Human Capital and Inclusive Growth:

A tentative framework and an application to Zambia

Jesus Crespo Cuaresma

I. Introduction

1. The purpose of this note is to sketch a simple framework for the analysis of the interaction of human capital and demographic developments to be used in inclusive growth analytics (see Ianchovichina and Lundstrom, 2009, for a discussion on the meaning of inclusive growth and the role of inclusive growth diagnostics), as well as to provide an example based on the analysis of educational attainment data for Zambia. The focus that the inclusive growth approach has on productive employment places human capital accumulation in a privileged position when it comes to analyzing the potential constraints to economic growth and its distribution across economic agents. This is particularly true since educational attainment is a key determinant of exclusion from the labor market (from the labor supply perspective) and labor demand mismatch.

2. While the traditional definition of human capital refers to both health and education, this note concentrates on the latter, although the interaction between the two dimensions will be particularly relevant in many developing economies. In particular, this note presents a series of tools to jointly analyze demographic and educational attainment dynamics as both a potential economic growth determinant and an instrument to identify constraints to inclusiveness. In this sense, the issue of health, as embodied in population developments, will also be present in the analysis, but will not be the main focus of the note.

3. The note is organized as follows. In section 2 we present a simple theoretical framework to analyze the potential constraints to economic growth related to the process of human capital accumulation. This is done with the background of Lucas’ (1988) standard economic growth model. In section 3 we present a set of tools aimed at evaluating binding constraints in terms of the interaction between education and demography. In this section we also present the IIASA/VID dataset on age structure and educational attainment (see Lutz et al. 2007 and Lutz et al. 2008), which is the most appropriate instrument available to date when approaching the joint dynamics of population and human capital. The exposition of the set of analytical tools is

1 Jesús Crespo Cuaresma is Professor of Economics at the Department of Economics, University of Innsbruck and Research Scholar at the World Population Program at the International Institute for Applied System Analysis (IIASA). Jesus.Crespo-Cuaresma@uibk.ac.at. This piece has profited enormously from comments from Elena Ianchovichina, Leonardo Garrido, Susanna Lundstrom, Juan Pedro Schmid and participants in the Applied Inclusive Growth Analytics Course at the World Bank in March 2009.
II. Human capital and economic growth: Sketching a framework to identify constraints

4. For the sake of simplicity, we start by setting up the standard Lucas model of economic growth and human capital accumulation without human capital accumulation externalities (Lucas, 1988). Assume a Cobb-Douglas production function linking total output ($Y$) to physical capital ($K$), total human capital ($H$) and technology ($A$, assumed constant for simplicity),

$$Y = AK^a H^{1-a},$$

where total human capital is given by the product of the labor force ($L$), human capital per worker ($h$) and the proportion of effort devoted to work ($u$),

$$H = uhL.$$

5. Human capital evolves according to the simple accumulation rule, $\dot{h}/h = \phi(1-u)$, where $\phi$ is the maximum attainable growth rate of human capital per worker if all individual effort is devoted to human capital accumulation. Assuming infinite-horizon utility maximizing individuals with constant relative risk aversion utility functions, the Euler equation for per capita consumption is given by

$$\frac{\dot{c}}{c} = \theta^{-1}(\phi - \rho),$$

where $\rho$ is the discount factor and $\theta^{-1}$ is the elasticity of intertemporal substitution. In this simple framework, differences in growth elasticities can be modeled by making $\phi$ depend on other factors which proxy constraints to both the accumulation of human capital and the return of a given level of education.

6. Notice that Lucas’ (1988) framework does not model explicitly the technology which transforms education attainment into human capital stock. The evidence of Mincerian wage regressions calls for a specification of the type $h = \exp(\eta(E))$, where $E$ stands for the number of years of educational attainment and $\eta(E)$ is the extra efficiency of a worker with $E$ years of education as compared to a worker without any educational attainment. The returns to education are given by the first derivative of this efficiency function, $\eta'(E)$. This setting is used, for example, by Hall and Jones (1999) in their seminal work on the effects of social infrastructure on economic growth. The type of market imperfections and constraints that may affect the transmission of improvements in educational attainment to economic growth may thus be classified into (a) those which affect the returns to education for a given level of attainment and (b) those which affect the trend and persistence of human capital stocks over time. Constraints

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Hall and Jones (1999) assume the efficiency function to be piecewise linear on $E$. 
to labor market participation of educated individuals which lead to brain drain would be an example of the constraints which are relevant to the second transmission channel.

7. If we assume that human capital externalities take place, the decentralized solution of the Lucas model is suboptimal. In this sense, this setting can be helpful to study binding constraints to growth in the framework of growth diagnostics (Hausmann et al., 2005, henceforth HRV). This generalization of the model implies a production function for each (homogeneous) agent $i$ in the economy given by

$$y_i = k_i^a (u_i h_i)^{1-a} h_a^{w} ,$$

where $h_a$ is the average human capital in the workforce. The intuition for this specification is that the level of human capital of the society affects the productivity of each individual. The steady state growth rate of human capital for each individual in this setting is given by

$$\dot{h}/h = \frac{\theta^{-1} (\phi - \rho)}{1 + \psi (1 - \theta^{-1})/(1 - \alpha)} ,$$

which leads to lower economic growth than in the case without externalities if the intertemporal elasticity of substitution ($\theta^{-1}$) is less than unity.

8. The Lucas model of economic growth can help us set a first coherent framework aimed at linking human capital accumulation and economic growth which can then be then embedded in the HRV framework. Here we present a first attempt at using the HRV framework to analyze applied research questions related to the accumulation of human capital. The assessment of binding constraints related to the accumulation of human capital, however, also sheds light on the potential constraints related to the effect of human capital on economic growth.

9. The HRV-type of decision tree analysis can easily embedded in research questions dealing exclusively with constraints related to human capital accumulation. In particular, the two main nodes of the HRV approach (Low return to economic activity and High cost of finance) can be reinterpreted in terms of low returns to human capital accumulation and high costs of finance for human capital accumulation. A more detailed analysis in terms of inclusive growth analytics implies the assessment of such constraints in terms of participation of excluded social groups in the human capital accumulation process and differentials of returns and costs of education across social groups.

10. A tentative decision tree concentrating on human capital investment in which inclusive growth analytics can be embedded is presented in Figure 1. The structure of the tree is similar to that in HVR, it concentrates however on human capital investment instead of physical capital accumulation. Inclusive growth analytics can be readily incorporated into this framework by evaluating differences across social groups in each one of the nodes of the decision tree. Take for example the node “Problems in school access/infrastructure”. In countries with a strong rural/urban divide, this constraint may play an important role for human capital accumulation in rural communities, while not being binding for similarly endowed individuals in an urban environment.
11. It is obviously the case that the use of such decision trees is not free of criticism, and the same caveats reported in Hausmann et al. (2008) apply here. We put forward this approach as one of many possible ways of tackling the problem, which does not necessarily exclude others and may complement them.

12. We start our analysis using data for Zambia by concentrating on overall dynamics in the age distribution of educational attainment. Information on the dynamics of educational attainment over time and across age groups is not only a useful tool to assess growth prospects, but also may contain relevant information concerning the distribution of attainable income (or income growth) among age/education groups within the labor force. This knowledge lies at the heart of the definition of inclusive growth.

13. It should be noticed that the theoretical framework of the Lucas model above interprets human capital as an extra input to the aggregate production function. This is not the only function that economic theory assigns to human capital in the process of economic growth. In particular, since the contribution of Nelson and Phelps (1966), human capital (and in particular, education) has been assigned the role of being a determinant of technology adoption (see also Benhabib and Spiegel 1994, 2005). Therefore, the distance between the technological frontier and the level of technology of a given country interacts with the level of education in order to determine the effect of human capital accumulation on long run economic growth. This implies that, at the macroeconomic level, the degree of development of a country is one of the main determinants of the macroeconomic returns to education in terms of income growth. On the other hand, the literature on endogenous economic growth considers education to be one of the main variables which affect technological innovation, which in turn has long-lasting effects on economic growth. These roles of human capital need to be therefore integrated in the empirical analysis of the effects of education on economic growth.
III. Human capital accumulation and constraints to inclusive growth: Tools and an application to Zambia

III.1 The labour supply side

14. Inclusive growth analysis calls for the use of data at the microeconomic level to assess the constraints to inclusion in the growth process of different social groups. We will start by assessing country-wide prospects concerning the interaction between human capital accumulation and demographic dynamics before moving to the microeconomic level.

15. The International Institute for Applied Systems Analysis (IIASA) and the Vienna Institute of Demography (VID) have recently carried out a back-projection exercise aimed at reconstructing the age/education profile of 120 countries by deriving proportions of 5-year age groups by educational attainment (Lutz et al. 2007). The method, described in detail in Lutz et al. (2007), goes back along cohort lines in five-year steps and derives age-group proportions by educational attainment. For a given country, take the group of 50-54 year old women without any formal schooling in 1995. There is a correspondence between this group and from that of 55-59 year old women in 2000. Only three factors can cause these two proportions to differ: differential mortality, differential migration and women who still acquire formal education after the age of 55. While such late educational transitions are typically irrelevant, differential mortality is a major issue because there is strong evidence in virtually all countries where such data exist that higher educational groups have significantly lower levels of mortality. Although this issue is mentioned in the literature of education data (see Cohen and Soto 2007), it is not explicitly dealt with when reconstructing human capital data.

16. Using Demographic and Health Surveys (DHS) data for 120 countries, Lutz et al. (2007) start by extracting an empirical distribution of the population by age, sex and four categories of educational attainment (no formal education, some primary, completed lower secondary, completed first level of tertiary) for the year 2000. Since United Nations (2005) provides historical estimates of the age and sex structure in five-year intervals for every country in the world, the only unknown that needs to be reconstructed is the proportions with different education levels in each age group. Mortality by education/age group was calibrated using existing estimates and used in order to reconstruct missing observations. The result is a set of data that allows us to retrieve age/education pyramids such as the ones in Figure 2 for Zambia.

17. The use of age-specific educational attainment can be problematic in regression analysis, due to the high correlation in the dynamics of human capital accumulation across age groups. In a first stage, it is thus useful to define the variable/s which will be used to summarize the age/education dynamics. In previous research, several different choices were made. Lutz et al. (2007) use educational attainment proportions aggregated in broad age groups, Crespo Cuaresma and Mishra (2008) use educational attainment at individual 5-year age groups, Crespo Cuaresma and Lutz (2007) use years of educational attainment by age
group. Here, we present synthetic indicators based on extracting the principal components of the data on age-structured human capital by gender, which have recently been used by Lutz et al. (2009) for the study of democratization processes and their relationship with education dynamics.

18. The results of a principal components analysis of the disaggregated data reveal a first component which assigns practically equal weights to all education measures by age and gender, and thus can be interpreted as the “Total education” factor. This factor summarizes overall movements in the full distribution of education across age groups and genders. This factor alone explains most of the variance in the dataset, mainly due to the importance of cross-country differences in the dispersion of education measures in the panel. The second factor, which we dub the “Older age group” factor, assigns increasingly positive loadings to the older age groups (both for males and females) and negative loadings to the younger groups. The factor summarizes thus the developments in the distribution of education attainment across age groups, independently of its distribution between genders. It is the third factor that summarizes the differences across genders, by assigning positive loadings to male education groups and negative loadings to female education groups. We thus name this component the “Male education” factor.

19. The principal components extracted from the IIASA/VID dataset (see above) can help us analyze and compare the nature of the human-capital-driven demographic dividend across economies. In particular, the components are able to track the common dynamics of demographic trends and educational attainment in a comprehensive manner. Figure 3 presents the components extracted from the dataset for five different African low income countries: Kenya, Mozambique, Uganda, Zambia and Zimbabwe. The factors are normalized to one in 1970. Since by definition the actual value of the components extracted from the dataset cannot be interpreted, it is particularly important to benchmark the developments in a given country against other comparable economies.

20. Figure 3 exemplifies clearly the positive developments in overall education levels in Zambia over the last decades, as well as the trend of improvements in the educational attainment of young cohorts during the period 1970-1990, which is visible in the downward trend of the “old age group” factor. This trend has reverted in the last decades, mostly due to the fact that, while these educated cohorts belong now to the “older” side of the age distribution, there have been no long-lasting further improvements on the educational attainment of young age groups. The analysis of the education/demographic components in a setting with benchmark economies offers a direct approach to identify differential dynamics in human capital accumulation for the country under study, but further research is needed to pinpoint the roots of the potential problem. We start by analyzing school enrollment rates, and rely on DHS data for Zambia, which exists for the years 1992, 1996/7 and 2001/2.
Figure 2: Age/education pyramids; Zambia, 1970, 1980, 1990 and 2000
Figure 3: Age/education factors; Kenya, Mozambique, Uganda, Zambia, Zimbabwe
21. In fact, in the last decade the educational attainment of young individuals has worsened. Survey data from the DHS (1992, 1996/7, 2001/2) show the generalized decrease in enrollment rates at all ages 6-14 between 1992 and 1996, which does not recover in the following five years (see Figure 4, which presents the corresponding enrollment rates at different ages). In order to grasp the levels and dynamics of enrollment across different groups of individuals, we present the enrollment rates of children ages 6 to 14 by gender and residence (urban versus rural households). This information is important for identifying social groups which present differential characteristics when it comes to human capital accumulation. Figures 5 and 6 present the results based on such divisions, and show that the decrease in enrollment rates has been particularly strong in female population and in urban areas. Figure 7 presents enrollment rates in primary and secondary education for a broader age group ranging from 6 to 24 years. This evidence reinforces the view that the decrease in primary school enrollment has been stronger in urban areas and in females belonging to the poorest quintile of the income distribution. It is important to note that the fall in enrollment has not taken place significantly in secondary schooling, where some improvement is observed, although the overall levels remain relatively low.

22. In addition to the information provided by the figures mentioned above, Figure 8 presents net attendance rates for primary and secondary schooling by gender, residence and income. These figures refer exclusively to children in primary or secondary school age, respectively, for the 2001/2 DHS. The differences found across income groups is particularly strong for both educational attainment levels, and net attendance rates fall dramatically for all groups when we move from primary to secondary. Survival to last grade in primary schooling has furthermore further decreased since the 2001/2 DHS. According to the data provided by the UNESCO Institute for Statistics, the survival rate to the last year of primary schooling fell from 87.5% in 2001 to 74.6% in 2006. Most of the decrease was furthermore concentrated on females, which had a survival rate in 2006 of 66.6%.
23. The characteristics of the drop in enrollment rates needs to be put in perspective by referring to the HIV/AIDS pandemic in Zambia. The prevalence of HIV/AIDS has affected urban population disproportionately more than rural households, thus imposing extra pressure on the educational sector by increasing teacher absenteeism (Das et al. 2006). This, in turn, increases the costs of education finance from the side of the public sector (training of new teachers, for instance) and creates a need for further investment in the education sector. The time series for public spending on education for Zambia is presented in Figure 9, together with the average value for the whole Sub-Saharan region. Although the data for 2004 indicate that the expenditure in education amounted to roughly 15% of total government expenditures, having risen from levels of 7% in 1991, when measuring it in percentage of income the level has remained significantly below that of the region for the last two decades.

24. A first question that arises is: from the point of view of households, what are the constraints to educational investment and how do they differ across groups? The DHS EdData Survey for Zambia (EdData, 2002) contains information on the perceived disadvantages of schooling and reasons for school absenteeism by income quintile.

Figure 5: Enrollment rate by gender and residence, Zambia, DHS 1992, 1996/7 and 2001/2
25. The reasons provided by the respondents of DHS EdData Survey for Zambia (EdData, 2002) for lack or delay of school attendance do not involve a pessimistic view of the contents taught at school, with practically the totality of the answers implying that parents value schooling (in general) as an investment which improves the chances of children in the labour market (see EdData, 2002).

26. Figure 10 presents the summary of the results on the reasons given by respondents of the EdData survey concerning the reasons for children never attending school. The results are presented by residence (urban/rural) and income quintile. The results indicate clear differences concerning perceived constraints across age groups as defined by residence and income. The most striking observation concerns the fact that financial constraints play an important role as a constraint to human capital formation of young individuals, in particular in urban areas, and that households belonging to higher quintiles of the income distribution assess this constraint to be more relevant. The relatively low level of public spending in Zambia, coupled with the evidence from the EdData survey, give a clear indication that there is room for improvement in terms of the contribution of the government to inclusive growth in Zambia. A more detailed analysis would be necessary to assess the sources of inefficiency in the assignment of educational expenditure and propose policy recommendations.

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3 Similar results arise if we concentrate on reasons for delayed schooling and for dropping out of school.
Figure 6: Enrollment rate by gender/residence, Zambia, DHS 1992, 1996/7 and 2001/2
Figure 7: Enrollment rate by gender, residence and income quintile, Zambia, DHS 1992, 1996/7 and 2001/2
Figure 8: Net attendance rate by gender, residence and income (richest and poorest quintile), DHS 2001/2
Figure 9: Education expenditure, Zambia and Sub-Saharan Africa

Figure 10: Reasons for never attending school by residence and income quintile, Zambia (DHS EdData, 2002)
III.2 Returns to education

27. In the analysis of the constraints to inclusive growth in terms of human capital accumulation, the estimation of returns to education is among the most important steps. Such an analysis could be based on existing Mincerian wage regressions for the country.
under study and should concentrate on the potential heterogeneity of returns to education across social groups defined by gender, educational attainment, income, wealth or any other relevant variable.

28. For the case of Zambia, the Productivity and Investment Climate Survey 2007 provides the so-called “employee questionnaire”, where data for over 900 employees in 153 enterprises can be found. The existing data includes information on wages earned, personal characteristics (age, gender, previous experience, job experience, …) as well as educational attainment (years of education, educational level attained). Since more than one employee is interviewed by enterprise, the dataset allows for the use of fixed firm effects, which control for firm-specific unobservable characteristics. A word of caution is however required here. The data from the Productivity and Investment Climate Survey refers exclusively to firms in the formal sector of the economy. According to the estimates provided by Schneider (2007), Zambia’s shadow economy accounts for roughly 50% of the reported GDP. An analysis of the flow of workers from the formal to the informal sector falls outside the scope of this note, but would prove especially important to understand binding constraints in Zambia’s labor market.

29. Using the Productivity and Investment Climate Survey data we can thus estimate specifications such as
\[
\ln(wage_{ij}) = \alpha + X_{ij}\beta + \epsilon_{ij},
\]
where \(wage_{ij}\) is the wage earned by individual \(i\) in firm \(j\), \(X\) contains data on variables which potentially affect wage and the error term is assumed to be composed by a fixed enterprise effect and a random error with the usual characteristics (homoskedastic and independent across observations). The use of interaction terms between the education variable and other explanatory variables in \(X\) leads to estimates of the differences in returns which could exist among social groups. In Table 2 we present estimations based on hourly wage data from the PIC dataset, including as explanatory variables age, experience, gender (dummy variable for female respondents), membership in a trade union (as a dummy variable), full-time employment and measures of educational attainment. In model 1, we include years of education as the relevant human capital accumulation measure, in model 2 we also include an interaction of this measure with the gender variable and in model 3 we replace years of education by different attainment level dummy variables.

30. The results of the estimations (see Table 3) provide an interesting insight concerning differences in returns to education across attainment levels and genders. The average return on education based on the regression which uses years of schooling is roughly 8%. As an example of a potential sign of barriers to inclusive growth, model 2 estimates the same model assigning a potentially different return to females versus males. The results of this estimation show that females with relatively low levels of education tend to receive a lower wage (the female dummy variable is negative and significant) than their male counterparts, but that the returns to schooling for females are higher than for men. However, the level at which the wage level across (otherwise similar) males and females equalizes is at the very high level of 11.75 years of education.
31. In model 3, the returns are estimated based on educational attainment levels, as opposed to years of schooling. The results indicate a strong significant return of secondary schooling and vocational training. On the other hand, the return to primary education does not appear significant. Some authors interpret such differences as signs of potential supply shortage for certain skills, which may pose constraints on the labour demand side. The large return of tertiary education can be put in perspective by referring to the shortage of university graduates in certain disciplines (see the figures and discussion in Amin and Mattoo, 2007).

32. Skyt Nielsen and Rosholm (2001) use quantile regressions in the framework of wage equations for Zambia. This method could also be used to assess labour market segmentation. The basic specification is a generalization of the wage regression above and specified as

$$\ln(wage_{ij}) = \alpha + X_{ij}\beta_{q} + \varepsilon_{ij},$$

where $\beta_{q}$ is the parameter vector associated with the $q$-th quantile of the conditional distribution of the wage variable.

33. The results presented in Table 3 for the quantile regressions using years of schooling show increasing returns to education for higher quantiles of the conditional wage distribution. More detailed analysis should be carried out to evaluate the determinants of the interquantile dynamics of wages.

III.3 Migration and brain drain

34. If the lack of attractive work opportunities is a constraint to the employability of educated individuals in the domestic economy, migration data by educational attainment may provide useful information as an indicator of a labor demand deficit related to human capital.

35. Following with our Zambian example, Figure 11 presents data on migration rates by comparable skill levels (low, medium, high) for a selected group of African economies in 2000, sourced from Docquier and Marfouk (2005). For all countries in the sample, migration rates are positively related to educational attainment (notice that the scales of the figure differs across educational attainment levels), with a very large shift in migration rates for the high skill group. Zambia shows relatively low levels of migration for all skill levels compared to the group of Sub-Saharan economies. The widespread phenomenon of “feminization of the brain drain”, which is a modern stylized fact of migration flows, can be observed in Figure 12, which shows migration rates by gender and educational attainment in Zambia.

36. Interestingly, even when the absolute migration figures for Zambia appear low for African standards, the relative differences in migration rates between unskilled and skilled workers belong to the highest in the region. Although it is difficult to obtain reliable data on the numbers of Zambian professionals abroad, estimates by the Zambian government give evidence that the brain drain is especially important in the health sector. This is particularly problematic, since the number of physicians per capita and the graduation rate in healthcare disciplines rank among the lowest in the world (see Amin and Mattoo, 2007).
III.4 The firm perspective

37. The results of Mincerian wage equations such as those presented above give an insight to firm behaviour, and provide useful information to study binding constraints from the point of view of the firm. Unusually large returns to education on certain types of educational attainment may be an indication of scarcity of a specific skill, and that in turn may result on a constraint to business expansion. When it comes to measuring firms’ perceptions on the importance of human capital as a constraint to investment, The World Bank’s Enterprise Surveys provide extensive information about investment constraints as perceived by firms.

38. The importance of human capital as a constraint to firm investment can be inferred directly from the dataset, since education of the labor force is one of the items that enterprises have to rank among their investment constraints. For Zambia, Figure 13 shows the percentage of firms identifying each one of the possible constraints as the greatest obstacle to investment. Apparently, skill mismatch is not systematically considered a serious problem by Zambian firms. A more detailed breakdown by ownership, size and exporting activity (Figure 14) reveals that skill mismatch is perceived as a more important constraint in domestic, medium-sized firms and those in the exporting sector. The results concerning the returns to education in wage regressions above give a hint concerning that such a mismatch may be related to the lack of workers with technical/vocational education, as well as workers with tertiary education.

39. Data on wage and employment developments by sector can also be useful to understand skill mismatch. The existence of sectors with decreasing employment and increasing wages could be an indicator of mismatch related to the skills needed for certain production processes. Unfortunately, lack of disaggregated data for Zambia does not allow us to further analyze the issue here.
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**Table 2: Wage regressions based on IPC Survey, Zambia**
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Table 3: Quantile wage regressions based on IPC Survey, Zambia
Figure 11: Constraints to firm investment, Zambia 2007
Figure 12: Skill level as a constraint to firm investment by size and ownership, Zambia 2007
IV Summary

41. This note approaches the issue of human capital in the framework of inclusive growth analytics. We propose a simple theoretical basis based on Lucas’ (1988) economic growth model as a background in order to embed the analysis in the HRV framework.

42. We concentrate on the assessment of binding constraints starting from an aggregate view, where we recommend the joint assessment of demographic and educational attainment trends. From a microeconomic perspective, the analysis of enrollment rates, returns to education, migration patterns by educational attainment and reported constraints by firms should give a coherent picture of the problems concerning human capital accumulation.

43. We provide examples of analytical tools and apply them to the case of Zambia. In particular, we exploit the newly developed IIASA-VID dataset of educational attainment by age group and gender to evaluate the global dynamics of human capital formation. We use DHS data to assess enrollment and attendance dynamics and make use of Mincerian wage regressions to obtain estimates of the returns to different educational attainment levels. Investment Climate Assessment data are used to analyse the importance of human capital as a perceived constraint for firms. In the spirit of inclusive growth analytics, the tools presented in this piece are able to grasp potential differences in constraints to human capital accumulation across social groups.

44. We exemplify the tools using data for Zambia. The preliminary analysis performed gives evidence of high costs of education being an important constraint to human capital accumulation for urban households. Our results indicate that the capabilities of the Zambian educational system to meet the demand for professionals with tertiary education are limited. This fact, coupled with a differentially high level of brain drain for this educational attainment level, seems to be at least partly responsible for a mismatch between demand and supply of workers with higher education. This is also reflected in the estimated returns to education from the Mincerian wage regressions. The low levels of public spending in education in Zambia indicate that public policy has some degrees of freedom to alleviate the constraints to human capital accumulation.
References


