University Rankings Game and its relation to GDP per capita and GDP growth

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Abstract

In this paper, ARWU is used as a benchmark of World-Class Universities (WCUs). Universities that are among the Top 500 are considered World-Class Universities.

The paper concludes that WCUs per capita (the number of World-Class Universities relative to the country's population) is strongly related to the country's GDP per capita. But WCU per capita has no effect on GDP growth.

There is an obvious increase in the significance level when the ranking lists used to define WCUs are expanded from Top 100 to Top 500. This suggests that to attain a higher GDP per capita, it is therefore more important for a country to have more decent World-Class Universities (in the top 500) than having only a few elite World-Class Universities (in the top 100).

When institutional factors are added into the regression model, clean government appears as the most important factor, followed by respect for property rights, business freedom, and investment freedom.

Introduction

Recently, the term "world-class university' has become the buzzword to describe research universities as the pinnacle of tertiary education hierarchy (Salmi 2009). A world class research university is crucial in enhancing a nation's competitiveness in the global knowledge economy (Wang, Cheng and Liu 2013). Salmi (2009) define world-class universities with the following characteristics : "(a) a high concentration of talent; (b) abundant resources to offer a rich learning environment and to conduct advanced research; and (c) favourable governance features that encourage strategic vision, innovation, and flexibility and that enable institutions to make decisions and to manage resources without being encumbered by bureaucracy."

There is universal recognition of the importance of building world-class research universities in almost every country (Altbach 2011). Many countries have the ambition of building at least one or more world class research universities. For example, a number of strategic funding programmes have been implemented to promote excellence by different countries, such as China's 985 Project, Japan's Centres of Excellence, Korea's Brain Korea 21, and Germany's Centres of Excellence, and selected universities in these countries are given extra funding to further develop their expertise in teaching and research (Wang, Cheng and Cai 2012).

We live in an age of academic hype in which all kinds of universities want to claim the esteemed status of "world-class universities" (Altbach 2004). But still, how to tell which university is considered world-class and more world-class than the rest, especially when students make their lifetime educational choices? University rankings emerged to fulfil this informational need.

> The history of university rankings dates back to 1983, when US News and World Reports started the first annual publication of “America’s Best Colleges”, and other countries quickly followed suit to publish their own national rankings. Initially, the rankings were limited to the context of only one country. But the rapid increase in the mobility of students due to economic integration and globalization has made universities more international in nature. It is no longer sufficient for universities to compete with universities from their own countries. They must compete in a global environment and many of the universities expect being considered as “World-Class Universities”. In 2003, Shanghai Jiaotong University published its first Academic Ranking of World Universities (ARWU), which is the precursor of an academic ranking of universities globally. After this initiative, many other entities published different versions of global university rankings as well.
>
> (An excerpt from Casal, G. B. and Martinez, O. G. and Sanchez, M. P. and Munoz, O. V. 2007)

According to Usher and Savino (2007), university rankings are lists of academic institutions ranked according to a common set of indicators in descending order, and they are usually presented in the format of a league table, in which universities are listed from best to worst.

The next question is then how to properly rank these universities. As we know, university performs both teaching and research, and thus we might need to measure both teaching and research quality to get a full picture of university quality. But as N.C. Liu and Y. Cheng (2005) noted, it is debatable whether we can directly measure the teaching or education quality of universities, and they argued that the only possible way to objectively rank universities is to rank their research performance, based on internationally comparable data that everyone can verify.

(N.C. Liu is the founder of the Academic Ranking of World Universities (ARWU) at Shanghai Jiaotong University. ARWU will be used to proxy for university quality in this paper.)

Many university administrators abhor “this form of detailed numerical ordering of the institutions” (Monks and Ehrenberg 1999) but as Merisotis (2002) has noted, university rankings are here to stay. Though they are imperfect, university rankings provide information about the quality of higher education institutes (Usher and Savino 2007). In fact, students used rankings as a basis to decide which university to attend (Hazelkorn 2008, Dill and Soo 2004). Even though university rankings measure universities’ research performance, the students use the rankings to help them decide which college to attend. It is also found that two-thirds of parents felt the rankings to be very useful in evaluating a college’s quality (Machung 1998). Therefore, in view of this phenomenon, many universities used rankings as part of their strategic plans for improvement and marketing strategy (Usher and Savino 2007). For example, Cornell University took actions to improve its rankings that had no effect on the university’s academic quality. (Monks and Ehrenberg 1999)

Countries, politicians and universities themselves often express their ambition to see their university to be among the Top 20 or Top 100, or indeed, simply enter the ranking lists in the future (EUA Report 2011). This is not realistic for many countries because by definition, there can only be 500 universities among the Top 500. The “university rankings game” is indeed a zero sum game. It may not be sensible for all countries to be obsessed with building highly ranked world-class universities. As Jalmi (2009) noted, it is not realistic to aspire for world-class universities for most countries, at least not when the more basic higher education needs are not addressed. Altbach (2004) agreed with this viewpoint too and he suggested that instead, it might be better for many countries to focus on building world-class departments, especially in fields that are most relevant to the needs of local economy.

To further investigate how university rankings impact GDP per capita and GDP growth, we need to look at papers that study factors contributing to country's performance in the "university rankings game".

Craig A. Depken, II and Egle Mazonaite investigated the factors that contribute to the number of universities ranked in the QS Top 500 World Universities in 2008, and they found that larger population, greater economic (and perhaps academic) freedom, being industrialized, ethnic fractionalization all contribute to having more universities ranked in the top 500 list. Also, Li, Shankar, and Tang (2009) found that how a university performs in the league tables depends on four socioeconomic factors, namely income, population size, R & D spending, and the national language.

Peter U. Okorie (Oct 2013) wrote a paper that shows African countries with better university performance generally performed better in the rankings of economic indicators such as Human Development Index (HDI). But apparently, Peter U. Okorie (Oct 2013) failed to look at the number of universities in Africa's top 100 on a per capita basis. Marginson (2007) compares the countries' share of Top 100 and Top 500 research universities with their share of world GDP, but he failed to take into account of the population effects.

To sum up all these findings, we can say that given other things equal, countries with higher income levels and larger population are able to produce more World-Class Universities (WCUs) that are able to enter the ranking lists. With this idea in mind, this paper will propose a new simple regression model to capture these features. In other words, this paper will investigate the relationship between the country's WCUs per capita and its GDP per capita or GDP growth. The model will later add in institutional factors such as freedom from corruption, respect for property rights, business freedom, and investment freedom. Also, the model will consider GDP growth as well as the dependent variable.

The following section will evaluate the evidence on the economics of education from micro, macro and institutional perspective.

Literature Review on Economics of Education

At a micro level, human capital theory suggests that education is an investment that increases the productivity of workers, hence increasing the lifetime earnings of workers (Becker, 1964). Mincer (1974) included the measure of on-the-job training and experience in his Mincer Equation. Many studies have confirmed the positive impact of education on individual's earnings, such as Card (1999), Amermuller, Kuckulenz and Zwick (2006), Cohn and Addison (1998), Schultz (1960), Becker (1967), Mincer (1958), Arrow (1973) and Spence (1974).

Temple (2001) and Harmon, Oosterbeek and Walker (2003) concluded that there is strong evidence that private returns to education are unambiguously high. Temple (2001) estimated that the private rate of return to a year's extra schooling is typically between 5 per cent and 15 per cent.

Xiao (1999) found that pre-work formal education had a positive impact only on the initial salary at hiring, and that firm-based on-the-job training increased salaries through productivity increases, based on a 1996 salary survey of 1,023 employees in Shenzhen, China. Mason et al. (2012) found that vocational skills had a positive impact on average labor productivity growth in 6 of the 7 countries considered. Therefore, education can be more than just formal schooling.

There is a school of thought which suggests education does not increase productivity but to indicate the potential of productivity. Spence (1973) developed his famous Job Market Signaling Model to suggest that people attend university to signal to the employers that they are more capable than the rest, even if universities do not increase their productivity. Arrow (1973) developed a mathematical model to show that higher education helps to identify the more capable individuals and filter out less capable individuals. Thurow (1975) suggested that firms can train well-educated workers at a lower cost. Indeed, Harmon, Oosterbeek and Walker (2000) pointed out that the coefficient on education variable may not fully reflect the impact of education on productivity if it is correlated with unobserved characteristics such as ability that are also correlated with wages, and therefore, the education coefficient is more likely to reflect both the impact of education on productivity and the impact of the unobserved variable that is correlated with education.

On the other hand, Arrow (1973) made it clear that he personally do not believe higher education serves as only a screening device because apparently, professional schools and degrees in science subjects teach useful skills that are highly sought after in the market, although it is much less clear for liberal arts courses. Sianesi and Van Reenen (2000) also concluded that based on the review of several studies, education indeed enhances productivity and not just a device for individuals to signal their ability to the employers.

I think that the most plausible answer would be that both productivity and signaling effects are at work, it is only a matter of which effects play a more dominant role in determining the individual returns to education.

Stevens and Weale (2003) argued that since education delivers economic benefits to individuals, it should be expected that countries with more education grow better too, and thus we might want to look at returns to education at a macro level too.

To look at the macroeconomic effects of education, we must look at how education can be measured. Education can be measured in terms of its quantity and quality.

Arusha V. Cooray (2009) summarized two important points. First, education quantity is measured by enrolment rates (Mankiw, Romer and Weil 1992, Barro 1991, Levine and Renelt 1992), the average years of schooling (Hanushek and Woessmann 2007, Krueger and

Lindhal 2001), adult literacy rate (Durlauf and Johnson 1995, Romer 1990), education spending (Baladacci et al.). Second, many researchers have found a positive relation between education quantity and economic growth, such as Hanushek (1995), Gemmel (1996), Krueger and Lindahl (2001), Temple (2001), whereas Benhabib and Spiegel (1994), Bils and Klenow (2000) and Prichett (2001) find a weak relation between education quantity and economic growth. Third, Barro (1991) concluded that "poor countries tend to catch up with rich countries if the poor countries have high human capital per person (in relation to their level of per capita GDP)".

Sianesi and Van Reenen (2000) found that the effects of primary and secondary schooling appear both larger in magnitude and statistically more significant for less developed countries. Also, primary and secondary skills are more related to growth in the poorest and in intermediate developing countries respectively, whereas tertiary skills are important for growth in OECD countries. Stevens and Weale (2003) also found that returns to education diminish with levels of development.

Increasing education quantity is not easy. Annababette Wils (2002) found that it took 55-100 years for 67% of the countries to go from 10 to 90 percent adult literacy, while remaining 23% countries progressed even slower. Also, Harry Anthony and George Psacharopoulos (2011) quoted that "For a typical country it takes 35-80 years to make a transition from 10 percent net primary enrollment to 90 percent (Wils 2003; Wils and O'Connor 2003a). Education transition follows an S-shaped curve due to the much education one can attain in terms of years of schooling (Meyer et al. 1992).

Sianesi and Van Reenen (2000) had a few important findings that are worth highlighting. First, neo-classical tradition argues that a one-off permanent increase in the human capital stock will cause a one-off increase in the economy's growth rate, until productivity per worker hour has reached its new (and permanently higher) steady state level. New Growth theories argue that the same one-off increase in human capital will cause a permanent increase in the growth rate. Dowrick (2002) also recognized that there are debates over whether changes in educational attainment ultimately affect the long-run growth rate of the economy, or only the long-run level of output. Second, there are reverse causality problems with education, which means income growth might lead to an increased demand for education, and they believe that most likely there is "a bi-directional causality between human capital accumulation and economic growth". Third, there are indirect benefits of human capital on growth, by fostering the accumulation of productive inputs such as physical investment, technology or health. Fourth, they concluded that overall, the available evidence suggests that education has a positive impact on growth.

Next, let's look at education quality, since Hanushek and Woessmann (2007) pointed out that one problem with the measure of education quantity implicitly assumes one year of education in anywhere (eg Papua New Guinea and Japan) is of the same quality.

Suggested measures of education quality include costs per student, number of library volumes per student, student-faculty ratios, faculty-administration ratios, and student-support staff ratios (Conrad and Pratt, 1985). Dahlin (2002) pointed out that there are difficulties measuring the quality of education and that “a low student-faculty ratio, for instance, says nothing about faculty’s ability to teach.” Hanushek (1996) found that spending per pupil is not a good proxy for school quality.

Hanushek and Kim (1995), Barro (1999), Hanushek and Kimko (2000), Hanushek and Woessmann (2007), Hanushek and Woessmann (2010) used standardized test scores to proxy for education quality. They found a strong positive relation between education quality and economic growth.

Hanushek and Woessmann (2007) found that the education quantity is statistically significantly related to economic growth when the model neglects education quality, but once the quality of education is included in the model, the relationship between education quantity and economic growth becomes insignificant. They measured the education quality by using a simple average of the mathematics and science scores over all international test scores.

Arusha V. Cooray (2009) also measured education quality by, survival rates, repetitions rates, student/teacher ratios, schooling life expectancy and trained teachers in primary education, and she found that education quantity, when measured by enrolment ratios at the primary, secondary and tertiary levels, have a positive and significant impact on economic growth. She also found that the interaction effect between government spending and education quality is significant for economic growth. However, she found no relation between government spending and economic growth.

However, measures of international standardized tests of cognitive skills could only at best, reflect education quality at the primary and secondary level. We need to know how to measure higher education quality as well. Studies found that higher education plays an important role to promote economic growth. For example, Sianesi and Van Reenen (2000) found that tertiary education are important for growth in OECD countries, while Bloom, Canning and Chan (2006) found that higher education is important for growth even in developing countries such as Sub-Saharan Africa. Wolff and Gittleman (1993) found that “university enrolment rates are positively associated with labor productivity growth.” Howitt (2013) suggested that university research can boost economic growth. Dowrick (2002) found that education and R & D are crucial for sustained economic growth.

University has a dual function of teaching and research. As N.C. Liu and Y. Cheng (2005) noted, it is debatable whether we can measure the quality of universities by mere quantitative indicators. They argued that the only possible way to reliably rank universities is to rank their research performance, based on “internationally comparable data that everyone can check”.
, but as N.C. Liu and Y.Cheng (2005) argued, it would be impossible to measure and rank the quality of university education globally due to “the huge differences of universities in the large variety of countries and the technical difficulties in obtaining internationally comparable data”, and they suggested to rank them according to their research performance based on “internationally comparable data that everyone can check”. They also warned that any rankings should be used with caution, including the ARWU that is compiled by them.

Usher and Massimo (2007) found that despite the huge differences in how different ranking systems rank the quality of an institution, there is nevertheless an unequivocal agreement among different ranking systems as to which universities are the best in a given country. They observed that the difference only becomes larger as one moves down the ordinal rankings. This might indicate that it is much harder to measure the majority of ordinary universities.

There is an abundant literature which shows that institution plays a complementary role for education to boost economic growth.

Bloom, Canning and Chan (2006) commented that without proper macroeconomic management, it will be less likely for fresh graduates to seek meaningful employment. A good example is provided by Harry Anthony Patrions, George Psacharopoulos (2001), who found that even though Sri Lanka has a highly educated labor force relative to its neighbors, it has a very poor economic performance due to bad political environment that has dampened the educated labor from realizing its potential.

Prichett (2001) find that the impact of education varies widely across countries. He provided three possible explanations. First, in some countries, the institutional quality is so horrible that the education actually lowered economic growth, such as producing more educated pirates. Second, the demand for educated labor remained the same, and so the marginal return to education declines as the supply of educated labor increases. Third, education quality in some countries is so poor that additional years of schooling is useless and produces no human capital. Therefore, we might say that increasing both education quantity and quality is important.

Murphy, Kevin M, Andrei S, Robert W. Vishny (1991) showed that talents will go to nonproductive rent-seeking activities if the country is conducive for corruption. They also run regressions to show that countries with more students studying engineering grow faster; whereas countries with more students studying law grow slower. Even though their paper is mainly about rent-seeking, and that they used college enrollment in law to proxy for talent allocated to rent seeking, and college enrollment in engineering to proxy for talent allocated to entrepreneurship, but it might also suggest that education in more technical subjects such as engineering have a more positive effect on growth. This view is supported by Tin-Chun Lin (2004) who found that higher education, especially engineering and natural sciences, had a positive and significant effect on Taiwan’s economic development.

To sum up, there is overall agreement that given the right institutions, more (quantity) and better (quality) education is good for economic growth, but there is clearly a lack of academic literature in addressing how higher education sector affects the economic well-being of a country, and therefore the purpose of this paper is to fill this void.

Using ARWU as a proxy for university quality

For the purpose of this paper, ARWU will be used as the benchmark of World-Class Universities (Top 100 or Top 500). ARWU is chosen because ARWU is regarded as the most objective and comprehensive indicator of university quality (Li, Shankar and Tang, 2009; Marginson, 2007; Taylor and Braddock, 2007; Hazelkorn, 2007). In contrast, the THES-QS ranking relies heavily on peer reviews, which are heavily criticized for being too subjective and leading to high volatility of ranking results (Li, Shankar and Tang, 2009).

The table below outlines the methodology of ARWU.

Indicators and Weights for ARWU

Criteria	Indicator	Code	Weight
Quality of Education	Alumni of an institution winning Nobel Prizes and Fields Medals	Alumni	10%
Quality of Faculty	Staff of an institution winning Nobel Prizes and Fields Medals	Award	20%
	Highly cited researchers in 21 broad subject categories	HiCi	20%
Research Output	Papers published in Nature and Science*	N&S	20%
	Papers indexed in Science Citation Index-expanded and Social Science Citation Index	PUB	20%
Per Capita Performance	Per capita academic performance of an institution	PCP	10%
Total			100%
* For institutions specialized in humanities and social sciences such as London School of Economics, N&S is not considered, and the weight of N&S is relocated to other indicators.			

Data source: http://www.shanghairanking.com/ARWU-Methodology-2013.html

ARWU measures universities' research performance by a number of indicators such as highly cited researchers, and papers published in Nature and Science. However, we must take note that ARWU does not reflect teaching quality because even the Quality of Education is measured by the number of alumni winning Nobel Prizes and Field Medal. Whether there is correlation between teaching quality and research quality is a debatable. Also, ARWU favours universities that are very strong in the sciences and it is therefore only a good guide for students who would like to study natural sciences, medicine and engineering (EUA report 2011).

A brief literature review on determinants of growth

It might not be a good idea to run only a simple regression model between GDP per capita/GDP growth and WCUs per capita. We need to control for other factors as well. The purpose of this section is then to shed light on what factors we should choose to control for in the regression model.

This section is based on the findings of 'Determinants of Economic Growth: The Expert's View' by Petrakos, Arvanitidis and Pavleas (2007), which provides an extensive overview on the determinants of growth. It also surveys experts' opinions on the determinant of growth.

The factors including investment, human capital, innovation and R&D activities, economic policies, macroeconomic conditions, openness to trade, Foreign Direct Investment (FDI), institution, political environment, socio-cultural factors, geography and demographic trends. But as they noted, until now, there is no unifying theory on the role of various factors that affect economic growth.

Their main contribution draws on a questionnaire to explore experts' on the factors that affect economic dynamism. More than 500 questionnaires were distributed and the response rate was about 63%. The sample was evenly distributed between those working in the academia, (33%), the private sector (33%) and in the public sector (30%). Most respondents (37%) have completed a doctorate, while 35% hold a postgraduate degree. The value of this survey is based on the characteristics of the respondents. The sample group consists of people with an "informed" opinion in the academia, the public and private sector, and the results are quite consistent with the mainstream literature.

The factors that are regarded as the most influential for developing countries and developed countries are quite different. The top 3 factors identified for developed countries innovation and R&D, high quality of human capital, and specialization in knowledge and capital intensive sectors. On the other hand, the top 3 factors for developing countries are stable political environment, significant foreign direct investments, and secure formal institutions (legal system, property rights, tax system, finance system)

Since our sample contains both developed and developing countries, we should take into account of these factors that are deemed relevant for both developed and developing countries. Also, assume that the university ranking factor already captures the high quality of human capital, innovation and R&D, and specialization in knowledge and capital intensive sectors. Clearly, the ones left out are stable political environment, and foreign direct investments, and secure formal institutions, which can be categorized as institutional factors. This result is consistent with the conclusion in the previous section (i.e. Literature Review on Economics of Education).

Therefore, I will choose Property Rights, Freedom from Corruption, Business Freedom, and Investment Freedom as the relevant proxies for the institutional factors, which are taken from the Index of Economic Freedom 2013, compiled by the Heritage Foundation.

Methodologies

World-Class Universities are defined as among the Top 100 or Top 500 of ARWU.

One of the main assumptions is that countries with large populations will tend to have more "world-class universities" in the ranking lists. The independent variable will be the "number of universities that a country has in the ARWU 2013 divided by millions of population".

Since we also assume that rich countries tend to produce more "world-class universities", the dependent variable will then be the GDP per capita and GDP growth.

I will run a simple regression with only GDP per capita and WCUs per capita.

The first group of regression contains five regression models.
GDP per capita = constant + Top 100 per capita
GDP per capita = constant + Top 500 per capita
Log GDP per capita = constant + Log Top 100 per capita
Log GDP per capita = constant + Log Top 500 per capita

Also, I am interested in whether the country's university performance affects its GDP growth as well. GDP growth rate will replace GDP per capita as the dependent variable in the second group of regression.

GDP growth = constant + Top 100 per capita
GDP growth = constant + Top 500 per capita.

Next, I want to control for institutional factors such as freedom from corruption, property rights, business freedom and investment freedom. All these institutional values are taken from the Heritage Foundation (Index of Economic Freedom).

GDP per capita = constant + Top 500 per capita + clean (i.e. freedom from corruption)
GDP per capita = constant + Top 500 per capita + property rights
GDP per capita = constant + Top 500 per capita + businessfreedom
GDP per capita = constant + Top 500 per capita + investmentfreedom

Finally, I include all institutional factors in the regression model.

GDP per capita = constant + Top 500 per capita + clean + property rights + businessfreedom + investmentfreedom

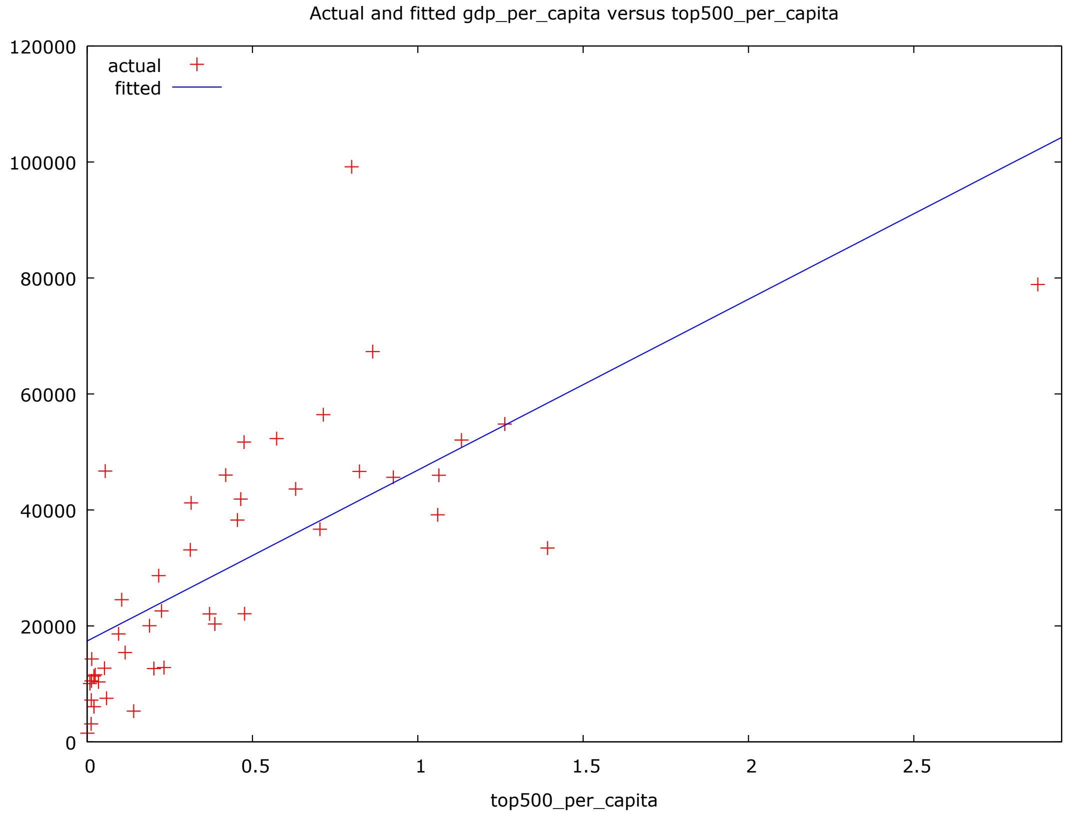
Results

Group 1: Simple Regression Model

Model 2: OLS, using observations 1-45
Dependent variable: gdp_per_capita

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	17398.9	2960.6	5.8768	<0.00001	***
top500_per_capita	29469.7	4251.92	6.9309	<0.00001	***

Mean dependent var	30720.62	S.D. dependent var	21728.42
Sum squared resid	9.81e+09	S.E. of regression	15105.81
R-squared	0.527668	Adjusted R-squared	0.516683
F(1, 43)	48.03759	P-value(F)	1.62e-08
Log-likelihood	-495.8569	Akaike criterion	995.7138
Schwarz criterion	999.3271	Hannan-Quinn	997.0608



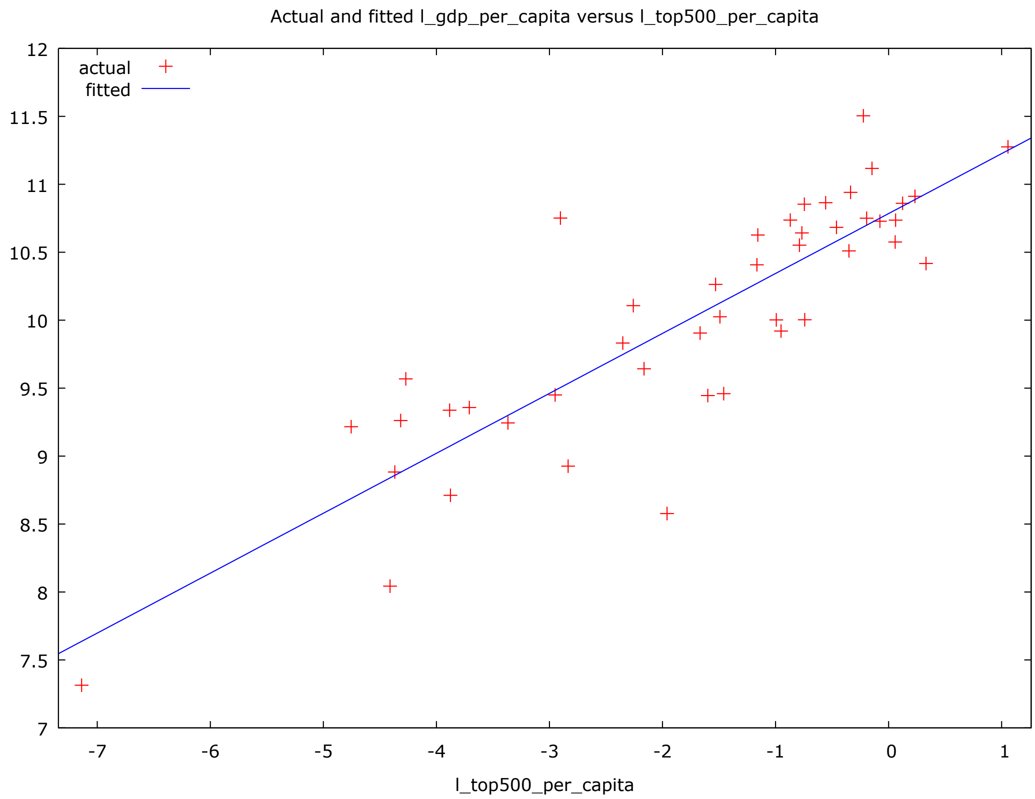
The coefficient is positive, which reflects the positive effect of higher education on economic well-being. The relationship between GDP per capita and Top 500 per capita is strong and statistically significant.

The outliers are Norway (0.800, 99170), Switzerland (0.055, 46707), Australia (0.864, 67304), Canada (2.875, 78881) and Sweden (1.392, 33433). Switzerland, Norway and Australia over performed in GDP per capita relative to their Top 500 per capita, whereas Sweden and Canada underperformed in GDP per capita relative to their Top 500 per capita.

Model 4: OLS, using observations 1-45
Dependent variable: l_gdp_per_capita

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	10.7846	0.0964747	111.7863	<0.00001	***
l_top500_per_capita	0.440994	0.0393603	11.2040	<0.00001	***

Mean dependent var	10.02093	S.D. dependent var	0.896423
Sum squared resid	9.021295	S.E. of regression	0.458037
R-squared	0.744853	Adjusted R-squared	0.738919
F(1, 43)	125.5303	P-value(F)	2.45e-14
Log-likelihood	-27.69306	Akaike criterion	59.38611
Schwarz criterion	62.99944	Hannan-Quinn	60.73312



The results in Model 4 are even more significant than that of Model 2 when both GDP per capita and Top 500 per capita are logged.

The outliers are Norway (-0.22, 11.5), Switzerland (-2.90, 10.75), Egypt (-4.41, 8.04), and Malaysia (-1.96, 8.58). Switzerland and Norway over performed in GDP per capita relative to their top 500 per capita, whereas Egypt and Malaysia under performed in GDP per capita relative to their top 500 per capita.

Group 2: When the dependent variable is the GDP growth

Model 5: OLS, using observations 1-16
Dependent variable: GDPgrowth2012

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	1.68245	0.706768	2.3805	0.03204	**
top100_per_capita	-2.22667	2.9791	-0.7474	0.46717	

Mean dependent var	1.250000	S.D. dependent var	1.599583
Sum squared resid	36.90726	S.E. of regression	1.623648
R-squared	0.038373	Adjusted R-squared	-0.030315
F(1, 14)	0.558654	P-value(F)	0.467172
Log-likelihood	-29.38957	Akaike criterion	62.77915
Schwarz criterion	64.32432	Hannan-Quinn	62.85827

Model 6: OLS, using observations 1-45
Dependent variable: GDPgrowth2012

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	1.23335	0.524091	2.3533	0.02325	**
top500_per_capita	-0.319579	0.752684	-0.4246	0.67326	

Mean dependent var	1.088889	S.D. dependent var	2.649033
Sum squared resid	307.4754	S.E. of regression	2.674059
R-squared	0.004175	Adjusted R-squared	-0.018984
F(1, 43)	0.180273	P-value(F)	0.673256
Log-likelihood	-107.0912	Akaike criterion	218.1824
Schwarz criterion	221.7958	Hannan-Quinn	219.5294

The negative coefficients may seem surprising at first sight, but this indicates that the emerging economies (with poorer universities' research performance) are growing faster than the developed nations (with highly ranked world-class universities).

The t-ratio is mostly below the coefficient of 1.0, which means that the results are not significant. There is no significant relationship between WCUs per capita and GDP growth.

Group 3: When we add in the institutional factors

Model 9: OLS, using observations 1-45
Dependent variable: gdp_per_capita

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	2801.13	7764.84	0.3607	0.72010	
investmentfreedom	242.835	120.09	2.0221	0.04956	**
top500_per_capita	25531.9	4545.27	5.6172	<0.00001	***

Mean dependent var	30720.62	S.D. dependent var	21728.42
Sum squared resid	8.94e+09	S.E. of regression	14590.83
R-squared	0.569572	Adjusted R-squared	0.549076
F(2, 42)	27.78867	P-value(F)	2.05e-08
Log-likelihood	-493.7666	Akaike criterion	993.5331
Schwarz criterion	998.9531	Hannan-Quinn	995.5537

Model 10: OLS, using observations 1-45
Dependent variable: gdp_per_capita

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	-12745	12343.7	-1.0325	0.30774	
top500_per_capita	23926.8	4581.25	5.2228	<0.00001	***
businessfreedom	415.683	165.802	2.5071	0.01613	**

Mean dependent var	30720.62	S.D. dependent var	21728.42
Sum squared resid	8.53e+09	S.E. of regression	14255.08
R-squared	0.589154	Adjusted R-squared	0.569589
F(2, 42)	30.11398	P-value(F)	7.71e-09
Log-likelihood	-492.7190	Akaike criterion	991.4379
Schwarz criterion	996.8579	Hannan-Quinn	993.4585

Model 12: OLS, using observations 1-45
Dependent variable: gdp_per_capita

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	-3754.48	6033.08	-0.6223	0.53710	
top500_per_capita	19830.2	4451.86	4.4544	0.00006	***
property	382.791	98.7653	3.8758	0.00037	***

Mean dependent var	30720.62	S.D. dependent var	21728.42
Sum squared resid	7.23e+09	S.E. of regression	13117.73
R-squared	0.652097	Adjusted R-squared	0.635530
F(2, 42)	39.36167	P-value(F)	2.35e-10
Log-likelihood	-488.9773	Akaike criterion	983.9546
Schwarz criterion	989.3746	Hannan-Quinn	985.9751

Model 14: OLS, using observations 1-45
Dependent variable: gdp_per_capita

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	-5805.87	5608.55	-1.0352	0.30651	
top500_per_capita	16621.1	4486.43	3.7047	0.00061	***
clean	477.711	103.928	4.5965	0.00004	***

Mean dependent var	30720.62	S.D. dependent var	21728.42
Sum squared resid	6.53e+09	S.E. of regression	12467.13
R-squared	0.685751	Adjusted R-squared	0.670787
F(2, 42)	45.82606	P-value(F)	2.77e-11
Log-likelihood	-486.6882	Akaike criterion	979.3764
Schwarz criterion	984.7964	Hannan-Quinn	981.3969

Model 16: OLS, using observations 1-45
Dependent variable: gdp_per_capita

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	-986.754	11679	-0.0845	0.93310	
clean	448.619	252.956	1.7735	0.08395	*
property	147.266	269.955	0.5455	0.58850	
businessfreedom	-28.5842	203.297	-0.1406	0.88891	
investmentfreedom	-157.554	176.753	-0.8914	0.37819	
top500_per_capita	16631.1	4615.34	3.6034	0.00088	***

Mean dependent var	30720.62	S.D. dependent var	21728.42
Sum squared resid	6.39e+09	S.E. of regression	12796.45
R-squared	0.692578	Adjusted R-squared	0.653165
F(5, 39)	17.57231	P-value(F)	4.34e-09
Log-likelihood	-486.1940	Akaike criterion	984.3880
Schwarz criterion	995.2280	Hannan-Quinn	988.4290

When we control for only one of the institutional factors in the regression models, the results are all quite significant, with Freedom from Corruption as the most significant, followed by Property Rights, Business Freedom, and Investment Freedom. However, when we include all the institutional factors in the regression model, all appears significant. A large part of the GDP per capita can be explained b the university's research performance indicator (i.e. Top 500 per capita).

Therefore, we can say that a clean government that is free from corruption is the most important institutional factor that will complement higher education to promote higher GDP per capita.

Conclusions

The paper concludes that there is a strong and significant relationship between WCUs per capita and its GDP per capita. But having more WCUs per capita does not have any significant effect on GDP growth.

Also, the relationship becomes more significant as the ranking list is expanded from top 100 universities to top 500 universities (see Appendix). It suggests that to attain a higher GDP per capita, it is more important for a country to focus on developing a good number of decent World-Class Universities (among the Top 500), rather than obsessed with building only one or a few elite World-Class universities (among the Top 100).

Institutional factors are important too, with freedom from corruption being the most important, followed by respect for property rights, business freedom, and investment freedom. But when all institutional factors are included in the regression model, only the variable "Top 500 per capita" appears significant. Therefore, WCUs per capita might alone explain more than just universities' research quality. A good government will naturally invest more in education and more educated citizens will hold the government accountable to continue the good work.

There is no "magic formula" for making a world class university (Salmi, 2009), which I think, is analogous to there is no "magic formula" for making a country richer and stronger than the rest. Each country should choose a strategy that suits its national circumstances the best. For most countries, addressing the fundamental tertiary education needs is far more meaningful than being obsessed with building one or two highly ranked world-class universities, in which only a minority of the population can attend. While university rankings serve the purpose of providing information about university quality, they should not be taken too seriously for higher education policy. Even N.C Liu and Y.Cheng (2002), in which N.C. Liu is the founder of the ARWU, recognized that "any rankings should be used with caution, including ARWU", and that rankings should be used as a reference only and judgements should be made with reference to their ranking methodologies.

On the other hand, university ranking is a zero sum game. There can only be 500 universities among the Top 500. Although it is said that it is not realistic for most countries to build highly ranked world-class universities, but the underlying reality is that for countries to attain a higher GDP per capita relative to other countries, it is not enough for their universities to merely improve over time but that their universities must improve fast enough to outshine other universities in other countries. There ought to be the better ones and the worse ones, even among the developed nations. Countries with more WCUs per capita are more likely to be at the forefront of technological change, and thus enjoying higher GDP per capita. This might seem a rather pessimistic and disturbing finding, but as long as globalization and free trade are ongoing, all countries can improve together as a whole even if inequality among countries persists.

There are many problems left unanswered in this paper and I believe they are worth further investigation. I would like to highlight a few of them here.

- How universities relates to the country's economic performance? It might be due to good research or good teaching or a combination of both. Clearly, the ARWU employed here is only a good indicator of university's research performance.
- There are 43 high-income economies (according to World Bank definition) with no "good universities", such as Brunei, Luxembourg, Macau, Qatar, and United Arab Emirates. Our sample contains a few developing countries such as China, India, Malaysia, Iran and Egypt. How is it that while several rich countries do not have a single university among the Top 500, a few developing countries actually manage to do it? Therefore, this requires further investigation as to why these economies perform well economically despite without even a single so-called world-class university. Possible reasons might be that some of these high-income economies are very small countries which specialize in only a few niche areas, such as oil exports, casinos, and tax haven.
- Not surprisingly, many poor developing countries (such as those in Africa) do not have any universities that appear in the Top 500 list. If there is a ranking for their universities, we can run the same regression again to see if the relationship holds among these countries. If it holds, it might mean more policy focus on tertiary education is needed in these developing countries.
- It is more difficult for authors whose first language is not English to publish in top journals (Altbach 2011), and that publications in languages other than English are read by fewer researchers (EUA Report on Rankings 2013). Any ranking based on research performance will be biased towards universities in English-speaking countries, and it is suggested that a special weight should possibly be allotted to papers published in other languages (N.C. Liu and Y. Cheng, 2005). However, due to the technical difficulties of classifying countries as English-speaking and non-English speaking (e.g. HEC Paris offers English-taught programs in a French-speaking country), our regression model do not include English as the dummy variable. Future research might want to look into this language bias issue.

(5607 words)

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Appendix

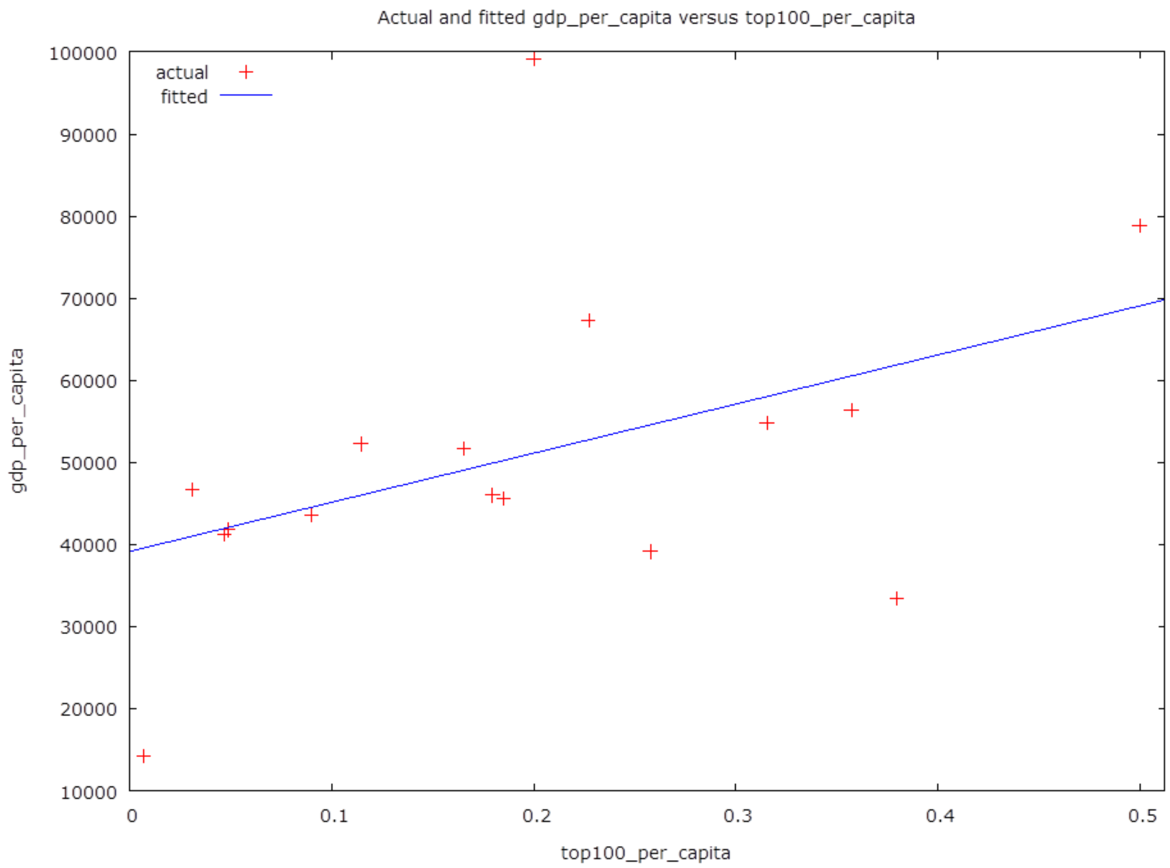
Results

Group 1

Model 1: OLS, using observations 1-16
Dependent variable: gdp_per_capita

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	39159.6	7757.11	5.0482	0.00018	***
top100_per_capita	59856.7	32697	1.8307	0.08852	*

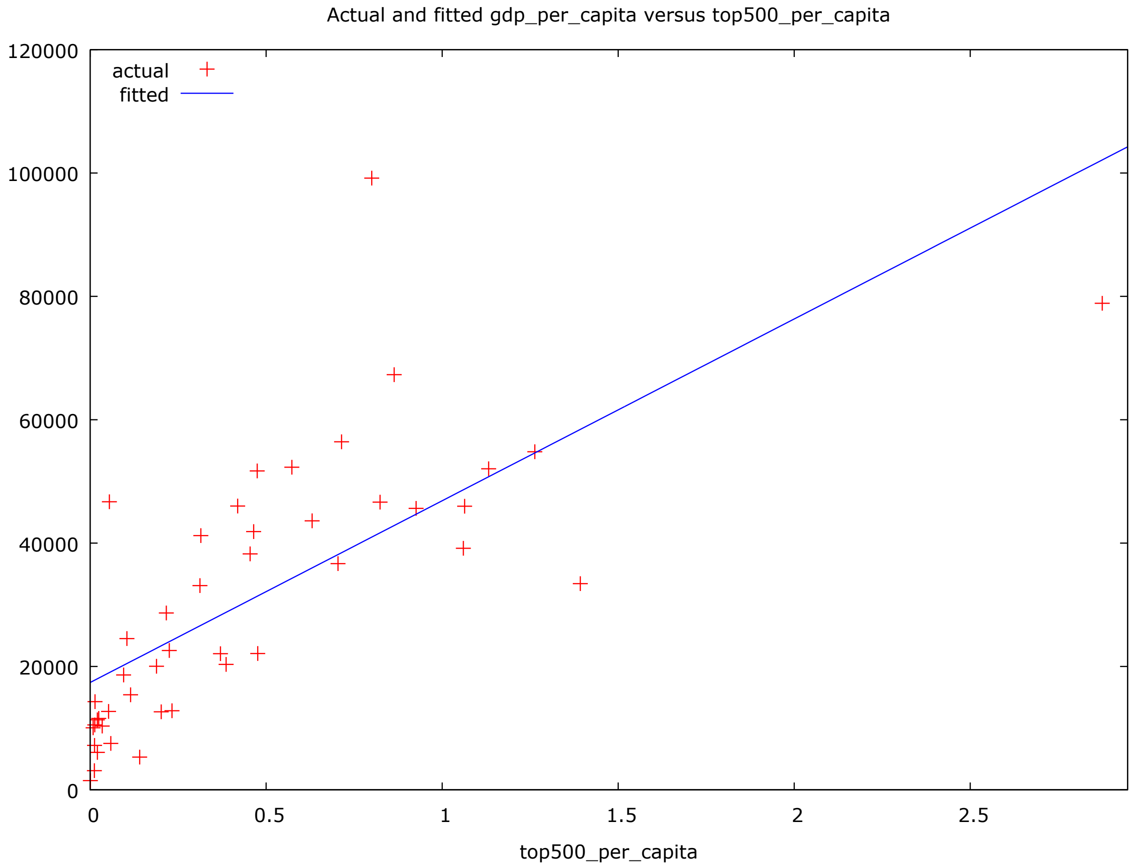
Mean dependent var	50784.56	S.D. dependent var	19166.16
Sum squared resid	4.45e+09	S.E. of regression	17820.30
R-squared	0.193143	Adjusted R-squared	0.135510
F(1, 14)	3.351280	P-value(F)	0.088518
Log-likelihood	-178.2443	Akaike criterion	360.4885
Schwarz criterion	362.0337	Hannan-Quinn	360.5676



Model 2: OLS, using observations 1-45
Dependent variable: gdp_per_capita

	Coefficient	Std. Error	t-ratio	p-value	
const	17398.9	2960.6	5.8768	<0.00001	***
top500_per_capita	29469.7	4251.92	6.9309	<0.00001	***

Mean dependent var	30720.62	S.D. dependent var	21728.42
Sum squared resid	9.81e+09	S.E. of regression	15105.81
R-squared	0.527668	Adjusted R-squared	0.516683
F(1, 43)	48.03759	P-value(F)	1.62e-08
Log-likelihood	-495.8569	Akaike criterion	995.7138
Schwarz criterion	999.3271	Hannan-Quinn	997.0608

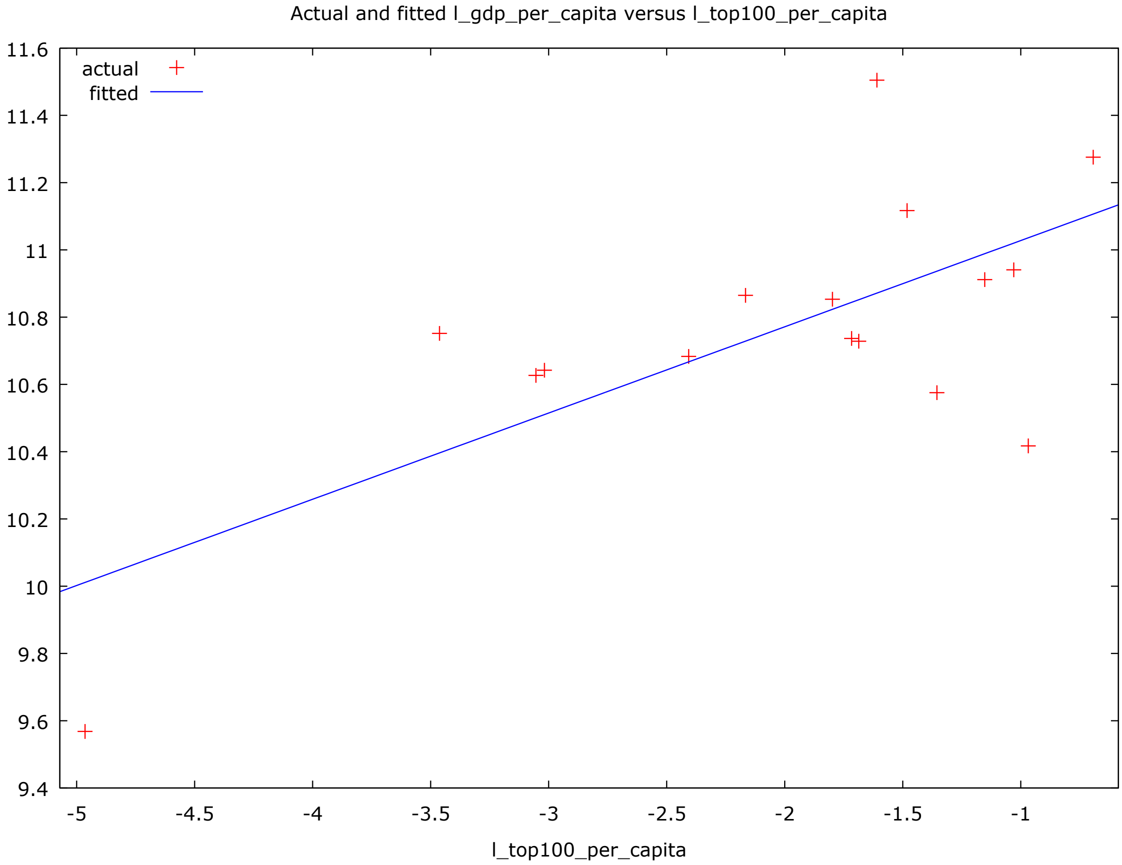


The outliers are Norway (0.800, 99170), Switzerland (0.055, 46707), Australia (0.864, 67304), Canada (2.875, 78881) and Sweden (1.392, 33433). Switzerland, Norway and Australia over performed in GDP per capita relative to their Top 500 per capita, whereas Sweden and Canada underperformed in GDP per capita relative to their Top 500 per capita.

Model 3: OLS, using observations 1-16
Dependent variable: l_gdp_per_capita

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	11.2842	0.168538	66.9537	<0.00001	***
l_top100_per_capit a	0.256425	0.073119	3.5070	0.00349	***

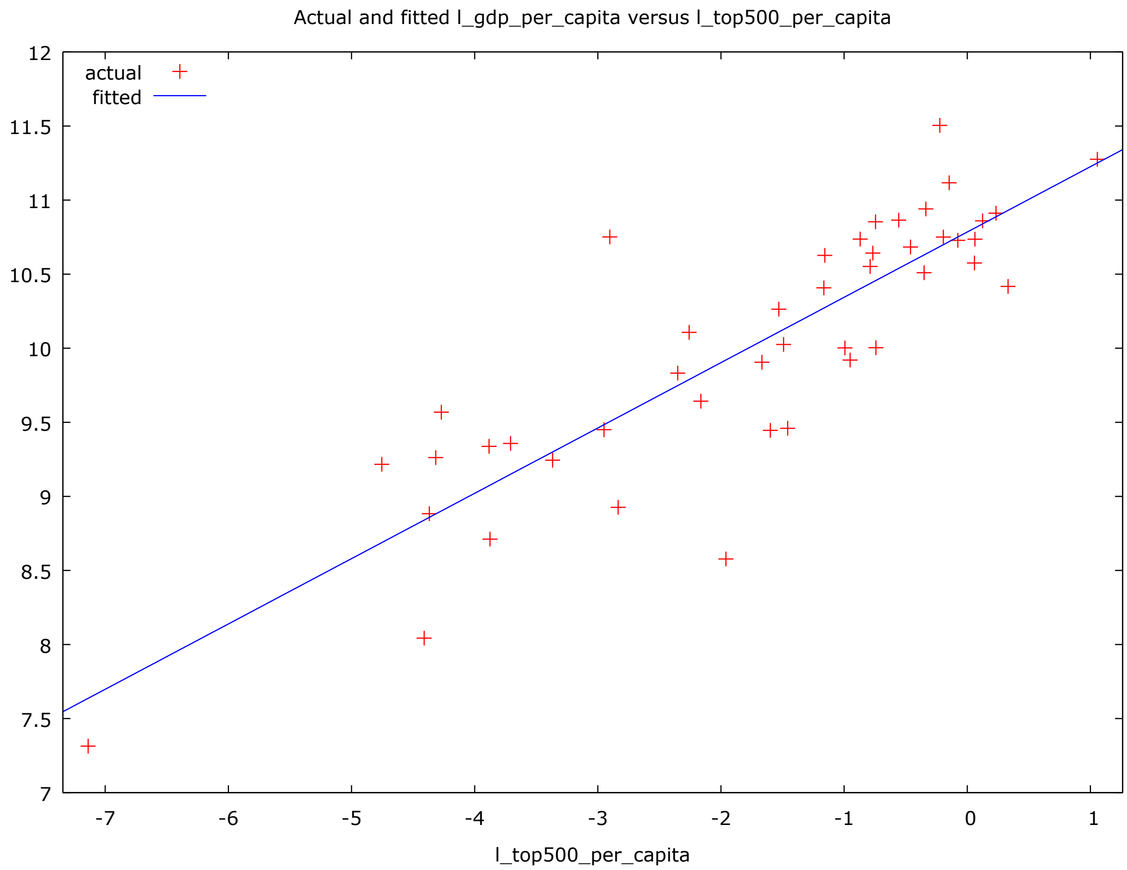
Mean dependent var	10.76234	S.D. dependent var	0.419062
Sum squared resid	1.402297	S.E. of regression	0.316487
R-squared	0.467655	Adjusted R-squared	0.429630
F(1, 14)	12.29874	P-value(F)	0.003487
Log-likelihood	-3.227197	Akaike criterion	10.45439
Schwarz criterion	11.99957	Hannan-Quinn	10.53352



Model 4: OLS, using observations 1-45
Dependent variable: l_gdp_per_capita

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	10.7846	0.0964747	111.7863	<0.00001	***
l_top500_per_capit a	0.440994	0.0393603	11.2040	<0.00001	***

Mean dependent var	10.02093	S.D. dependent var	0.896423
Sum squared resid	9.021295	S.E. of regression	0.458037
R-squared	0.744853	Adjusted R-squared	0.738919
F(1, 43)	125.5303	P-value(F)	2.45e-14
Log-likelihood	-27.69306	Akaike criterion	59.38611
Schwarz criterion	62.99944	Hannan-Quinn	60.73312



The outliers are Norway (-0.22, 11.5), Egypt (-4.41, 8.04), Malaysia (-1.96, 8.58) and Switzerland (-2.90, 10.75). Switzerland and Norway over performed in GDP per capita relative to their top 500 per capita, whereas Egypt and Malaysia under performed in GDP per capita relative to their top 500 per capita.

<u>Group 2: How university performance affects GDP growth?</u>

Model 5: OLS, using observations 1-16
Dependent variable: GDPgrowth2012

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	1.68245	0.706768	2.3805	0.03204	**
top100_per_capita	-2.22667	2.9791	-0.7474	0.46717	

Mean dependent var	1.250000	S.D. dependent var	1.599583
Sum squared resid	36.90726	S.E. of regression	1.623648
R-squared	0.038373	Adjusted R-squared	-0.030315
F(1, 14)	0.558654	P-value(F)	0.467172
Log-likelihood	-29.38957	Akaike criterion	62.77915
Schwarz criterion	64.32432	Hannan-Quinn	62.85827

Model 6: OLS, using observations 1-45
Dependent variable: GDPgrowth2012

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	1.23335	0.524091	2.3533	0.02325	**
top500_per_capita	-0.319579	0.752684	-0.4246	0.67326	

Mean dependent var	1.088889	S.D. dependent var	2.649033
Sum squared resid	307.4754	S.E. of regression	2.674059
R-squared	0.004175	Adjusted R-squared	-0.018984
F(1, 43)	0.180273	P-value(F)	0.673256
Log-likelihood	-107.0912	Akaike criterion	218.1824
Schwarz criterion	221.7958	Hannan-Quinn	219.5294

Group 3: Institutional Factors

Model 7: OLS, using observations 1-45
Dependent variable: l_gdp_per_capita

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
Const	10.3445	0.364274	28.3975	<0.00001	***
investmentfreedom	0.0054897	0.00438398	1.2522	0.21742	
l_top500_per_capita	0.400667	0.0506569	7.9094	<0.00001	***

Mean dependent var	10.02093	S.D. dependent var	0.896423
Sum squared resid	8.696611	S.E. of regression	0.455041
R-squared	0.754036	Adjusted R-squared	0.742323
F(2, 42)	64.37835	P-value(F)	1.62e-13
Log-likelihood	-26.86833	Akaike criterion	59.73666
Schwarz criterion	65.15665	Hannan-Quinn	61.75718

Model 8: OLS, using observations 1-45
Dependent variable: gdp_per_capita

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	2801.13	7764.84	0.3607	0.72010	
investmentfreedom	242.835	120.09	2.0221	0.04956	**
top500_per_capita	25531.9	4545.27	5.6172	<0.00001	***

Mean dependent var	30720.62	S.D. dependent var	21728.42
Sum squared resid	8.94e+09	S.E. of regression	14590.83
R-squared	0.569572	Adjusted R-squared	0.549076
F(2, 42)	27.78867	P-value(F)	2.05e-08
Log-likelihood	-493.7666	Akaike criterion	993.5331
Schwarz criterion	998.9531	Hannan-Quinn	995.5537

Model 9: OLS, using observations 1-45
Dependent variable: l_gdp_per_capita

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	10.0499	0.589641	17.0441	<0.00001	***
l_top500_per_capita	0.391729	0.055229	7.0928	<0.00001	***
businessfreedom	0.00826739	0.00654721	1.2627	0.21365	

Mean dependent var	10.02093	S.D. dependent var	0.896423
Sum squared resid	8.691335	S.E. of regression	0.454903
R-squared	0.754185	Adjusted R-squared	0.742480
F(2, 42)	64.43018	P-value(F)	1.60e-13
Log-likelihood	-26.85468	Akaike criterion	59.70935
Schwarz criterion	65.12934	Hannan-Quinn	61.72987

Model 10: OLS, using observations 1-45
Dependent variable: gdp_per_capita

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	-12745	12343.7	-1.0325	0.30774	
top500_per_capita	23926.8	4581.25	5.2228	<0.00001	***
businessfreedom	415.683	165.802	2.5071	0.01613	**

Mean dependent var	30720.62	S.D. dependent var	21728.42
Sum squared resid	8.53e+09	S.E. of regression	14255.08
R-squared	0.589154	Adjusted R-squared	0.569589
F(2, 42)	30.11398	P-value(F)	7.71e-09
Log-likelihood	-492.7190	Akaike criterion	991.4379
Schwarz criterion	996.8579	Hannan-Quinn	993.4585

Model 11: OLS, using observations 1-45
Dependent variable: l_gdp_per_capita

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	10.0755	0.339246	29.6998	<0.00001	***
l_top500_per_capita	0.357967	0.0537269	6.6627	<0.00001	***
property	0.00848161	0.00390426	2.1724	0.03552	**

Mean dependent var	10.02093	S.D. dependent var	0.896423
Sum squared resid	8.110015	S.E. of regression	0.439426
R-squared	0.770627	Adjusted R-squared	0.759704
F(2, 42)	70.55376	P-value(F)	3.73e-14
Log-likelihood	-25.29707	Akaike criterion	56.59414
Schwarz criterion	62.01413	Hannan-Quinn	58.61466

Model 12: OLS, using observations 1-45
Dependent variable: gdp_per_capita

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	-3754.48	6033.08	-0.6223	0.53710	
top500_per_capita	19830.2	4451.86	4.4544	0.00006	***
property	382.791	98.7653	3.8758	0.00037	***

Mean dependent var	30720.62	S.D. dependent var	21728.42
Sum squared resid	7.23e+09	S.E. of regression	13117.73
R-squared	0.652097	Adjusted R-squared	0.635530
F(2, 42)	39.36167	P-value(F)	2.35e-10
Log-likelihood	-488.9773	Akaike criterion	983.9546
Schwarz criterion	989.3746	Hannan-Quinn	985.9751

Model 13: OLS, using observations 1-45
Dependent variable: l_gdp_per_capita

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	9.83992	0.340382	28.9085	<0.00001	***
l_top500_per_capita	0.320422	0.0555253	5.7707	<0.00001	***
clean	0.012116	0.00421315	2.8758	0.00630	***

Mean dependent var	10.02093	S.D. dependent var	0.896423
Sum squared resid	7.537183	S.E. of regression	0.423623
R-squared	0.786828	Adjusted R-squared	0.776677
F(2, 42)	77.51191	P-value(F)	8.00e-15
Log-likelihood	-23.64892	Akaike criterion	53.29784
Schwarz criterion	58.71783	Hannan-Quinn	55.31836

Model 14: OLS, using observations 1-45
Dependent variable: gdp_per_capita

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	-5805.87	5608.55	-1.0352	0.30651	
top500_per_capita	16621.1	4486.43	3.7047	0.00061	***
clean	477.711	103.928	4.5965	0.00004	***

Mean dependent var	30720.62	S.D. dependent var	21728.42
Sum squared resid	6.53e+09	S.E. of regression	12467.13
R-squared	0.685751	Adjusted R-squared	0.670787
F(2, 42)	45.82606	P-value(F)	2.77e-11
Log-likelihood	-486.6882	Akaike criterion	979.3764
Schwarz criterion	984.7964	Hannan-Quinn	981.3969

Model 15: OLS, using observations 1-45
Dependent variable: l_gdp_per_capita

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	9.83042	0.59838	16.4284	<0.00001	***
l_top500_per_capita	0.318984	0.0616475	5.1743	<0.00001	***
clean	0.0148174	0.00869877	1.7034	0.09645	*
property	-0.0034927	0.00929687	-0.3757	0.70919	
businessfreedom	-0.000191771	0.00728053	-0.0263	0.97912	
investmentfreedom	0.00134603	0.00616931	0.2182	0.82843	

Mean dependent var	10.02093	S.D. dependent var	0.896423
Sum squared resid	7.509598	S.E. of regression	0.438810
R-squared	0.787608	Adjusted R-squared	0.760378
F(5, 39)	28.92454	P-value(F)	3.84e-12
Log-likelihood	-23.56642	Akaike criterion	59.13284
Schwarz criterion	69.97282	Hannan-Quinn	63.17388

Model 16: OLS, using observations 1-45
Dependent variable: gdp_per_capita

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	-986.754	11679	-0.0845	0.93310	
clean	448.619	252.956	1.7735	0.08395	*
property	147.266	269.955	0.5455	0.58850	
businessfreedom	-28.5842	203.297	-0.1406	0.88891	
investmentfreedom	-157.554	176.753	-0.8914	0.37819	
top500_per_capita	16631.1	4615.34	3.6034	0.00088	***

Mean dependent var	30720.62	S.D. dependent var	21728.42
Sum squared resid	6.39e+09	S.E. of regression	12796.45
R-squared	0.692578	Adjusted R-squared	0.653165
F(5, 39)	17.57231	P-value(F)	4.34e-09
Log-likelihood	-486.1940	Akaike criterion	984.3880
Schwarz criterion	995.2280	Hannan-Quinn	988.4290

Statistics of Shanghai Ranking (ARWU)

Statistics by Region

Region	Top 20	Top 100	Top 200	Top 300	Top 400	Top 500
Americas	17	56	95	127	156	182
Europe	3	33	75	126	164	200
Asia/Oceania	—	11	30	46	78	114
Africas	—	—	—	1	2	4
Total	20	100	200	300	400	500

Statistics by Country

Country	Top20	Top100	Top200	Top300	Top400	Top500
United States	17	52	85	108	131	149
United Kingdom	2	9	19	29	33	37
Switzerland	1	4	6	7	7	7
Australia	—	5	7	9	16	19
Germany	—	4	14	23	30	38
France	—	4	8	16	18	20
Canada	—	4	7	16	18	23
Japan	—	3	9	10	15	20
Netherlands	—	3	8	10	12	12
Sweden	—	3	5	8	10	11
Israel	—	3	4	4	6	7
Denmark	—	2	3	4	4	4
Belgium	—	1	4	6	7	7
Norway	—	1	1	3	3	4
Finland	—	1	1	1	3	5
Russia	—	1	1	1	2	2
China	—	—	7	13	26	42
Italy	—	—	4	9	12	19
South Korea	—	—	1	4	7	11
Austria	—	—	1	3	3	7
Saudi Arabia	—	—	1	2	3	4

Singapore	—	—	1	2	2	2
Brazil	—	—	1	1	5	6
Argentina	—	—	1	1	1	1
Mexico	—	—	1	1	1	1
Spain	—	—	—	4	8	10
New Zealand	—	—	—	2	2	5
Ireland	—	—	—	1	3	3
South Africa	—	—	—	1	2	3
Czech	—	—	—	1	1	1
Portugal	—	—	—	—	2	4
Greece	—	—	—	—	2	2
Poland	—	—	—	—	2	2
Hungary	—	—	—	—	1	2
India	—	—	—	—	1	1
Serbia	—	—	—	—	1	1
Chile	—	—	—	—	—	2
Croatia	—	—	—	—	—	1
Egypt	—	—	—	—	—	1
Iran	—	—	—	—	—	1
Malaysia	—	—	—	—	—	1
Slovenia	—	—	—	—	—	1
Turkey	—	—	—	—	—	1
Total	20	100	200	300	400	500

The breakdown of China into Taiwan, Hong Kong and Mainland China.

Due to political reasons, the "China" in the statistics above includes Mainland China, Taiwan and Hong Kong, and we need to break it down into the rankings for Mainland China, China-Taiwan and China-Hong Kong.

Academic Ranking of World Universities 2013

China-Taiwan

Country Rank	Institution	World Rank
1	National Taiwan University	101-150
2	National Tsing Hua University	201-300
3-5	Chang Gung University	301-400
3-5	National Cheng Kung University	301-400
3-5	National Chiao Tung University	301-400
6-9	China Medical University	401-500
6-9	National Central University	401-500
6-9	National Sun Yat-Sen University	401-500
6-9	National Yang Ming University	401-500

* Institutions within the same rank range are listed alphabetically.

Data source: http://www.shanghairanking.com/World-University-Rankings-2013/China-tw.html

Academic Ranking of World Universities 2013

China-Hong Kong

Country Rank	Institution	World Rank
1	The Chinese University of Hong Kong	151-200
2-3	The Hong Kong University of Science and Technology	201-300
2-3	The University of Hong Kong	201-300
4-5	City University of Hong Kong	301-400
4-5	The Hong Kong Polytechnic University	301-400

* Institutions within the same rank range are listed alphabetically.

Data source: http://www.shanghairanking.com/World-University-Rankings-2013/China-hk.html

Academic Ranking of World Universities 2013

China

Country Rank	Institution	World Rank
1-5	Fudan University	151-200
1-5	Peking University	151-200
1-5	Shanghai Jiao Tong University	151-200
1-5	Tsinghua University	151-200
1-5	Zhejiang University	151-200
6-8	Nanjing University	201-300
6-8	Sun Yat-sen University	201-300
6-8	University of Science and Technology of China	201-300
9-16	Beijing Normal University	301-400
9-16	China Agricultural University	301-400
9-16	Harbin Institute of Technology	301-400
9-16	Huazhong University of Science and Technology	301-400
9-16	Jilin University	301-400
9-16	Shandong University	301-400
9-16	Sichuan University	301-400
9-16	Xian Jiao Tong University	301-400

17-28	Beihang University	401-500
17-28	Central South University	401-500
17-28	Dalian University of Technology	401-500
17-28	Lanzhou University	401-500
17-28	Nankai University	401-500
17-28	Peking Union Medical College	401-500
17-28	South China University of Technology	401-500
17-28	Southeast University	401-500
17-28	Tianjin University	401-500
17-28	Tongji University	401-500
17-28	Wuhan University	401-500
17-28	Xiamen University	401-500

* Institutions within the same rank range are listed alphabetically.

Data source: http://www.shanghairanking.com/World-University-Rankings-2013/China.html