# The contribution of university rankings to country's GDP per capita

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24 February 2013

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Abstract

I investigate the impact of country's university performance in global university rankings on the country's GDP per capita, and I found the relationship to be strong and statistically significant. Also, the relationship becomes much more significant when the ranking lists are expanded from top 100 to top 500. This suggests that as far as attaining a higher GDP per capita is concerned, it is far more pertinent for a country to have more decent universities (in the top 500) than having only a few elite universities (in the top 100)

However, country's university performance seems to have no effect on the GDP growth rate.

Institutional factors are investigated too. Among the institutional factors, freedom from corruption appears to be the most significant factor in most cases.

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).

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).

To give a more concrete idea of what constitutes a world-class university, I will quote the definition given by Salmi (2009): "(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."

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 the indicators that should be used to rank universities. As we know, university performs both teaching and research. 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. 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 heads the SJTU's Higher Education Group to compile and publish the Academic Ranking of World Universities (ARWU).

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 ranking performance, the prestige of universities are still important basis of where students choose to attend college. 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 or group universities to be among the Top 20, appear in the 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. University ranking are indeed a zero sum game. It may not be sensible for all countries to be obsessed with developing 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 satisfied. 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.

So what are the factors contributing to country's performance in the "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", which means they can afford to build more universities 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 number of world-class universities that a country has per capita and the country's GDP per capita. The model will later add in institutional factors such as freedom from corruption and respect for property rights. 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.

A brief literature review on determinants of growth

It might not be a good idea to run only a simple regression model. 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 (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 Freedom, compiled by the Heritage Foundation.

Using ARWU as a proxy for university quality

For the purpose of this paper, ARWU will be used to proxy for the university quality.

The table below outlines the methodology of ARWU.

Nian Cai Liu (2009), the director of Center for World-Class Universities of Shanghai Jiao Tong University (CWCU), stated that it would be impossible to rank the "quality of education, administration, campus culture, and national contribution". They instead chose to rank universities worldwide by their research performance.

**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 does not reflect the quality of teaching because even the Quality of Education is measured by the number of alumni winning Nobel Prizes and Field Medals. 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)

Thus, measuring a country's university performance in ARWU per capita is akin to measuring the country's innovation and R&D. It is debatable whether it is a good measure of the country's human capital.


## **Methodologies**

There are many global university rankings, such as Academic Ranking of World Universities (ARWU), the Times Higher-Quacquarelli Symonds World University Rankings, and US News and World Rankings. I choose to use ARWU because it is the most widely cited (Li, Shankar, and Tang 2009), and that it is one of the most objective and comprehensive.

The purpose of this paper is to investigate the relationship between tertiary education quality and GDP per capita. ARWU is chosen to proxy university quality.

As mentioned before, 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.

I will run two groups of regressions, one with the original variables, and one with all the variables logged.

The first group of regression contains five regression models.

GDP per capita = constant + Top 100 per capita
GDP per capita = constant + Top 200 per capita
GDP per capita = constant + Top 300 per capita
GDP per capita = constant + Top 400 per capita
GDP per capita = constant + Top 500 per capita

In words, I will run the regression for GDP per capita against the number of universities a country has in Top 100 per millions of population, number of universities in Top 200 per millions of population, number of universities in Top 300 per millions of population, number of universities in Top 400 per millions of population, number of universities in Top 500 per millions of population respectively.

Next, I would like to log all the variables too to see if the relationship becomes stronger and more significant.

Log GDP per capita = constant + Log Top 100 per capita
Log GDP per capita = constant + Log Top 200 per capita
Log GDP per capita = constant + Log Top 300 per capita
Log GDP per capita = constant + Log Top 400 per capita
Log GDP per capita = constant + Log Top 500 per capita

In words, I will run the regression for logged GDP per capita against the logged the number of universities a country has in Top 100 per millions of population, logged the number of universities in Top 200 per millions of population, logged the number of universities in Top 300 per millions of population, logged the number of universities in Top 400 per millions of population, logged the number of universities in Top 500 per millions of population respectively.

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 200 per capita

GDP growth = constant + Top 200 per capita
GDP growth = constant + Top 400 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 + freedom from corruption + property rights
GDP per capita = constant + Top 500 per capita + freedom from corruption + clean
GDP per capita = constant + Top 500 per capita + freedom from corruption + businessfreedom
GDP per capita = constant + Top 500 per capita + freedom from corruption + investmentfreedom

(Note: clean stands for freedom from corruption)

The number of patent applications per capita will be used as the proxy for measures of innovation.

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 |



Actual and fitted gdp_per_capita versus top500_per_capita

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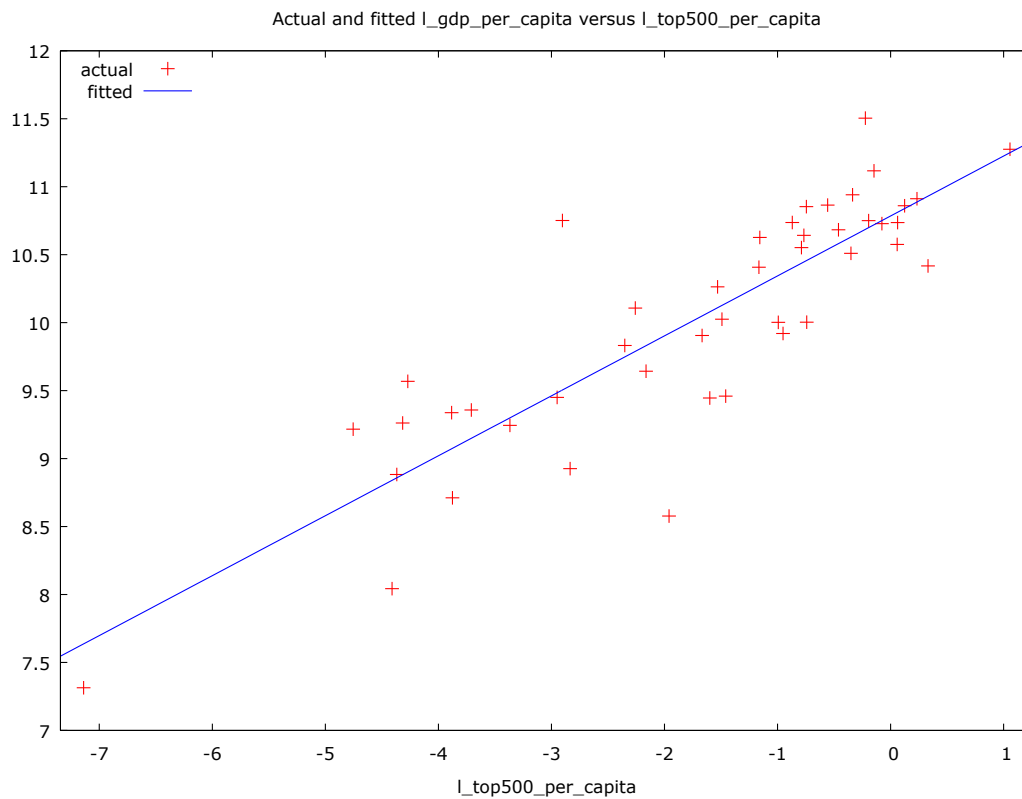
Model 4: OLS, using observations 1-45
Dependent variable: l_gdp_per_capita

|  | 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 |



Actual and fitted l_gdp_per_capita versus l_top500_per_capita

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 2.0, which means that the results are not significant. There is no significant relationship between university performance and GDP growth.

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.

**Language bias in the rankings**

English had emerged as the global language in the academic world. Universities in non-English-speaking countries are to varying degrees using English as a language of instruction (Altbach 2011). For example, in China and Korea, English is used in scientific areas and in professional fields such as business administration (Altbach 2011). It is noted that 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). In fact, many academics recognized that any ranking based on research performance will be biased towards universities in English-speaking countries, and they suggested that a special weight should possibly be allotted to papers published in other languages. (N.C. Liu and Y. Cheng, 2005).

**Conclusions**

The paper concludes that there is a strong and significant relationship between the number of universities a country has in ARWU and its GDP per capita.

Also, the relationship becomes more significant as the ranking list is expanded from top 100 universities to top 500 universities (see Appendix). We can infer that it is more pertinent for a country to focus on developing a good number of decent universities, rather than obsessed with building world-class universities.

University ranking is a zero sum game. Although it may not be realistic for most countries to build world-class universities, we might want to say that for countries to attain a relatively higher GDP per capita, it is not enough for their universities to improve constantly but that their universities must outbeat other universities in other countries. This might seem a rather pessimistic and disturbing finding, but I do believe that it is possible to eliminate all forms of poverty if the poverty thresholds never change. But still, I could not imagine a world in which all countries are equally rich. There must be richer and poorer ones. In other words, countries with better world-class universities are more likely to be at the forefront technology change, rather than the follower, and thus, enjoying higher GDP per capita.

But there is no "magic formula" for making a world class university. (Salmi, 2009) Each country should choose a strategy that best suits its national circumstances. One might want to say that promoting education for all is a better economic policy than practising elitism in education.

There is no "universal recipe or magic formula" for building world class universities (Salmi 2009). National contexts must be taken into account when countries devise strategies to improve their universities.

We should not be overly reliant on university rankings for education policy. Even N.C Liu and Y.Cheng (2002), who leads the group to compile ARWU, recognized that "any rankings should be used with caution, including ARWU", and that rankings should be used as a reference and judgements should be made with reference to the ranking methodologies.

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 developed countries do not have a single university among the Top 500, a few developing countries manage to do it? Therefore, this requires further investigation as to why these economies perform well economically despite without a so-called good university? It 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.

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**Appendix**

<u>Results</u>

<u>Group 1</u>

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 |



Actual and fitted gdp_per_capita versus top100_per_capita

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 |

Actual and fitted gdp_per_capita versus top500_per_capita



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_capita | 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 |

Actual and fitted l_gdp_per_capita versus l_top100_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 |

Actual and fitted l_gdp_per_capita versus l_top500_per_capita



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.

Group 2: How university performance affects 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 |

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_capit a | 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 |

| Country | | | | | | |
|---|---|---|---|---|---|---|
| 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