Generation of Twelfth Graders - Ghana:			
Baseline - No Intervention	13,930.5	-	-
10% Increase	13,985.1	25.4	54.6
30% Increase	14,045.8	76.4	115.3
80% Increase	14,268.1	204.7	337.5

Note: Information on the costs of education for Chile (all levels) were obtained from OECD (2013). Costs of education in Ghana were obtained directly from household survey GLSS6. Average family income is obtained from Household Surveys.