CHAPTER 4

Human capital

While many countries in the transition region perform well with respect to primary and secondary education, they are weaker when it comes to training and retaining highly skilled people. In addition, the financial returns to university education vary substantially across countries. This reflects weak university systems, as well as a mismatch between supply and demand. To address this, countries must improve the quality of higher education and their economic, legal and political institutions.

FACTS AT A GLANCE

AROUND
37%
The proportion of the population aged 25 and over in the transition region that had completed at least secondary education in 1990 (compared with 35% in advanced economies).

10
The number of universities in the transition region among the top 500 universities in the 2013 Shanghai ARWU league table.

IN
14
transition countries, having an inadequately educated workforce was among the top three (out of 14) business environment obstacles.

ALMOST
75%
of migrants from countries in the transition region emigrated to other countries in the region.

Education, institutions and human capital

This chapter examines the state of human capital and education in the transition region and in southern and eastern Mediterranean (SEMED) countries.[1] There is substantial evidence that human capital – defined as the accumulated stock of education, knowledge and skills – is important for economic development and growth.[2] Some economists believe that this is the most important factor.[3] Human capital may affect growth not only directly, but also through its interaction with other factors, particularly economic, legal and political institutions (the "institutional environment"). Education may lead to improvements in those institutions which are conducive to growth. Conversely, the accumulation of human capital is influenced by the institutional environment. Furthermore, institutions may have an important impact on how human capital is used.[4]

Modern economies tend to provide significant returns to those with the most talent.[5] This chapter argues that for transition economies to converge towards their mature economy counterparts, their returns need to be comparable to – or even greater than – those available in advanced economies. High returns not only provide incentives to invest in graduate or postgraduate education, but also help to retain the country's most talented people. This is important because brain drain has proven to be an obstacle to development.

The following analysis shows that returns to tertiary education – the increase in lifetime income, relative to the income associated with secondary schooling, which an individual can expect as a result of obtaining a tertiary degree – differ greatly across transition economies. It highlights a strong correlation between these returns and the quality of institutional factors – such as the business environment, governance, the rule of law and political freedom. Where returns are low, the gap relative to advanced economies may widen because of the consequent under-investment in education, erosion of the education system and brain drain.

While most transition economies are ahead of their emerging market peers at similar levels of development, convergence with the most advanced economies in the European Union (EU) is not improving, and may slow down in the future. By providing comparative evidence on three key aspects critical to the accumulation of human capital – quality of education, retention of talented people and returns to tertiary education – this chapter can help policy-makers to identify critical weaknesses that require attention in order to close that gap.

Chart 4.1. Percentage of the population aged 25 and over who have completed secondary and tertiary education

Source: Educational attainment dataset in Barro and Lee (2013).

Note: "Other" refers to the rest of the world – that is to say, other emerging market and developing economies.

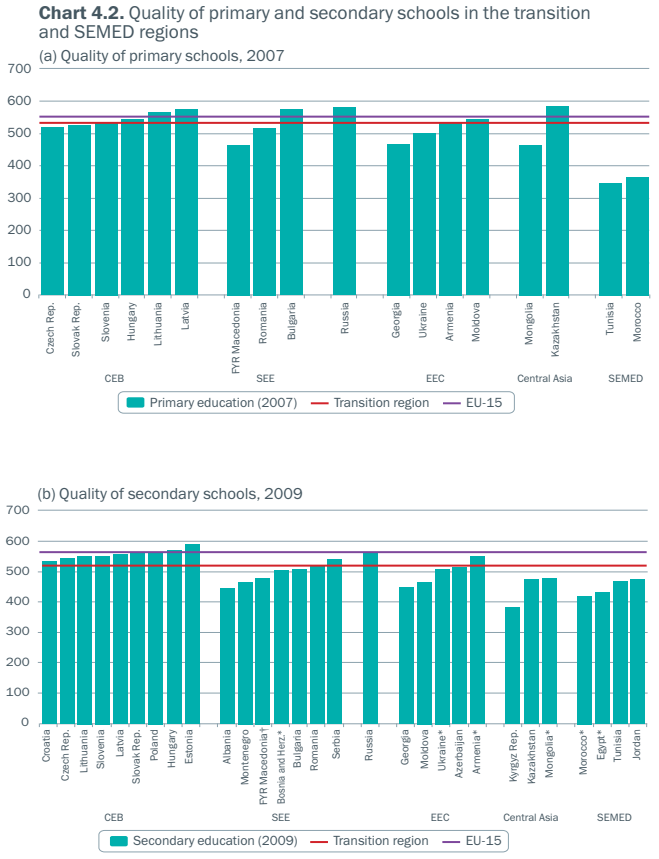
EDUCATION AND HUMAN CAPITAL IN TRANSITION AND SEMED COUNTRIES

At the beginning of the transition process the stock of human capital in the former communist economies was equivalent to – and even above – that in most advanced economies. The proportion of the population aged 25 and over that had completed at least secondary education stood at 36.6 per cent in 1990, compared with 34.9 per cent in advanced economies (see Chart 4.1a).[6] In 2010 the figures were 51.8 per cent and 49.4 per cent, respectively.

However, most countries in the transition region lag behind at tertiary level. In 1990, 8.1 per cent of the population had completed tertiary education, compared with 10.3 per cent in advanced economies (see Chart 4.1b). The gap had widened by 2010, with figures of 11.0 per cent and 16.6 per cent respectively. Nevertheless, several countries – Estonia, Lithuania, Russia

[1] In this chapter, the term "transition region" refers to Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, FYR Macedonia, Georgia, Hungary, Kazakhstan, Kosovo, Kyrgyz Republic, Latvia, Lithuania, Moldova, Mongolia, Montenegro, Poland, Romania, Russia, Serbia, Slovak Republic, Slovenia, Tajikistan, Turkmenistan, Ukraine, and Uzbekistan. SEMED refers to Egypt, Jordan, Morocco and Tunisia.
[2] See Sianesi and Van Reenen (2003) and Eichengreen et al. (2013).
[3] See Gennaioli et al. (2013).
[4] See Easterly (2002) and Natkhov and Polishchuk (2013).
[5] See Kaplan and Rauh (2013), Katz and Murphy (1992), Garicano and Rossi-Hansberg (2006), Autor et al. (2006), Garicano and Hubbard (2009), Terviö (2008) and Gabaix and Landier (2008).
[6] See Barro and Lee (2013). Advanced economies consist of high-income countries according to the World Bank's July 2013 classification, excluding transition countries.

Chart 4.2. Quality of primary and secondary schools in the transition and SEMED regions



Source: Authors' calculations based on Altinok et al. (2013).
Note: * – data refer to 2007; † – data refer to 2003. Hong Kong achieved the highest primary education score (649.0), while Taiwan achieved the highest secondary education score (661.4).

and Ukraine – are now close to or above the average for advanced economies. The transition region as a whole is also significantly ahead of the SEMED countries and other emerging market and developing economies.

On the basis of educational attainment data of this type, many governments and international organisations assumed after the collapse of communism that transition to a market economy would be "promoted by a valuable and transferable stock of human capital".[7] However, some observers warned that there was a significant gap between technical and business-related skills.[8] It was nevertheless hoped that the gap could be closed quickly, at least in some countries, by providing and improving higher education in "key subjects such as economics, administration, and Western languages".[9]

However, several researchers found evidence suggesting that the skills of older cohorts of educated workers depreciated significantly after the start of the transition process, and that their productivity and wages did not increase.[10] More recently, concerns about the quality of management skills have emerged from surveys[11] and annual census-type data.[12] In addition, large-scale brain drain has deprived a number of countries of skilled workers. The fact that in some countries migrant remittances account for more than 10 per cent of GDP illustrates the scale of the problem.[13]

Such findings suggest that focusing on educational attainment is not enough. Building a stock of human capital that will promote development requires an emphasis on the quality – rather than just the quantity – of education.[14]

QUALITY OF EDUCATION AND HUMAN CAPITAL

Primary and secondary education

Since 2000, 16 countries in the transition region have participated in international assessments of students in primary education and 25 have taken part in assessments of secondary students. Prior to this, participation was limited to a handful of countries. Charts 4.2a and b show the latest available scores.[15]

On average, primary school students in the transition region achieved slightly lower scores than those in advanced economies in 2007, although Bulgaria, Kazakhstan, Latvia, Lithuania and Russia were above the EU-15 average. Armenia, Kazakhstan, Latvia, Moldova, Russia and Slovenia have all seen improvements in primary school scores over time, while scores have deteriorated in the more mature economies of the Czech Republic, Hungary, Lithuania, Romania and Slovak Republic.

Larger differences emerge at the secondary level, partly owing to the increased number of countries participating. In 2009 the leading transition country was Estonia, which was also ahead of all EU countries and only trailed South Korea, Taiwan, Hong Kong, Japan, Liechtenstein and Switzerland. Hungary, Poland and Slovak Republic also surpassed the EU-15 average, while Latvia and Russia were comparable to the EU-15.

SEMED countries are lagging significantly behind most

[7] See Kertesi and Köllő (2002).
[8] See Kertesi and Köllő (2002).
[9] See Svejnar (1990).
[10] See Kertesi and Köllő (2002), Rutkowski (1996), Puhani (1997), Večerník (1995), Flanagan (1995), Chase (1998), Krueger and Pischke (1995), Burda and Schmidt (1997) and Guriev and Zhuravskaya (2009).
[11] See Bloom et al. (2012) and Schweiger and Friebel (2013).

countries in the transition region, particularly in terms of the quality of primary education. This can lead to problems later on, such as students dropping out or a failure to cover the secondary school curriculum. However, the case of Kazakhstan shows that even when primary education is of relatively high quality, the quality of secondary education can still be low.

Tertiary education

The communist bloc's restricted access to cutting-edge research prior to the 1990s (the former Yugoslavia being an exception in some respects) meant that transition challenges were particularly likely at tertiary level. Science and engineering (S&E) may have been an exception, as these were promoted under communism because of their military relevance, but the resulting research knowledge and expertise did not necessarily spill over into the broader university system.[16]

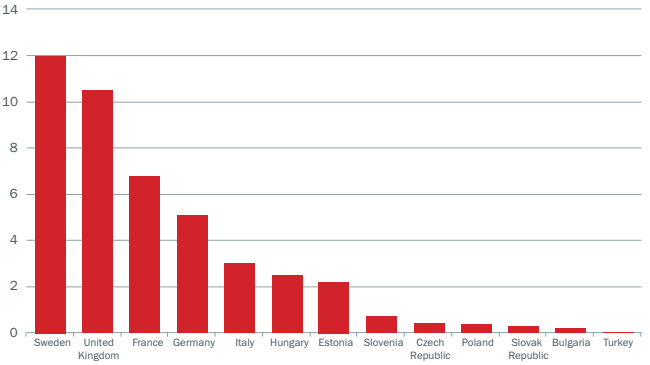
There are no international student assessments at tertiary level. However, the quality of tertiary education can be gauged from university rankings, the citation of academic publications, applications for European Research Council (ERC) grants and recipients of S&E doctorates at universities in the United States. Although a few countries in the transition region – the Czech Republic, Estonia, Hungary, Poland and Slovenia – excel in this respect, they do not match Western counterparts such as Germany, the Scandinavian nations, Switzerland or the United Kingdom (see Annex 4.1).

League tables of top universities are a popular measure of the quality of tertiary education institutions, although they tend to reflect research performance more accurately than teaching quality. The top 500 universities in the 2013 edition of the Shanghai Academic Ranking of World Universities (ARWU) include 10 universities from countries in the transition region – Croatia, Czech Republic, Hungary, Poland, Russia, Serbia and Slovenia – and one (in Egypt) from the SEMED region. By comparison, there are 38 UK universities, 37 from Germany and 20 from France, while among the smaller Western countries, Sweden has 11, the Netherlands 13, and Belgium and Switzerland seven each.

Citations of academic publications are a research-focused measure of the quality of tertiary education. The number of citable documents remains about five times greater in advanced market economies than in the transition region, although there were impressive increases between 1997 and 2011 in places such as Serbia, Turkey and the SEMED region (especially Tunisia). Articles by authors in the transition region also tend to be cited less often (4.5 times per article on average, compared with almost 10 for those of authors from advanced economies), and they also trail in terms of the "h-index", which reflects the productivity and impact of the published work of a scholar.[17] Egypt leads the SEMED region in this regard, with an h-index that is about 55 per cent of the average for an author in an advanced economy.

ERC grants support top researchers of any nationality or age who wish to pursue their cutting-edge research in an EU member state or an associated country or organisation. These long-term grants are almost entirely based on the assessment of researchers' abilities, as shown by their publication records, and should therefore be a good proxy for the quality of an individual researcher's tertiary education. Chart 4.3 shows ERC grant recipients per million people of working age (15 to 64-year-olds) in the country of the host institution in the period 2007-12. The list features only seven countries in the transition region and Turkey (out of 18 eligible countries). Hungary and Estonia are the leading countries in the transition region (and Hungary is also ahead of Western counterparts Greece and Portugal).

Chart 4.3. ERC grant recipients per million people of working age in the country of the host institution, 2007-12



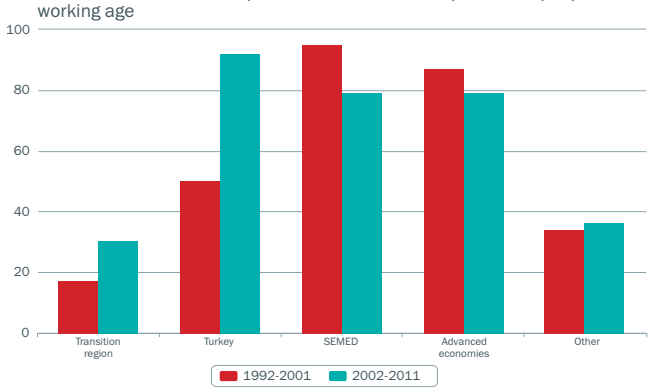
Source: European Research Council.

The quality of an education system is also reflected in the number of students from that country who successfully complete doctoral degrees in the United States. Between 2002 and 2011 the average number of recipients of S&E doctorates at US universities per million people of working age was 79.5 in advanced economies, compared with 30.5 in transition countries (see Chart 4.4). Nonetheless, there has been a significant improvement over time, mostly owing to students from Bulgaria, Croatia, FYR Macedonia, Romania, Serbia and Slovenia. This may indicate improvements in the dissemination of information among students regarding universities and job options abroad, the influence of networks established over time or the increased affordability of application fees given increases in average incomes.

Among the SEMED countries, Jordan stands out with 278.1 recipients of S&E doctorates from US universities per million people of working age in the period 2002-11. However, all countries have experienced a downward trend.

[12] See Brown et al. (2006).
[13] According to the World Bank (2011), Tajikistan (47%), the Kyrgyz Republic (29%), Moldova (23%), Armenia (13%), Jordan (12%) and Bosnia and Herzegovina (11%) were among the countries with the largest remittance inflows as a share of GDP in 2011.
[14] See Pritchett (2001).
[15] See Altinok et al. (2013).
[16] In the former Soviet Union basic research was concentrated in science cities, "closed" cities and academic cities. Funding for these cities has been hit hard post-1990. See Schweiger and Zacchia (2013).
[17] The h-index is based on a scientist's most-cited papers and the number of times that these are cited in other publications.

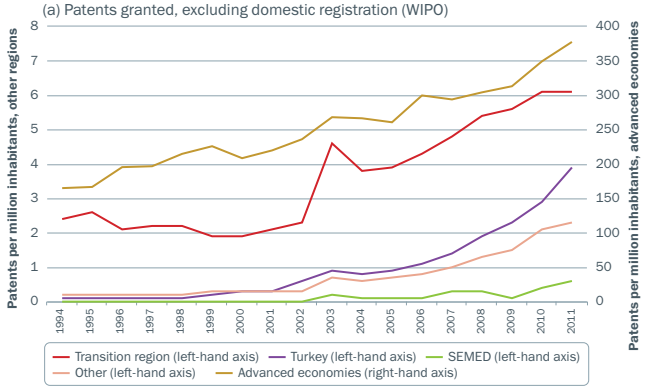
Chart 4.4. Number of recipients of S&E doctorates per million people of working age



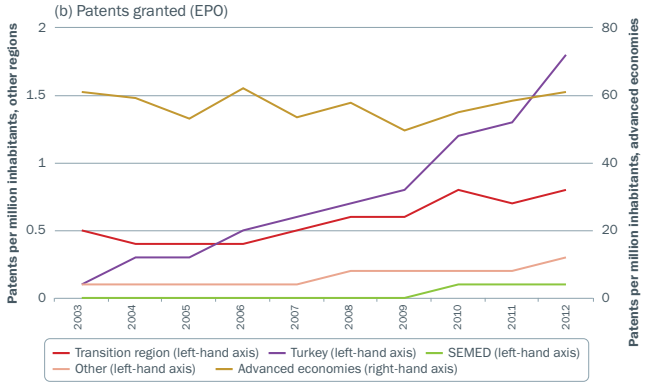
Source: Survey of Earned Doctorates, National Science Foundation (2013).

Chart 4.5. Patents per million inhabitants: EPO and WIPO

(a) Patents granted, excluding domestic registration (WIPO)



(b) Patents granted (EPO)



Source: EPO and WIPO.
Note: The right-hand axes relate to patents in advanced economies; the left-hand axes relate to all other regions. Patents that are registered in the country of origin only are excluded from the WIPO data.

WORKFORCE SKILLS AND PATENTS GRANTED

A high-quality education at primary, secondary or tertiary level may not generate faster economic growth if the skills acquired during formal schooling do not match the demands of employers or the needs of the economy. According to some estimates, up to one-third of people in employment are either under- or over-qualified for the work that they do, and skills mismatches are increasing.[18] Highly educated people in many countries cannot find good jobs – or any jobs at all.

The Business Environment and Enterprise Performance Survey (BEEPS) conducted by the EBRD and the World Bank, which focuses mainly on small and medium-sized enterprises in most countries in the transition region, is one source of employer perceptions. In the 2008-09 survey round, having an inadequately educated workforce was judged the main business environment obstacle in Estonia, Kazakhstan, Romania and Uzbekistan, the second largest obstacle in Belarus, Croatia, Lithuania, Russia, Slovak Republic and Tajikistan, and the third largest in Latvia, Moldova, Montenegro and Poland. Across the 30 countries, having an inadequately educated workforce was, on average, the third largest business environment obstacle (out of 14), after informal sector competition and electricity.[19]

The fact that private sector firms in Estonia – the transition country with the best secondary schools in terms of quality – viewed workforce skills as the main obstacle appears puzzling. This could indicate that skills obtained during education are not meeting the requirements of businesses or that businesses are not willing to offer sufficient remuneration to attract workers with the skills they need.

Another indicator of the quality of human capital is innovation, coupled with intellectual property rights and access to finance. Patenting activity in transition countries has accelerated on average in the last decade, but it remains significantly behind that seen in advanced economies[20] (see Charts 4.5a and b, which are based on World Intellectual Property Organization (WIPO) and European Patent Office (EPO) data).[21] SEMED countries trail other regions.

Among the countries in the transition region, Slovenia is the best performer on a population-adjusted basis (18.5 and 87.7 patents per million inhabitants according to the WIPO and EPO respectively), followed by the Czech Republic, Hungary, Estonia and Latvia. Jordan is the best performer among the SEMED countries according to both EPO (0.2 patents per million) and WIPO (3.7 patents per million) data.

BRAIN DRAIN OR BRAIN GAIN?

Building high-quality human capital stock depends not only on the high quality of education, but also on a country's ability to attract and retain skilled people. This section focuses on emigration and brain drain, using data on international bilateral migration for Organisation for Economic Co-operation and Development

[18] See World Bank (2012).
[19] For details of the methodology behind these figures, see EBRD (2010), Chapter 5. The analysis controls for the characteristics of companies and respondents.
[20] The top 10 countries and territories are dominated by those commonly regarded as tax havens (such as Barbados, Bermuda, the Cayman Islands, Liechtenstein and Luxembourg) and those with low tax rates (such as Switzerland). The EPO list includes Germany and Sweden, while the WIPO list includes Japan, Finland and the Netherlands. The data need to be interpreted with caution.

Table 4.1
Share of emigration stock by origin, destination and skill level: 1990 and 2000

		2000			1990		
Origin	Destination	Total	Low skill	High skill	Total	Low skill	High skill
Transition region	Transition region	72.3	75.3	64.1	73.6	76.6	57.4
Transition region	Turkey	1.9	2.1	1.2	2.1	2.2	1.3
Transition region	SEMED	0.0	0.0	0.1	0.0	0.0	0.0
Transition region	Advanced economies	21.7	19.2	28.9	20.7	17.8	36.9
Transition region	Other	4.1	3.4	5.8	3.6	3.5	4.4
Turkey	Transition region	1.4	1.3	2.9	0.9	0.8	2.0
Turkey	SEMED	0.1	0.1	0.1	0.0	0.0	0.0
Turkey	Advanced economies	93.3	93.7	89.3	92.2	92.4	90.5
Turkey	Other	5.2	4.9	7.7	6.9	6.8	7.4
SEMED	Transition region	0.2	0.1	0.5	0.1	0.1	0.3
SEMED	Turkey	0.0	0.0	0.1	0.0	0.0	0.1
SEMED	SEMED	2.6	2.4	3.5	2.9	2.6	4.2
SEMED	Advanced economies	43.0	40.8	53.2	40.2	37.9	54.0
SEMED	Other	54.2	56.7	42.7	56.8	59.4	41.4
Advanced economies	Transition region	2.6	3.1	1.8	2.4	2.9	1.2
Advanced economies	Turkey	0.8	0.9	0.7	0.4	0.5	0.2
Advanced economies	SEMED	0.3	0.3	0.3	0.2	0.2	0.1
Advanced economies	Advanced economies	84.9	83.0	88.3	87.4	85.9	91.2
Advanced economies	Other	11.4	12.9	8.8	9.5	10.4	7.2
Other	Transition countries	0.5	0.5	0.6	0.2	0.2	0.4
Other	Turkey	0.0	0.0	0.1	0.0	0.0	0.1
Other	SEMED	0.5	0.6	0.5	0.5	0.5	0.3
Other	Advanced economies	50.5	41.1	81.5	38.4	30.0	79.0
Other	Other	48.4	57.9	17.4	60.8	69.3	20.2

Source: Author's calculations based on Artuç et al. (2013).
Note: As a percentage of total stock of emigration from the region of origin for the year shown.

(OECD) and non-OECD countries of origin and destination, based on census data for 100 countries in 2000 and 60 countries in 1990.[22] An aggregated group-level breakdown is presented in Table 4.1.

Almost 75 per cent of migrants from countries in the transition region emigrated to other countries in the transition region. Migration from countries that were formerly part of the Soviet Union – primarily to Russia, but also to Kazakhstan and Ukraine – played a major role, alongside migration between former Yugoslav countries (partly owing to the wars of the 1990s). The percentage of migration within the former Soviet Union and the former Yugoslavia was lower for high-skilled emigrants, indicating that more developed transition countries became a more attractive destination for high-skilled emigrants from less developed countries.

The United States, Germany, Canada and Australia were among the top advanced economy destinations for emigrants from the transition region in both 1990 and 2000. There are also some interesting patterns involving neighbouring countries. The majority of Albanian emigrants moved to Greece and Italy, while Bulgarian emigrants favoured Turkey. Finland had the second largest stock of Estonian emigrants (after Russia), while Poland was the most popular choice for emigrants from Lithuania. Slovak emigrants mainly chose the Czech Republic. In virtually all countries in the transition region, emigration to a neighbouring country tended to be more popular for the less educated than for their high-skilled counterparts.[23]

The majority of emigrants from Turkey moved to Germany and the United States. Germany was particularly attractive for low-skilled workers. The top destinations for emigrants from Egypt were Saudi Arabia and Libya, while Jordanians opted for Palestine, Kuwait and Saudi Arabia. Moroccans favoured France, Israel and Spain, and Tunisians chose France, Israel and Libya. The differences in terms of destinations between less and more educated emigrants were more pronounced in the SEMED region than in transition countries, particularly for emigration to the United States and Canada.

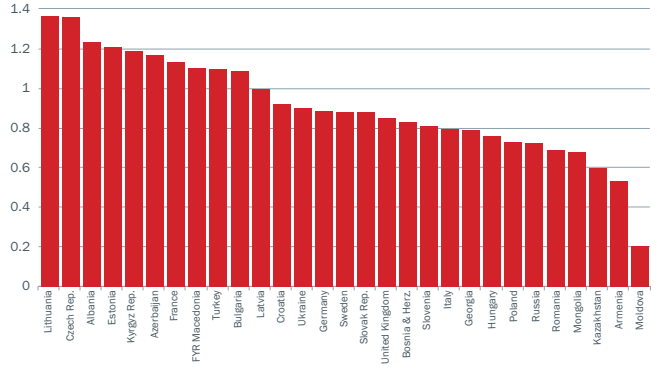
The migration patterns shown in Table 4.1 are important

[21] The EPO data are better in terms of comparability, but proximity and country-specific interests clearly play an important part.
[22] See Artuç et al. (2013).
[23] See Artuç et al. (2013) and Docquier and Rapoport (2012). The exceptions in 2000 were migrants moving from Bosnia and Herzegovina to Serbia and Montenegro, from Georgia to Armenia, from Turkmenistan to Kazakhstan, from Poland to Germany, from Moldova to Romania and from Russia to Kazakhstan, but the differences were small.

Chart 4.6. High-skilled net emigration rates (brain drain) in transition and SEMED regions

Source: Authors' calculations based on Artuç et al. (2013).
Note: The high-skilled net emigration rate is calculated as net emigration from the country (that is to say, the stock of the country's emigrants abroad minus the stock of foreign-born immigrants in the country) as a percentage of the country's native labour force.

Chart 4.7. Income ladder returns to tertiary education (adjusted for supply and demand factors); employed heads of households



Source: Authors' calculations using the EBRD/World Bank Life in Transition Survey (2006 and 2010).

because destination countries can have a substantial impact on migrants' countries of origin through remittances, return migration and the creation of trade and business networks.[24] That said, the first-order effect of emigration on the human capital stock of the country of origin is the loss of skilled labour – the classic brain drain problem.

Chart 4.6 illustrates this loss by showing high-skilled net emigration stock rates (net emigration as a share of the country's native labour force) for transition and SEMED countries. All countries experienced emigration by their high-skilled workers, but also received high-skilled immigrants from other countries. Several former Yugoslav countries suffered the worst brain drain, owing to the wars in the early 1990s.

In most countries net emigration rates were higher in 2000 than they had been in 1990. Estonia seems to have benefited the most. Its gross emigration rate was relatively high in both 1990 and 2000, but immigrants to Estonia were also highly skilled. Latvia, Kazakhstan, Moldova and Russia also appear to have been net "winners" in recent years.

While complete data are not yet available, it is likely that brain drain accelerated after 2000 with the accession to the EU of eight transition countries in 2004, followed by Bulgaria and Romania in 2007 and Croatia in 2013. There is some evidence that substantial numbers of high-skilled workers have emigrated from some of these countries to incumbent EU countries. This trend may have been reinforced by the global economic crisis seen since 2008, as social and political problems associated with recessions (such as poverty, unemployment, discrimination and repression) tend to increase emigration, particularly emigration by high-skilled workers.[25]

RETURNS TO TERTIARY EDUCATION IN THE TRANSITION REGION

People with tertiary schooling typically earn higher incomes than those who start work after completing secondary schooling, with the difference between the two representing returns to tertiary education. More precisely, returns to tertiary education are the increase in lifetime income, relative to the income associated with secondary schooling, which an individual can expect as a result of obtaining a tertiary degree. This is a critical factor both in an individual's decision to pursue higher education and, consequently, in the development of a country's human capital stock.

Returns depend on the supply of, and demand for, tertiary-educated workers.[26] It is not a problem when returns are comparatively low because of an abundant supply of highly educated graduates. However, when returns are low because of weak demand, this raises concerns. One reason for such a scenario could be the poor quality of tertiary education. Another could be that highly educated people are not being matched with the appropriate jobs and cannot use their skills effectively. A third reason could be that even though well-trained graduates

[24] See Docquier and Rapoport (2012) and Burchardi and Hassan (2013).
[25] See Docquier and Rapoport (2012).
[26] See Montenegro and Patrinos (2013).

are being matched with the right jobs, they are being under-paid. The last two interpretations imply that while a good education system is necessary to build an effective stock of human capital, this is not sufficient for growth if that stock is not used effectively or if there are inadequate incentives for an individual to invest in tertiary education.

Regression analysis can be used to identify the share of returns to tertiary education that is not explained by either the supply of and demand for tertiary graduates or the quality of the education system. This is illustrated in the first two columns of Table 4.2. Returns are estimated as average country-level differences in terms of the subjective income ladder between employed heads of households who have a university degree and those with just a secondary school diploma. The data used are taken from the Life in Transition Survey (LiTS) conducted by the EBRD and the World Bank in 2006 and 2010.[27] On the supply side, returns depend on the proportion of people with a university degree and brain drain, measured as a high-skilled net emigration stock rate.[28] Demand for tertiary graduates, on the other hand, is influenced by the quality of universities in the given country (measured by the number of S&E students originating from each country who later obtain a doctorate in the United States), as well as the average quality of secondary schooling (measured by the number of undergraduate students in the United States per million people of working age and by international assessment tests for secondary schools). In addition, the regressions use either the share of high-technology exports or GDP per capita as proxies for the degree to which the economic structure is likely to require (and value) tertiary education graduates.[29]

Chart 4.7 shows income ladder returns to tertiary education by country, adjusted for basic supply and demand forces, using the residuals from the first regression in Table 4.2.[30] Assuming that raw returns and supply and demand factors are measured correctly, these adjusted returns reflect differences in the extent to which human capital is used and remunerated across countries. The chart shows a high degree of heterogeneity across countries. For instance, in Lithuania and the Czech Republic university graduates are, on average, almost 1.4 income ladder steps above secondary school graduates, while the difference in the perceived ladder position in Moldova is only 0.2 of a ladder step. The adjusted returns ranking in the chart is likely to be imprecise owing to measurement errors, the relatively small sample, the subjective nature of the relative income measure used in the analysis and the fact that the self-reported position on the income ladder may not reflect informal payments or gifts. Therefore, while a country's broad position in the ranking – that is, whether it is near the top, at the bottom or in the middle – should be informative, the exact order need not be.

The remaining columns of Table 4.2 explore the correlation between returns to education and variables describing the quality of the institutional environment, while controlling for supply and demand. For example, Sweden's level of government effectiveness is associated with returns about one income ladder step above the levels seen in the Kyrgyz Republic and Moldova (column 3). Similarly, the rule of law in Germany and Sweden is associated with returns that are about two-thirds of an income ladder step higher than those seen in Albania, Azerbaijan, Kazakhstan, Kyrgyz Republic, Russia and Ukraine (column 4).

For the same sets of countries, the difference between the minimum and maximum levels of court impartiality is estimated to be associated with a difference in returns of about half an income ladder step (column 5). Levels of contract viability in EU countries (excluding Bulgaria, Poland and Romania) are associated with returns about half a ladder step above those seen in Armenia, Moldova and Russia (column 6). Lastly, the level of transition progress in Estonia – as measured by the EBRD transition indicator – is associated with returns about three-quarters of an income ladder step above those seen in Azerbaijan (column 7).

There are several reasons why the institutional environment could (directly or indirectly) affect the level of returns to education.

- Institutions affect implicit decisions by highly educated people to engage in rent-seeking or socially productive activities.[31] Improvements in government effectiveness reduce the returns to rent-seeking, which is consistent with the regression results. The country-specific legal setting is also crucial, with a stronger rule of law, more impartial courts and a greater level of contract viability all reducing the cost of productive activities (for example, entrepreneurship). Greater progress with transition to a market economy also increases the potential benefits of entrepreneurship, while reducing the relative attractiveness of rent-seeking.
- Market development, government effectiveness and country-specific legal characteristics also affect the allocation of highly educated people across the economy and within particular firms, in terms of both their positions and their actual effectiveness. Better institutions lead to more efficient matching of talented people with demanding jobs, leading to more efficient use of such people and, ultimately, greater productivity.
- By reducing various risks that affect people and firms, a better institutional environment – particularly the legal aspects – directly or indirectly encourages the highly educated to further improve their knowledge and skills, which in turn enhances the quality of human capital stock, even after the completion of formal schooling.

To sum up, a better institutional environment increases the productivity of highly educated people and – by fostering higher returns to schooling – encourages more talented people to complete tertiary education. This, in turn, creates momentum for human capital accumulation and, consequently, for growth.

[27] The data and the estimation method are described in more detail in Box 4.1

[28] Brain drain will reduce the number of tertiary-educated workers competing for jobs and therefore increase returns to tertiary education. At the same time, brain drain could have a downward impact on the returns to education if the human capital of workers who emigrate is higher than that of workers who stay in the country. The regression results suggest that the first channel generally prevails, although the net effect is not statistically different from zero.

[29] See Goldin and Katz (2010).

[30] Chart 4.7 shows the country-specific residuals from the regression (contained in column 1 of Table 4.2).

[31] See Natkhov and Polishchuk (2013).

Table 4.2
Income ladder returns to tertiary education in terms of human capital supply and demand and the institutional environment

	Dependent variable: income ladder return to tertiary education						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Determinants of supply							
Percentage of people with tertiary education	-0.024**	-0.013	-0.015	-0.017	-0.025**	-0.006	-0.014
	(0.011)	(0.011)	(0.010)	(0.011)	(0.011)	(0.011)	(0.013)
Brain drain	0.487	-0.031	0.180	0.268	0.206	0.436	0.008
	(0.599)	(0.572)	(0.485)	(0.562)	(0.616)	(0.599)	(0.626)
Determinants of demand							
Recipients of US S&E doctorates	0.023	0.014	0.014	0.018	0.020	0.023	0.009
	(0.022)	(0.018)	(0.020)	(0.022)	(0.022)	(0.017)	(0.021)
Undergraduates in the United States	-0.001**	-0.001**	-0.001***	-0.001***	-0.001**	-0.001***	-0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Secondary school test scores	-0.000	-0.003	-0.003**	-0.003*	-0.001	-0.002	-0.003*
	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
High-technology exports	0.015**	0.009	0.004	0.009	0.010	0.014*	0.003
	(0.007)	(0.007)	(0.006)	(0.007)	(0.008)	(0.008)	(0.010)
GDP per capita		0.039					
		(0.024)					
Institutional environment							
Effectiveness of government			0.186**				
			(0.072)				
Rule of law				0.127**			
				(0.057)			
Impartial courts					0.090*		
					(0.052)		
Contract viability						0.175***	
						(0.049)	
Transition progress							0.185*
							(0.100)
Transition country indicator	-0.075	0.463	0.143	0.107	0.108	0.110	
	(0.138)	(0.391)	(0.152)	(0.160)	(0.154)	(0.161)	
Intercept	0.912	1.434**	1.329**	1.382**	0.815	0.050	0.826
	(0.813)	(0.570)	(0.505)	(0.659)	(0.728)	(1.217)	(0.580)
Observations	29	29	29	29	29	25	24
R-squared	0.405	0.556	0.587	0.495	0.463	0.648	0.452
Adjusted R-squared	0.207	0.379	0.422	0.294	0.248	0.472	0.212
F	3.383	3.510	4.652	3.983	4.670	5.642	2.079

Source: Barro and Lee (2013), US National Science Foundation, Institute of International Education, Altinok et al. (2013), World Bank (World Development Indicators and Worldwide Governance Indicators), Fraser Institute (Economic Freedom of the World index), International Country Risk Guide and EBRD.
Note: Robust standard errors in parentheses. ***, ** and * denote statistical significance at the 1, 5 and 10 per cent levels respectively. Transition country indicator is a variable equal to 1 if the country is a transition country and 0 otherwise.

Note on variable definitions in Table 4.2 (sources in brackets): "Percentage of people with tertiary education" refers to share of population aged 25 and over who had completed tertiary schooling in 2005 (based on Barro and Lee, 2013, and own calculations); "recipients of US S&E doctorates" refers to average number of recipients in the United States in 2007-11 per million people of working age (National Science Foundation); "undergraduates in the United States" refers to average number of undergraduate students in United States in 2007-11 per million people of working age (Institute of International Education); "secondary school test scores" refers to average score in tests in 1995-2010 (Altinok et al. 2013); "GDP per capita" refers to 2006 GDP per capita at purchasing power parity in thousands of constant 2005 international dollars (World Development Indicators); "high-technology exports" refers to high-technology exports as a percentage of manufactured exports in 2006 (World Development Indicators); "effectiveness of government" refers to an effectiveness indicator for 2006 (Worldwide Governance Indicators); "rule of law" refers to a rule of law indicator for 2006 (Worldwide Governance Indicators); "impartial courts" refers to the variable measuring efficiency, transparency and neutrality of the legal framework with respect to dispute settlements and challenging government actions and or regulations in 2006 (Economic Freedom of the World); "contract viability" refers to the viability of contracts in 2006 (International Country Risk Guide); and "transition progress" refers to the average EBRD transition indicator score in 2006 (EBRD).

CONCLUSION

In many transition countries the stock of human capital educated to secondary level or higher is nominally on a par with, or above, most mature market economies. However, there are large differences in the quality of human capital across the transition region. A few countries (such as Estonia, Hungary, Poland and Slovenia) appear to be relatively close to the mature market economies, while others (including most countries in Central Asia) lag far behind. Countries in the SEMED region tend to be somewhere in the middle. Thus, many transition and SEMED countries risk being left behind. Only a few transition and SEMED countries – and also Turkey – have increased their international competitiveness in terms of education and research.

How can more countries catch up in this respect? This chapter has presented a number of measures that policy-makers can use to benchmark primary, secondary and tertiary education in their countries. At the same time, the regressions suggest that the quantity and quality of education are not all that matter when building an effective stock of human capital. Economies with better economic and legal institutions which are open to new ideas and global markets use their human capital in a more efficient way. This also means that they can provide high-skilled workers with higher returns and therefore deter brain drain.

Governments must provide a good regulatory framework to ensure excellence in the fields of research and teaching. They also need to recognise the relevance of specific skills, particularly at secondary and vocational levels.

A higher proportion of educated people does not necessarily lead to faster economic growth if the skills acquired during schooling do not match employers' needs. Better communication and cooperation between the private sector and universities would be beneficial and should be encouraged. Similarly, governments should not subject universities to political interference, which may deter creativity and trigger brain drain. They should provide adequate funding.

Policy-makers must also realise that having weak economic institutions and lagging behind in terms of economic reform will impede the development of human capital. Improved institutional environments are necessary to develop, attract and retain high-skilled people who will innovate, adapt to global technological changes and promote economic growth.

The stock of human capital tends to improve slowly, while brain drain may rapidly reduce it. Nevertheless, institutions can sometimes change quickly for the better through political or economic reform. They can influence the creation of human capital because they determine what returns to education people can expect. Institutions can also affect growth by determining how the existing human capital stock is used and by influencing migration flows. Developing human capital and improving institutions in transition economies are therefore complementary strategies. They reinforce each other, and should therefore be pursued in parallel.

Box 4.1
Estimating returns to tertiary schooling

Investigating the determinants of returns to tertiary schooling, as summarised in Table 4.2, is a two-stage process. The first involves estimating returns at the country level. The following equation is estimated for each country using the pooled sample of wage-earning heads of households in the first and second LiTS surveys:[32]

$$y_{i,c}=\beta_{0,c}+\beta_{PrimEduc,c}PrimEduc_{i,c}+\beta_{TertEduc,c}TertEduc_{i,c}+\beta_{Exp,c}Experience_{i,c}+\beta_{Exp2,c}Experience^2_{i,c}+\beta_{Wave,c}Wave_{i,c}+u_i$$

where i and c denote household i in country c and $y_{i,c}$ denotes the household's subjective income ladder position, measured on a scale of 1 to 10 (where 10 means that the head of the household considers the household to be in the highest income decile).[33] $PrimEduc_{i,c}$ is an indicator that takes the value 1 if the head of the household has completed only primary education and 0 otherwise, $TertEduc_{i,c}$ is a similar indicator for tertiary education, and $Experience_{i,c}$ denotes the work experience of the head of household i in country c, which is assumed to be equal to the length of the individual's post-school life.[34] $Wave_{i,c}$ indicates the LiTS survey round to which the data correspond. $\beta_{TertEduc,c}$ is the coefficient of interest, capturing the added value of attaining a tertiary degree compared with completing only secondary schooling in country c.

It is important to point out two potential limitations of this regression.

- A crucial assumption is that the experience and educational achievements of the *head* of the household contribute to his or her perception of the subjective income of the entire household. Since that income may also reflect the spouse's income, for example, or other sources of income, this may not always hold.
- The subjective income position may not be a reliable predictor of objective economic outcomes.[35] As a result, it is important to consider the true nature of the subjective variable when interpreting the results.

In the second stage, the estimated country-level returns to tertiary education ($\beta_{TertEduc,c}$) are regressed on supply and demand factors, as well as institutional environment variables, as follows:

$$\beta_{TertEduc,c}=a_0+a_{Supply}Supply_c+a_{Demand}Demand_c+a_{InstEnvir}InstEnvir_c+\varepsilon_c$$

where $Supply_c$ and $Demand_c$ represent country-specific factors (or proxies for such factors) affecting the supply and demand channels in country c, as described in the main text.[36] $InstEnvir_c$ denotes a particular aspect of the institutional environment. Table 4.1.1 shows that the institutional variables used in the analysis are highly correlated with each other.[37] For this reason, only one is included at any given time (see Table 4.2).

Table 4.1.1
Correlation between institutional environment variables in the context of returns to schooling

	Effectiveness of government	Rule of law	Impartial courts	Contract viability
Rule of law	0.951			
Impartial courts	0.724	0.696		
Contract viability	0.792	0.796	0.510	
Reforms	0.909	0.887	0.602	0.687

For sources and notes, see Table 4.2.

Annex 4.1

MEASURING THE QUALITY OF EDUCATION

PRIMARY AND SECONDARY EDUCATION: PISA, TIMSS AND PIRLS

The rankings for primary and secondary education shown in Charts 4.2a and 4.2b in the main text are based on the combined average country scores in three international student assessments: the Progress in International Reading Literacy Study (PIRLS), the Trends in International Mathematics and Science Study (TIMSS) and the Programme for International Student Assessment (PISA).[38] Of the transition countries, only Belarus, Kosovo, Tajikistan, Turkmenistan and Uzbekistan have yet to participate in any of these three assessments.

Reading literacy in the fourth grade (PIRLS) is reasonably good in most transition countries. Russia shared the second place with Finland in 2011 (after Hong Kong). However, Azerbaijan and Georgia lagged significantly behind other transition countries.

Proficiency in mathematics in the eighth grade lags only slightly behind the average for advanced economies. Russia was the best performer of the 10 countries in the transition region that participated in the mathematics TIMSS in 2011. It was also ahead of all western European countries, but trailed South Korea, Singapore, Taiwan, Hong Kong and Japan. Countries in the SEMED region lagged behind other transition countries, although Tunisia was roughly on a par with FYR Macedonia and Georgia in 2011.

Transition countries' average level of attainment in science in the eighth grade was roughly the same as that seen in the advanced economies in 2011. The leading countries were

[32] This follows the standard "Mincerian" regression approach to estimate the determinants of wages or earnings. The LiTS survey is split into two parts, with two possible respondents. The first respondent is the head of the household or a knowledgeable family member, while the second is selected randomly from among the members of the household using the Kish grid method (a pre-assigned table of random numbers). The subjective income variable and the education level variable are included in the second part of the survey, where the respondent is chosen at random.

[33] The exact wording is as follows: "Please imagine a ten-step ladder where on the bottom, the first step, stand the poorest people and on the highest step, the tenth, stand the richest. On which step of the ten is your household today?"

[34] Specifically, $Experience_{i,c}=age_i-6-YrsEduc_i$, where *YrsEduc* is six years of schooling for primary education, 12 years for secondary education and 16 years for tertiary education.

[35] See Cojocaru and Diagne (2013).

[36] The percentage of the population aged 25 and over who had completed tertiary education in 2005 (which is the year closest to the base year) was calculated on the basis of the widely used Barro-Lee

Table A.4.1.1
PISA, TIMSS and PIRLS scores

Country	PISA						PIRLS (fourth grade)		TIMSS (eighth grade)			
	Reading (2000)	Maths (2006)	Science (2006)	Reading (2009)	Maths (2009)	Science (2009)	2001	2011	Maths (1999)	Science (1999)	Maths (2011)	Science (2011)
Transition region and Turkey												
Albania	348.8			384.8								
Armenia									478[b]	461[b]	467	437
Azerbaijan	352.9[c]	476.0	382.3	361.5	431.0	373.2	462					
Bosnia and Herzegovina											456[d]	
Bulgaria	430.4	413.4	434.1	429.1	428.1	439.3	550	532	540[a]	565[a]	464[d]	479[b]
Croatia	477.4[c]	467.2	493.2	475.7	459.9	486.4	553					
Czech Republic	491.6	516.5[b]	512.9	478.2	492.8	500.5	537	545	564[a]	574[a]	504[d]	539
Estonia	500.7[c]	514.6	531.4	501.0	512.1	527.8			531[b]	552[b]		
FYR Macedonia							442	442[c]	447	458	426	407
Georgia							471[c]	488	410[d]		431	420
Hungary	480.0	490.0[b]	503.9	494.2	490.2	502.6	543	539	537[a]	554[a]	505	522
Kazakhstan											487	490
Kyrgyz Republic	284.7[c]	310.6	322.0	314.0	331.2	329.5						
Latvia	458.1	483.4[b]	489.5	484.0	482.0	493.9	545	541[c]	493[a]	485[a]	508	512[b]
Lithuania	470.1[c]	486.4	488.0	468.4	476.6	491.4		557[c]	477[a]	476[a]	502	514
Moldova							492	500[c]	469	459	460	472[b]
Montenegro	392.0[c]	399.3	411.8	407.5	402.5	401.3						
Poland	479.1	490.2[b]	497.8	500.5	494.8	508.1	519[c]	526				
Romania	427.9	414.8	418.4	424.5	427.1	428.2	512	502	482[a]	486[a]	458	465
Russia	461.8	468.4[b]	479.5	459.4	467.8	478.3	528	568	535[a]	538[a]	539	542
Serbia	411.7[b]	436.9[b]	435.6	442.0	442.4	442.8			477[b]	468[b]	486[d]	
Slovak Republic	469.2[b]	498.2[b]	488.4	477.4	496.7	490.3	518	535	547[a]	544[a]	508	517[b]
Slovenia	494.4[c]	504.5	518.8	483.1	501.5	511.8	502	530	541[a]	560[a]	505	543
Turkey	441.0[b]	423.4[b]	423.8	464.2	445.5	453.9	449		429	433	452	483
Ukraine									462[d]		479	501
SEMED countries												
Egypt									406[b]	421[b]	391[d]	
Jordan	400.6[c]	384.0	422.0	405.0	386.7	415.4			428	450	406	449
Morocco							350	310	337	323	371	376
Tunisia	374.6[b]	358.7[b]	385.5	403.6	371.5	400.7			448	430	425	439

Source: PISA, PIRLS and TIMSS.
Note: a – 1995; b – 2003; c – 2006; d – 2007.

Slovenia and Russia, which performed better than the United States and all EU countries except Finland.

More countries from the transition region participated in the 2006 and 2009 rounds of the PISA programme, which pointed to an increase in the gap between those countries and advanced economies. The order of countries in terms of the achievements of 15-year-old school pupils was similar to that seen for fourth grade pupils. Estonia performed the best in reading, mathematics and science in 2009 – on a par with Switzerland in reading, Germany and Belgium in mathematics and sixth out of all participating countries in science.

TERTIARY EDUCATION

This annex presents more detailed information and data on some of the proxies for the quality of tertiary education presented in the main text.

League tables of top universities typically rank the world's top 500 universities (out of a total of approximately 17,000 universities worldwide). The Academic Ranking of World Universities (ARWU) was first published in 2003 by the Shanghai Jiao Tong University. That was followed by the Times Higher Education (THE) World University Rankings, which were first produced in cooperation with Quacquarelli Symonds (QS) in 2004. In 2010 THE partnered Thomson Reuters in producing new rankings, while QS continued using the same methodology as before in partnership with US News & World Report.

A purely research-based ranking, the Performance Ranking of Scientific Papers for World Universities – also known as the Higher Education Evaluation and Accreditation Council of Taiwan Ranking (HEEACT Ranking) – was first published in 2007. Since 2012 the ranking has been known as the National Taiwan University Ranking (NTU Ranking).[39]

dataset, augmented with additional census-based and survey-based data used to impute figures for the missing countries. For the countries missing from the Barro-Lee dataset, the percentage of people having completed tertiary education in 2005 was imputed using census data, IIASA/VID imputations and data from the UNESCO Global Education Digest (GED; 2008 and 2011). Where data for people over the age of 25 were not available, data for people over the age of 15 were linearly interpolated using the assumption that the percentage of people between the ages of 15 and 24 who have completed tertiary education is equal to the percentage of all people over the age of 15 who have such an educational level. In Kosovo there were no census data available prior to 2011, so the Demographic and Health Survey from 2003 was used for the purposes of interpolation. Further adjustments were made to reflect the fact that unlike the Barro-Lee dataset, the IIASA/VID and GED datasets include non-university education in the tertiary category.

[37] To improve the comparability of the institutional factors, all of the institutional indices were adjusted to fit a scale between 0 and 10.

[38] See Altinok et al. (2013) for details. PIRLS and TIMSS are conducted by the International Association for

Table A.4.1.2
Number of top 500 universities in league tables by region

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Transition region										
ARWU	8	8	7	8	8	8	8	9	10	10
QS		15						12	11	
NTU									7	
Turkey										
ARWU	0	2	0	1	1	1	1	1	1	1
QS		4						5	2	
NTU									0	
SEMED										
ARWU	0	0	1	1	0	0	0	1	1	1
QS		1						1	1	
NTU									0	
Advanced economies										
ARWU	465	459	461	462	451	448	443	439	432	432
QS		429						435	427	
NTU									455	
Other										
ARWU	29	31	31	38	43	44	48	50	56	56
QS		51						47	60	
NTU									38	

Source: Authors' calculations based on ARWU, QS World University Ranking and NTU Ranking.

Table A.4.1.3
Number of citable documents published in the three previous years, average h-index and average number of citations per document

	Transition region	Turkey	SEMED	Advanced economies	Other
Number of citable documents published in three previous years (thousands)					
1997	72.1	5.6	4.7	883.4	90.9
1998	72.9	6.1	4.9	886.1	99.5
1999	72.8	7.1	5.1	887.9	105.3
2000	75.2	7.2	5.4	904.5	113.8
2001	76.6	8.6	5.7	883.3	128.1
2002	79.5	11.1	6.1	921.9	136.2
2003	86.4	13.8	7.0	1,024.0	161.7
2004	90.7	16.4	7.8	1,061.7	203.3
2005	104.0	18.7	8.5	1,213.8	274.7
2006	105.7	21.1	9.8	1,343.4	332.9
2007	112.5	23.1	11.1	1,375.0	372.9
2008	120.8	23.4	12.6	1,382.6	429.5
2009	123.7	26.8	15.2	1,414.8	496.7
2010	137.1	29.5	16.9	1,557.7	570.7
2011	142.5	30.2	19.0	1,588.9	644.6
Average number of citations per document (excluding self-citations)					
1996-2011	4.6	4.5	4.3	9.8	7.6
Average h-index					
1996-2011	100.6	193.0	91.0	223.3	59.7

Source: Authors' calculations based on the SCImago Journal and Country Rank portal (www.scimagojr.com).

Table A.4.1.2 shows the number of top 500 universities by region according to the ARWU, QS and NTU rankings, respectively. The number of universities from transition and SEMED countries in the top 500 varies across the rankings; universities from the Czech Republic, Poland and Russia are included in the latest available versions of each ranking.

The 2013 ARWU includes 10 universities from seven transition countries (Croatia, Czech Republic, Hungary, Poland, Russia, Serbia and Slovenia) and one from Turkey. The 2013 ranking also included a university from one SEMED country – Egypt. The 2012 QS ranking contained 11 universities from four countries in the transition region (the Czech Republic, Kazakhstan, Poland and Russia) and two from Turkey, while the SEMED region was again represented by a single Egyptian university. Turkey and the SEMED countries are missing from the 2012 NTU ranking, which features seven universities from six countries in the transition region (Croatia, Czech Republic, Hungary, Poland, Russia and Slovenia).

Table A.4.1.3 shows, for each year, the number of citable articles published by academic journals in the three previous years, the average h-index for the period 1996-2011 and the number of citations (excluding self-citations) per document. The number of citable documents has increased across the world, particularly in Turkey and the SEMED countries (especially Tunisia). In the transition region, Serbia and Bosnia and Herzegovina have also recorded large rises. This could be due to increases in the number of peer-reviewed journals over time; unfortunately, the aggregate data do not provide any information about this, nor about the quality of journals.

Advanced economies lead in terms of the average number of citations per document (excluding self-citations), with 9.8 between 1996 and 2011, followed by the transition region,

the Evaluation of Educational Achievement (IEA), while PISA is conducted by the OECD. PIRLS is designed to measure reading literacy in the fourth grade and is a successor to the IEA's Reading Literacy Study, which ran from 1970 to 1991. Since 2001 PIRLS has been conducted every five years. TIMSS measures trends in achievement levels for mathematics and science in the fourth and eighth grades. It has been conducted at regular four-year intervals since 1995. PISA has measured the reading, mathematics and science achievements of 15-year-old school pupils at regular three-year intervals since 2000.

[39] See Rauhvargers (2011) for an excellent overview of the existing university rankings.

Turkey and SEMED countries with around 4.5. Hungary and Estonia are the two countries that are closest to the advanced economies' average, with 8.8 and 8.6 citations per document respectively.

The United States leads in terms of the average h-index (with 1,305), followed by the United Kingdom, Germany, France and Canada. Turkish scholars follow relatively closely behind, with an average of 193.0 (similar to the level in Chile), while academics in the transition and SEMED regions trail some way behind with averages of 100.6 and 91.0 respectively. Among the transition countries, the best performers are Russia, Poland and Hungary, while Egypt leads in the SEMED region.

Table A.4.1.4 shows the number of recipients of S&E doctorates at US universities for the period 1982-2011.[40] More than half of all doctoral degrees in the United States are awarded in the field of S&E. This yardstick does not take into account recipients of doctorates in other advanced economies, nor the attractiveness of doctoral training in recipients' home countries. However, it is still likely to be a reasonable proxy for the quality of undergraduate education in recipients' countries of origin, given the high ranking positions of US universities (which account for half of the world's top 100 universities and almost half of the world's top 200 universities according to ARWU). Also, US universities typically offer paid graduate assistantships to the majority of graduate students accepted, making doctoral studies more attractive there than in other countries.

With the exception of students from the former Yugoslavia, S&E doctorate recipients at US universities from the transition region were rare prior to the collapse of communism. This was probably a reflection of restrictions on travel, rather than the quality of tertiary education in those countries. The following two decades saw large increases, due mainly to recipients from Bulgaria, Romania, Serbia, Croatia and Slovenia. Moreover, between 2002 and 2011 Bulgaria was among the top three sources of undergraduate students from transition countries. The number of doctorate recipients from Turkey also increased sharply, while the number of Jordanian recipients declined (albeit from a high level).

Table A.4.1.4

Number of S&E doctorate recipients, undergraduate students and graduate students in the United States per million people of working age in the country of origin

	Recipients of S&E doctorates			Undergraduate students	Graduate students
Country of origin	**1982-91**	**1992-2001**	**2002-11**	**2002-11**	**2002-11**
Transition region					
Albania	n/a	10.57	50.74	253.22	128.00
Bulgaria	1.52	53.12	107.97	339.83	219.30
Czech Republic	2.08	21.10	24.60	68.33	46.77
Hungary	6.16	40.81	35.45	52.77	59.09
Mongolia	n/a	n/a	28.00	369.91	123.88
Poland	10.69	17.22	17.56	55.82	31.36
Romania	1.54	38.01	103.84	59.03	118.42
Slovak Republic		13.32	26.86	80.10	52.55
Former Soviet Union	0.38				
Armenia		13.89	60.00	66.25	109.69
Azerbaijan		1.65	4.39	22.75	24.79
Belarus		2.82	12.44	32.23	25.13
Estonia		22.28	35.23	173.71	91.15
Georgia		8.30	19.92	50.30	66.37
Kazakhstan		1.71	7.21	61.27	29.49
Kyrgyz Republic		0.00	6.27	31.49	28.98
Latvia		7.36	26.69	155.82	69.97
Lithuania		14.75	27.46	143.17	71.48
Moldova		3.35	14.65	78.70	47.53
Russia		11.89	18.91	20.98	24.76
Tajikistan		6.13	1.45	27.34	12.53
Turkmenistan		n/a	2.58	24.22	16.68
Ukraine		5.05	19.97	21.50	29.22
Uzbekistan		0.98	2.99	14.42	11.54
Former Yugoslavia	32.57				
Bosnia and Herzegovina		12.27	25.13	105.03	43.25
Croatia		52.61	65.80	111.41	91.10
FYR Macedonia		17.85	38.42	116.43	85.90
Kosovo			n/a	392.01	124.56
Serbia and Montenegro (figures for 2002-2006)		67.25	55.85	55.03	59.43
Montenegro			16.67	123.33	55.24
Serbia			44.08	105.48	90.97
Slovenia		36.85	46.08	73.24	63.95
Turkey	30.38	50.44	92.18	85.48	149.43
SEMED countries					
Egypt	42.47	24.87	24.53	11.75	26.30
Jordan	419.65	302.02	278.11	191.01	342.79
Morocco	12.58	11.24	5.43	43.82	23.05
Tunisia	26.46	41.92	8.50	21.59	20.85

Source: Authors' calculations based on National Science Foundation (2013) and Institute of International Education (2002-11).
Note: "n/a" stands for "not available". Data for countries with fewer than five recipients of S&E doctorates in a given time period are not disclosed owing to confidentiality concerns.

[40] We would like to thank Mark K. Fiegener from the National Science Foundation for sharing this breakdown of earned S&E doctorates for all countries of origin.

References

N. Altinok, C. Diebolt and J.-L. Demeulemeester (2013)
"A new international database on education quality: 1965-2010", Association Française de Cliométrie Working Paper No. 03-13. See www.cliometrie.org/images/wp/AFC_WP_03-2013.pdf (last accessed 30 August 2013).

E. Artuç, F. Docquier, C. Ozden and C. Parsons (2013)
"A global assessment of human capital mobility: the role of non-OECD destinations", mimeo, February. See http://perso.uclouvain.be/frederic.docquier/filePDF/DOPA_V2.pdf (last accessed 30 August 2013).

D. Autor, L. Katz and M. Kearney (2006)
"The polarization of the U.S. labor market", *American Economic Review*, Vol. 96, No. 2, pp. 189-194.

R.J. Barro and J.-W. Lee (2013)
"A new data set of educational attainment in the world, 1950–2010", *Journal of Development Economics*, Vol. 104, No. 4, pp. 184-198.

N. Bloom, H. Schweiger and J. Van Reenen (2012)
"The land that lean manufacturing forgot? Management practices in transition countries", *Economics of Transition*, Vol. 20, No. 4, pp. 593-635.

J.D. Brown, J. Earle and A. Telegdy (2006)
"The productivity effects of privatization: Longitudinal estimates from Hungary, Romania, Russia, and Ukraine", *Journal of Political Economy*, Vol. 114, No. 1, pp. 61-99.

K.B. Burchardi and T.A. Hassan (2013)
"The economic impact of social ties: Evidence from German reunification", *Quarterly Journal of Economics*, Vol. 128, No. 3, pp. 1219-1271.

M. Burda and C.M. Schmidt (1997)
"Getting behind the East-West German wage differential", Discussion Paper No. 250, University of Heidelberg. See http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.45.5517&rep=rep1&type=pdf (last accessed 30 August 2013).

S.R. Chase (1998)
"Markets for communist human capital: returns to education and experience in the Czech Republic and Slovakia", *Industrial and Labor Relations Review*, April, Vol. 51, No. 5, pp. 401-423.

A. Cojocaru and M.F. Diagne (2013)
"How reliable and consistent are subjective measures of welfare in Europe and Central Asia?", World Bank Policy Research Working Paper No. 6359. See http://elibrary.worldbank.org/content/workingpaper/10.1596/1813-9450-6359 (last accessed 30 August 2013).

F. Docquier and H. Rapoport (2012)
"Globalization, brain drain, and development", *Journal of Economic Literature*, Vol. 50, No. 3, pp. 681-730.

W.R. Easterly (2002)
"The elusive quest for growth", MIT Press, Cambridge MA, United States.

EBRD (2010)
Transition Report 2010: Recovery and Reform, London.

B. Eichengreen, D. Park and K. Shin (2013)
"Growth slowdowns redux: new evidence on the middle-income trap", NBER Working Paper No. 18673.

R.J. Flanagan (1995)
"Wage structures in the transition of the Czech economy", *IMF Staff Papers*, Vol. 42, No. 4, pp. 836-854.

X. Gabaix and A. Landier (2008)
"Why has CEO pay increased so much?", *Quarterly Journal of Economics*, Vol. 123, No. 1, pp. 49-100.

L. Garicano and T. Hubbard (2009)
"The return to knowledge hierarchies", mimeo, October. See www.kellogg.northwestern.edu/faculty/hubbard/htm/research/papers/draft_20091021.pdf (last accessed 30 August 2013).

L. Garicano and E. Rossi-Hansberg (2006)
"Organization and inequality in a knowledge economy", *Quarterly Journal of Economics*, Vol. 121, No. 4, pp. 1383-1435.

N. Gennaioli, R. La Porta, F. López-de-Silanes and A. Shleifer (2013)
"Human capital and regional development", *Quarterly Journal of Economics*, Vol. 128, No. 1, pp. 105-164.

C. Goldin and L. Katz (2010)
"The race between education and technology", Harvard University Press, Cambridge MA, United States.

S. Guriev and E. Zhuravskaya (2009)
"(Un)Happiness in transition", *Journal of Economic Perspectives*, Vol. 23, No. 2, pp. 143-168.

Institute of International Education (various years)
"International students by academic level and place of origin", Open Doors Report on International Educational Exchange. See www.iie.org/opendoors (last accessed 30 August 2013).

S. Kaplan and J. Rauh (2013)
"It's the market: the broad rise in the return to top talent", *Journal of Economic Perspectives*, Vol. 27, No. 3, pp. 35-56.

L. Katz and K. Murphy (1992)
"Changes in relative wages, 1963-1987: Supply and demand factors", *Quarterly Journal of Economics*, Vol. 107, No. 1, pp. 35-78.

G. Kertesi and J. Köllő (2002)
"Economic transformation and the revaluation of human capital – Hungary, 1986–1999", in A. De Grip, J. van Loo and K. Mayhew (eds.): "The economics of skill obsolescence: theoretical innovations and empirical applications" (pp. 235-273), *Research in Labour Economics*, Vol. 21.

B. Krueger and J.S. Pischke (1995)
"A comparative analysis of East and West German labour markets before and after unification", in R. Freeman and L. Katz (eds.): "Differences and changes in wage structures", University of Chicago Press, United States.

C.E. Montenegro and H.A. Patrinos (2012)
"Returns to schooling around the world", background paper for the WDR 2013. See http://siteresources.worldbank.org/EXTNWDR2013/Resources/8258024-1320950747192/8260293-1320956712276/8261091-1348683883703/WDR2013_bp_Returns_to_Schooling_around_the_World.pdf (last accessed 30 August 2013).

National Science Foundation (2013)
Survey of Earned Doctorates.

T. Natkhov and L. Polishchuk (2013)
"Institutions and allocation of talent", mimeo.

L. Pritchett (2001)
"Where has all the education gone?", *World Bank Economic Review*, Vol. 15, No. 3, pp. 367-391.

P. Puhani (1997)
"All quiet on the wage front in Poland?", *ZEW Discussion Papers*, No. 97-03 E. See ftp://ftp.zew.de/pub/zew-docs/dp/dp0397.pdf (last accessed 30 August 2013).
A. Rauhvargers (2011)
Global university rankings and their impact – European University Association Report on Rankings 2011. See www.eua.be/pubs/Global_University_Rankings_and_Their_Impact.pdf (last accessed 30 August 2013).
J. Rutkowski (1996)
"High skills pay off: the changing wage structure during economic transition in Poland", *Economics of Transition*, Vol. 4, No. 1, pp. 89–112.
H. Schweiger and G. Friebel (2013)
"Management quality, ownership, firm performance and market pressure in Russia", *Open Economies Review*, Vol. 24, No. 4, pp. 763-788.
H. Schweiger and P. Zacchia (2013)
"Are science cities fostering innovation in firms? Evidence from Russia's regions", mimeo.
B. Sianesi and J. Van Reenen (2003)
"The returns to education: Macroeconomics", *Journal of Economic Surveys*, Vol. 17, No. 2, pp. 157-200.
J. Svejnar (1990)
"A framework for the economic transformation of Czechoslovakia", *Eastern European Economics*, Vol. 29, No. 2, pp. 5-28.
M. Terviö (2008)
"The difference CEOs make: An assignment model approach", *American Economic Review*, Vol. 98, pp. 642-668.
UNESCO (2008)
Global Education Digest 2008, UNESCO Institute for Statistics, Montreal, Canada. See www.uis.unesco.org/Library/Documents/ged08-en.pdf (last accessed 30 August 2013).
UNESCO (2011)
Global Education Digest 2011, UNESCO Institute for Statistics, Montreal, Canada. See www.uis.unesco.org/Education/GED%20Documents%20C/GED-2011-Book-EN-web2.pdf (last accessed 30 August 2013).
J. Večerník (1995)
"Changing earnings distribution in the Czech Republic: Survey evidence from 1988-94", *Economics of Transition*, Vol. 3, No. 3, pp. 355-371.
World Bank (2011)
Migration and Remittances Factbook 2011, World Bank, Washington, DC. See http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTDECPROSPECTS/0,,contentMDK:22759429~pagePK:64165401~piPK:64165026~theSitePK:476883,00.html (last accessed 30 August 2013).
World Bank (2012)
World Development Report 2013: Jobs, World Bank, Washington, DC. See http://siteresources.worldbank.org/EXTNWDR2013/Resources/8258024-1320950747192/8260293-1322665883147/WDR_2013_Report.pdf (last accessed 30 August 2013).