First tentative results:

Is the demographic dividend in fact an education dividend?

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In a first stage, we need 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 construct synthetic indicators based on extracting the principal components of the data on age-structured mean years of education. Let $X = \left(\text{MYS}_{i,t}^{15}\ \text{MYS}_{i,t}^{20} \ldots \text{MYS}_{i,t}^{60}\right)$ be a matrix of stacked data on the mean years of schooling for each age group, where $\text{MYS}_{i,t}^{a}$ denotes the mean years of schooling of individuals with in the age group *(a, a+5)* for country *i* in period *t.* We perform the principal component analysis by extracting the eigenvalues of the correlation matrix based on X and reducing the dimension of the data by projecting the original data on the subspace spanned by the first *L* eigenvectors.

The first component assigns practically equal positive weights to the education measure corresponding to all age groups. Human capital accumulation in a given country is thus reflected in upward trends in this component. The second component, on the other hand, assigns (increasingly) negative loadings to the educational attainment of older age groups. Increases in this component are related to populations in which the inequality in educational attainment across cohorts is increasing as a result of an educational transition.

The information contained in the IIASA/VID dataset concerning the interplay of overall educational developments and the distribution of education across age groups allows us to assess the effects of human capital accumulation on economic growth by exploiting differences in the timing and extent of education expansions.

Age dynamics of human capital in growth regressions

The models we estimate take the form

$$y_{i,t} - y_{i,t-5} = \theta X_{i,t-5} + \gamma y_{i,t-5} + \varepsilon_{i,t},$$

where $y_{i,t}$ is (log) GDP per capita for country *i* at time *t*, the vector $X_{i,t}$ is a group of growth deteminants and economic growth is also assumed to depend on the initial level of income, so as to capture income convergence dynamics. The error term, $\varepsilon_{i,t}$, is assumed to be composed of a country-specific effect, a time specific effect and an otherwise standard Gaussian random error. The assumption of country-specific fixed effects, together with the inclusion of the initial level of income per capita on the right-hand side of the econometric model implies that the usual assumption concerning the lack of correlation between the regressors and the error term is not fulfilled and the model needs to be estimated using

GMM methods. We estimate the model using the Arellano-Bond estimator (Arellano and Bond 1991) which exploits lagged levels of the dependent variable to instrument the endogenous variable in a first-differenced version of the model.

As part of the vector of explanatory variables we choose the usual variables emanating from a production function setting: population growth and the physical investment rate. We also include opennes to trade and life expectancy in some specifications, as well as the share of working age population to total population and its growth rate (INCLUDE LINK TO THE DEMOGRAPHIC DIVIDEND LITERATURE). We present estimations based on two different groups of education variables. In the first set of regressions we include the measure which is most used in the literature, namely mean years of schooling of the population above 15 years of age. The variable enters the specification as a normal (linear) explanatory variable and as an interaction with the level of income, to model technology adoption in the catching-up process (REFER TO THE NELSON-PHELPS PARADIGM AND THE PAPERS BY BENHABIB AND SPIEGEL). In the second set of regressions we replace the aggregate education variable by the two components extracted from the dataset and also include the interaction between them as an extra regressor. Table 2 presents the estimates of the different specifications.

Tentative summary of results so far:

- MYS15+ does not appear significant (or close to significance) in any of the specifications.
- The inter-cohort inequality variable does tend to appear significant both with and without interaction, implying that increases in MYS in younger generations lead to economic growth, and that this effect is stronger in poorer countries (thus speeding the convergence process).
- The most significant and robust variable is the interaction between the two components. This can be interpreted as follows: the difficulty in finding robust effects of educational attainment on economic growth is explained by the fact that MYS15+ does not contain information on the age structure of educational dynamics. The quantitative effect of education on growth depends on whether new generations are attaining higher educational levels than the population in older age groups, and is higher the higher the push in educational attainment of the young generations.
- Neither the working age share nor its growth rate are significant in this setting.

More sensitivity analysis will be done.

Lagged income level	0.785***	0.769***	0.832***	0.858***	0.854***	0.853***	0.648***	0.652***	0.753***	0.733***	0.709***	0.706***
	[0.128]	[0.135]	[0.0891]	[0.0988]	[0.101]	[0.0849]	[0.0836]	[0.0710]	[0.0675]	[0.0668]	[0.0677]	[0.0528]
Lagged income level × MYS15+	-0.00144	-0.00105	-0.00419	-0.00789	-0.00834	-0.012						
	[0.00824]	[0.0103]	[0.00803]	[0.00783]	[0.00808]	[0.00927]						
MYS15+	-0.0552	-0.0603	0.0113	-0.0245	0.00321	0.0739						
	[0.0692]	[0.0935]	[0.0694]	[0.0645]	[0.0671]	[0.0839]						
Lagged income level × Total education component							-0.0123	-0.0139	-0.0114	-0.0115	-0.0152	-0.0173*
							[0.0107]	[0.0106]	[0.00915]	[0.00943]	[0.00974]	[0.00918]
Lagged income level × Inter-cohort education gap component							-0.117**	-0.126***	-0.103*	-0.103**	-0.079	-0.0982*
							[0.0494]	[0.0456]	[0.0535]	[0.0487]	[0.0507]	[0.0509]
Total education component							0.0868	0.101	0.0753	0.0733	0.1	0.109
							[0.0993]	[0.0977]	[0.0848]	[0.0869]	[0.0894]	[0.0840]
Inter-cohort education gap component							0.882**	0.974**	0.793*	0.787*	0.582	0.754*
							[0.424]	[0.393]	[0.458]	[0.422]	[0.439]	[0.441]
Total education component × Inter-cohort education gap component							0.0458***	0.0472***	0.0344**	0.0376***	0.0342**	0.0380***
							[0.0142]	[0.0132]	[0.0145]	[0.0135]	[0.0137]	[0.0135]
Investment rate	0.400**	0.402*	0.357*	0.420**	0.480**	0.459**	0.134	0.228	0.199	0.189	0.231	0.367**
	[0.185]	[0.207]	[0.190]	[0.183]	[0.195]	[0.202]	[0.215]	[0.194]	[0.195]	[0.211]	[0.222]	[0.183]
Population growth	-0.167	-0.22	-0.157	-0.153	-0.138	-0.161	0.435	0.326	-0.144	0.25	0.215	0.0425
	[0.379]	[0.388]	[0.398]	[0.396]	[0.395]	[0.420]	[0.302]	[0.291]	[0.386]	[0.299]	[0.285]	[0.313]
Openness		-0.00204				0.0332		0.0652				0.115**
		[0.109]				[0.0972]		[0.0660]				[0.0573]
Life expectancy			-0.0230**			-0.0212**			-0.000851			0.00278
			[0.00935]			[0.00853]			[0.00569]			[0.00527]
Working age share				1.163	0.389	0.41				0.0514	-0.0298	0.167
				[0.818]	[0.598]	[0.664]				[0.495]	[0.479]	[0.489]
Working age share growth					-0.76	-0.988*					-0.893*	-0.635
					[0.536]	[0.588]					[0.465]	[0.446]
Observations	508	508	508	506	506	506	508	508	508	506	506	506
Countries	109	109	109	109	109	109	109	109	109	109	109	109

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