Supplementary information to:
Build science in Africa

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Supplementary Information: Build science in Africa

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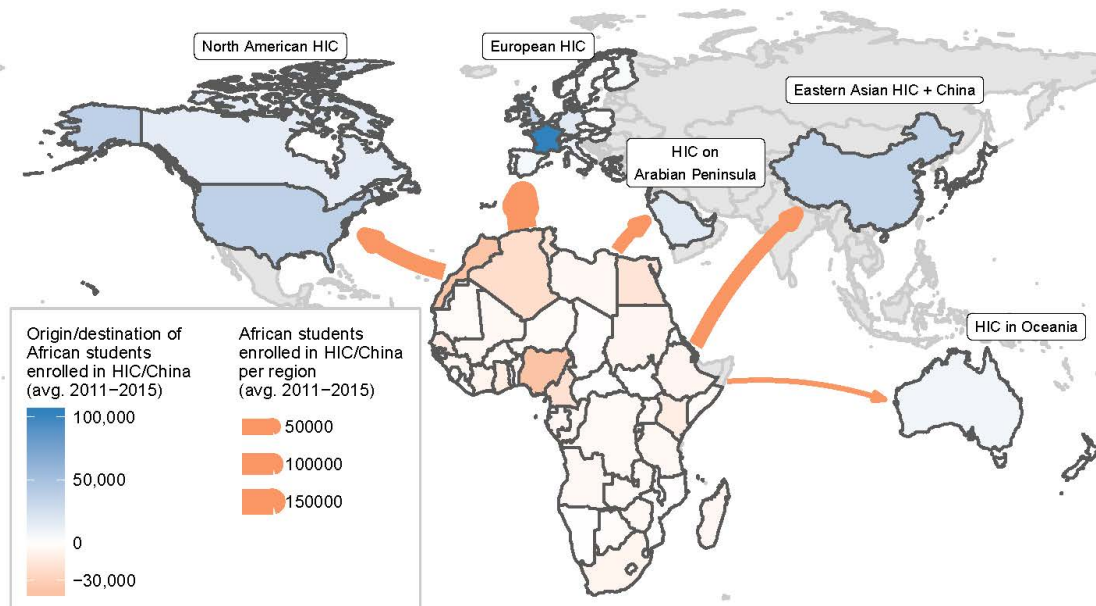
Supplementary Figure

Figure legend: Origin and destinations of African students enrolled in tertiary education programs in large high-income countries (HIC) and China. The color indicates the number of students from African countries enrolled in large HIC or China per destination (blue) and origin (red). The red arrows illustrate the flow of African students to HIC and China summarized for different regions of the world. With data from the UNESCO Institute for Statistics, World Bank, and the Ministry of Foreign Affairs of China. See below for details.

Methods behind the Figure:
To illustrate the number of African students per origin and destination country, we obtained data from the UNESCO Institute for Statistics[1] (UIS), the World Bank[2], and the Ministry of Foreign Affairs of China[3]. From the UIS data set, we used the variable "Inbound internationally mobile students by country of origin". Because these data were not available for China from the UIS, we obtained them from the Department of Policy Planning, Ministry of Foreign Affairs of China as provided by the webpage China Power[4]. The Google sheet with the data as provided by China Power is available at: https://docs.google.com/spreadsheets/d/1A7YDhF9T3OOjQGuB-I85EfrIGf3rPeR3_JKex_vCHu0/edit#gid=0.

These datasets were used to summarize 1) the number of African students enrolled in tertiary education in each of the large HIC and China; and 2) the number of African students enrolled in a large HIC or China per country of origin. We then calculated the mean value for each country for the period from 2011-2015.
The world map to create Figure 2 was obtained from Natural Earth (https://www.naturalearthdata.com) using the R package rnaturalearth ver. 0.1.0 [5].

Supplementary information to the main text: Methods behind the graphic 'Trends in higher education'

To illustrate indicators for the situation of tertiary education in large high income countries (HIC), China, and African countries, we obtained data from the UNESCO Institute for Statistics[1] (UIS), the World Bank[2], and the National Bureau of Statistics of China[6] (NBS). Furthermore, we used data from Natural Earth (https://www.naturalearthdata.com) to obtain country summary statistics to determine large High Income Countries (HIC), which we defined as high-income countries with a population larger than 4.5 million people.

We obtained and analyzed the following variables from the UIS and World Bank data sets using the R package wbstats version 0.2[7] in R ver. 3.5.2[8]: **(1) Gross Domestic Product** in constant 2010 US$ (Indicator ID = NY.GDP.MKTP.KD; hereafter *GDP*); **(2) Total population** (Indicator ID = SP.POP.TOTL; hereafter *population*); **(3) Enrolment in tertiary education**, all programmes, both sexes, as number (Indicator Id = SE.TER.ENRL; hereafter *enrolment*); **(4) Government expenditure on tertiary education** as % of GDP (Indicator Id UIS.XGDP.56.FSGOV; hereafter *expenditure*); **(5) Graduates from tertiary education**, both sexes, as number, (Indicator ID = SE.TER.GRAD; hereafter *graduates*); **(6) Teachers in tertiary education**, both sexes, as number (Indicator ID = SE.TER.TCHR; hereafter *teachers*) Government expenditure on tertiary education for China for the period after 1999 was not available from the UIS. However, the NBS[6] reports "Educational Funds in Institutions of Higher Education", which we used to estimate the percentage of the GDP spent by the Chinese government on tertiary education. This indicator is not identical to the one reported above, expenditure on tertiary education in general. However, for 1999, the spending of the Chinese government on tertiary education was only 6.5 % higher than the spending in tertiary institutions according to UIS data. The average difference in the UIS data set for all countries and years where both indicators were available was 17.6%. Thus, the spending by the Chinese government on tertiary education in general might be slightly higher than shown in Fig. 1 B, but this would not change the general pattern illustrated in the figure.

Using these six original variables, we derived the three variables shown in the graphic: Top panel) Graduates per 1000 people, which is *graduates* / *population* * 1000. middle panel) Students per teacher, which is *enrolment* / *teachers*; and bottom panel) Government expenditure per student in constant US$, which is *expenditure* (in %) * *GDP* (in US$) / *enrolment*;

Then, we summarized each of these variables for each country group for each year. To do so, we first calculated the sum for each of the variables for all countries with available data per country group for each year (e.g. the sum of all students, i.e. *enrolment*, in Africa in 2005 or the sum of all *teachers* in Africa in 2005). Then, we derived the new variable per year and country group (in this example: sum of *enrolment* in Africa in 2005 / sum of *teachers* in Africa in 2005). In the next step, we summarized these values for the five-year periods (1996 – 2000, 2001 – 2005, 2006 – 2010, 2011 – 2015) by calculating the average.

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