real-world economics review, issue no. 76
subscribe for free

Using regression analysis to predict countries' economic growth: illusion and fact in education policy[1]

Nelly P. Stromquist [University of Maryland, USA]

Abstract
Regression models employed to help understand, predict, and enhance national economic growth have increasingly come to rely on quality of education as an important variable. Such models, however, often make a number of untenable assumptions not congruent with reality. A case in point is the recent book by E. Hanushek and L. Woessmann, *Universal Basic Skills: What Countries Stand to Gain.* Unpacking the notion of educational quality – which the book argues is totally captured by PISA and TIMSS scores in math and science – this paper critiques regression models that assume a particular PISA threshold score as quality and stable and linear national development over 80 years, regardless of great variability in countries' economic production systems, histories, physical resources, and social contexts. Hanushek and Woessmann argue that quality of education makes a substantial contribution to economic growth and that quality contributes 6.3 times more than quantity (i.e., secondary school enrollment). However, the narrow definition of quality and the disregard for complexity in explaining social and economic conditions seriously diminish the validity of the findings. The emphasis on education to the exclusion of other forces in society serves to detract attention from deeper policy measures and makes the book less a valid academic study than an effort to manipulate the soft power of OECD to convince governments of the usefulness of international student testing.

Introduction

The introduction of the "knowledge society" has increased global attention to education and with it a greater concern for quality and an appeal to governments to develop education systems that promote cognitive achievement rather than rely solely on expanding access to schooling. This development has been supported in recent years by several economists who have found that quality of schooling is related to economic growth (Barro, 2001; Sahlgren, 2014; Barrow & Lee, 2015), and some even argue (Hanushek & Kimko, 2000; Hanushek & Woessmann, 2007; Hanushek & Woessmann, 2015) that quality is much more important that quantity in predicting a country's wealth.

This claim, however, is not uncontested. Breton (2011) observes that a major flaw in the optimistic calculation by Hanushek and Woessmann is that they rely on the cognitive skills of students measured at a later period than when workers were productive in the labor force. Other criticism has been expressed by Ramirez et al. (cited in Kamens, 2015), who found that recent analyses of the impact of test scores on economic growth show that the impact was substantial only when countries such as Singapore, Hong Kong, Taiwan, and South Korea were included in the study. Kamens (2015) correlational analysis focusing on 1990 growth found little support for ths relationship between test scores and GNP per capita, which led him to assert that globalization had introduced new dynamics in the production structure of many

[1] Paper was presented at the annual CIES conference, Vancouver, 7-10 March 2015. I benefited greatly from the comments and suggestions offered by Theodore Breton, James Cobbe, Steven J. Klees, and Judith Torney-Purta.

countries. No strong effects of test scores on economic growth were found by Levin and Kelley (1994), who considered that the absence of complementary inputs to the economy in the regression models was a major cause for the lack of substantial effect linked to test scores. In a similar study, Lee and Barrow (1997) found that cognitive skills affected economic growth, but only when such skills related to reading, not when they concerned math and science. Glewwe, Maiga, and Zheng's analysis focusing on sub-Saharan countries (2007) raised methodological concerns, arguing that it is easy to misspecify variables in regression models dealing with diverse cultural contexts and that since individuals usually work for several decades after their formal education, the impact of education alone may not be easy to isolate from other concurrent developments over such long periods.

Despite controversy in the academic world, among key international agencies there is a strong consensus that quality (as measured by standardized testing) is highly related to economic growth (usually measured in terms of GDP). This concern with "quality" has been reinforced by two simultaneous developments: the abundance of international test data and advances in computational science. The measurement of student achievement is often being taken as the only indication of cognitive development and thus as a proxy for quality of education. International student test data has been available since 1960 with IEA studies, but in recent decades more countries are participating and several regional and global tests such as SECQMEC, TIMSS, PIAAC, and PISA have become popular and/or have been mandated by some agencies.[2] The ease with which complex statistical models on which such test results can be run makes the computation of various forms of regression analysis accessible through a relatively modest personal computer and thus econometric modeling has become easy and inexpensive to perform.

This paper takes as its main reference the 2015 book produced by E. Hanushek and Ludger Woessmann, entitled *Universal Basic Skills: What Countries Stand to Gain*. Hanushek and Woessmann (H&W hereafter) make strong claims about the highly positive role of knowledge in the creation of national wealth. This paper's objectives are thus: (1) to examine this claim as operationalized in the model proposed by H&W, (2) to probe the model's analytical strength, and (3) to examine its potential for generalization to low-income countries.

Theories underlying the critical role of knowledge and skills

The assertion that knowledge and skills serve as a major predictor of GNP growth is based on two theoretical premises: (1) the quality of knowledge is the principal determinant of wealth generation; (2) a country's economic output is determined primarily by internal/endogenous factors. The first premise, though quite appealing, is insensitive to well-demonstrated factors of production, which identify physical capital, land, and labor (which includes the knowledge of workers) as combined elements, acting in strong interaction. The second premise blends neoclassical theory and endogenous growth theory; the former holds that economic growth is determined primarily by capital intensive production, which leads to higher worker productivity; the latter holds that national investments in human capital and innovation are the main causes behind economic growth.

[2] The international testing regime is expanding to include the testing of teachers, as embodied in TALIS, a survey organized by OECD.

Endogenous growth theory is based on investment in human capital (knowledge and skills) to foster innovation. Essential to endogenous growth theory is the adoption of domestic policies that embrace openness, competition, and innovation, as these are expected to promote economic growth. However, the pervasive impacts of current globalization trends oblige us to consider new economic complexities, particularly the enormous impact of trade and the prices of commodities on economic activity. Advances in the understanding of economic growth are also recognizing the importance of non-economic factors; among them, notably, the characteristics and stability of institutions guiding social action. Natural endowments (particularly minerals) are also important, especially in an export-led economy.

Few scholars would deny the role of human capital as a key ingredient to countries' economic wellbeing, bringing higher productivity and faster and presumably more useful innovations leading to technological advancement. Since human capital is comprised of knowledge and skills, it is increasingly recognized that education makes a contribution not only through years of schooling attainment but mainly through what is learned in school – i.e., the quality of schooling.

But, what is education quality? This is a complex concept that includes the learned knowledge and skills that are essential to a given society. While economists might wish to reduce quality to the acquisition of knowledge and skills needed for future workers, other social scientists direct their attention toward the knowledge and skills needed to produce and sustain a society that is both democratic and inclusive, one that promotes positive transformations in gender, race, and ethnic relations. Measures of quality are necessarily proxies, such as student/teacher ratio, length of school term, teacher salaries. Increasingly, in many dominant analyses, the one proxy for education quality, which ignores the effect of family characteristics, has become student performance in international tests; moreover, this measure is being further narrowed to include performance in only three academic domains: reading, math, and science. International testing programs introduce distortions of their own, one of the most salient being student motivation to perform well in those tests. While such motivation might be strong in countries that aggressively seek to present an advanced national face, other countries might view these international tests as relatively useless, nationally embarrassing, and/or expensive exercises, which might not promote student motivation to perform well.

The H&W model

Regression models in general seek to capture complex realities through a small set of variables and simplified assumptions about our social world. Being parsimonious, models necessarily exclude other important variables that may impact long-term economic growth (Sahlgren, 2014, p. 19; see also Glewwe, Maiga, & Zheng, 2014). Often, lack of conceptual clarity is present in regression models. Thus, the studies on which they are based may cite relevant pieces of the literature but do not explain the logic for inclusion or exclusion of certain variables in the model. Moreover, as a growing number of economists continue to acknowledge (e.g., Levin, 1994; Glewwe et al., 2007; Klees, 2016), omitting a variable that has a true causal effect and is correlated with other variables retained in the regression will change the estimates on those other variables. This is known to all empirical economists but they ignore this basic issue and tend to overinterpret their econometric results.

The H&W model is both innovative and categorical in its assertions. Their projections assume endogenous growth, in which increases in human capital (i.e., a better educated workforce) are the main determinant of economic growth. Productivity of individuals is key and somehow their increased productivity will lead to a more organized society in which national economic output will rapidly augment over time. The model is based on implicit and explicit assumptions about how the economy works and how key variables can be measured.

Explicit assumptions made by H&W are that national growth will occur *linearly* from 2015 to 2095, workers will remain in the labor force an average of 40 years, the growth rate of the economy will be about 1.98%, and future gains in GDP are discounted for evaluation purposes at the rate of 3% (Hanushek & Woessmann, 2015). The authors hold these assumptions to be reasonable, but it could be argued, on the contrary, that these assumptions are overly optimistic by today's realities. In fact, Krueger and Lindahl (2000) have observed that the assumption of linearity in most models of macro-economic growth is often rejected by the empirical data.

The key independent variable in the model used by H&W – the set of knowledge and skills embodied in individuals – is assumed to be measured in valid and reliable form by international tests. Specifically, it is implicitly assumed that PISA tests are able to measure cognitive achievement across nations, thus providing a variable that operates with force regardless of differences in culture and history – and as noted above, regardless of students' motivation to perform well on the test.

Since today there is a widespread recognition that economic, social, and political institutions shape a country's economic outcomes, H&W incorporate two variables they consider crucial measures of the institutional context of countries. These are "openness of the economy to international trade" and "security of property rights." It should be remarked that by selecting these two "institutions," H&W accord attention and value to these institutions over other possible institutions and other possible sets of variables. This is an example of how you can incorporate in a regression function variables of your own political preference rather than proven theoretical value. The variables dealing with openness to trade and security of property rights are directly connected to neoliberal theories in which the role of international business entrepreneurs is seen as paramount to economic growth. Other economists observe that life is more complicated today. Romer, for instance, citing the effects of globalizing forces, finds that "people with human capital migrate from places where it is scarce to places where it is abundant" (1994, p. 19). In Romer's view, therefore, migration would be a crucial variable to incorporate in models where knowledge is being considered. Kamens (2015) also express concerns about the role of globalization, holding that the process of production have changed under globalization so that what matters is not only cognitive skills of workers but also the country's ability to attract investors and the investors' own efforts to discover new markets and cheaper sources of labor, react quickly to international conditions, and, when needed, withdraw abruptly from certain markets. The economy also needs to be able to absorb people with high cognitive skills; thus, the capacity to use educated talent depends on access to capital and financial markets in the external environment (Kamens, 2015). Other economists have advanced models in which they control for "institutional effects" that are more expansive than those considered by H&W. These include such issues as enrollment shares of independent schools, existence of exit exams, centralization in decision-making and choice, and the decentralization and autonomy of schools. None of this is considered pertinent in the H&W model. The fact that key variables sensitive to the current world are not taken into account in the H&W model renders it unrealistic.

Operationalizing the H&W model

The regression model used by H&W is parsimonious and simple. The dependent variable is GDP growth projected for 80 years (estimated GDP by 2095), subject to the assumptions about economic performance cited above. Since the unit of analysis is the country, and a small number of cases are available, the regression has only four independent variables: GDP in 2015, national performance in international tests, the country's openness to trade, and the country's protection of property. By most analytical standards, this is a reductionist view of reality.

In the introduction to the H&W book, written by Andreas Schleicher, director of PISA at OECD and Qian Tang, current UNESCO assistant-director general for education, lofty claims are made for PISA, which is said to measure "not only whether students have learned what they were taught, but also assesses whether students can creatively and critically use what they know" (Schleicher & Tang, 2015, p. 9).

H&W would ideally have liked to rely only on PISA tests, but its global administration in 2012 yielded only 65 cases. They therefore added 11 other nations which had data from another test: TIMSS, 2011. Since the TIMSS data does not cover reading, the authors decided to construct the key independent variable—cognitive achievement—by taking into account only performance in math and science. Reading, which in most understandings of the curriculum is a vital subject, was thus summarily eliminated. The official justification presented by H&W is that they measured mathematics and science because these "can be measured reliably and consistently across countries and cultures" (p. 12).

H&W assert that cognitive achievement or quality should have a minimum threshold. Selected as such was Level 1 of PISA, or a score of 420 points in this test. This decision, they argue, was based on the need for individuals to have "modern functional literacy," which was defined as "not just the ability to read simple words," but "the capacity to understand, use and reflect critically on written information, the capacity to reason mathematically and use mathematical concepts, procedures and tools to explain and predict situations, and the capacity to think scientifically and draw evidence-based conclusions" (p. 21).

Findings

To assess the impact of students' cognitive skills on economic growth, H&W ran simulation model under three scenarios: one in which countries focused only on the expansion of the secondary school system (full participation by all, but at current basic skills), another in which countries centered on the students' skills (secondary schools at current enrollment rates attain a minimum of 420 PISA points), and a third scenario combining both schooling quantity and student capability variables (i.e., full secondary school enrollment and a minimum of 420 PISA points is attained by all).

Assuming an endogenous growth model, H&W find that combining full participation in secondary school and achievement of a minimum level of skills (all students achieve a minimum of 420 PISA points),would make a sizable contribution to economic growth: in lower-middle income countries (N=8) the GDP would grow 27.9% per year, in upper-middle income countries (N=23) 15.6% per year, while in high income OECD countries (N=31) the GDP would grow 3.5% year (p. 66). In additional regressions, H&W show that GDP growth due to

achievement of minimum skills far exceeds that due to the quantity of schooling. Not surprising, the combined scenario – schooling quantity and minimum skills – offers the largest GDP gains. H&W thus find that among lower-middle income countries, economic growth due to universal secondary enrollment at current levels of school quality would yield a growth of 206% in their GPD (over an 80-year period), while growth due to universal secondary school enrollment jointly with universal attainment of 420 PISA points would yield an increase of 1,300% of the GDP over the same period. In other words, school quality would increase the GDP 6.3 times more than school quantity (pp. 15 and 69).

But, are these gains real? Explanatory narratives based on such small number of countries should be very cautious about making predictions. A Harvard economist, Barro (c. 2000, p. 5), warns, "My view is that it is impossible to use the experience of one or a few countries to get an accurate empirical assessment of long-term growth effects from legal and educational institutions, size of government, monetary and fiscal policies, and other variables."

Further, the countries in their sample comprise a set of very disparate economies. H&W note that the 76 countries in the sample account for 61% of the world GDP (H&W, 2015, p. 36). The high percentage suggests a balanced representation of countries; but such is not the case. According to Hanushek (2015), all countries that participate in PISA are among the best regional performers, so most of the countries in the sample are upper-middle income (members of OECD), with only eight of the 76 classified as lower-middle income and none as low-income. High-income countries in the H&W book are further classified as OECD or non-OECD. The classification of countries based solely on levels of income casts doubts on the validity of this conceptualization. "Lower-middle income" comprises countries as diverse as Ghana, Honduras, Ukraine, and Viet Nam. The "upper-middle income" countries present a more uneven mix with enormous diversity in size, history, and economic structures, such as Montenegro, Thailand, Turkey, and Costa Rica. The "high-income non-OECD" countries also forms a disparate group; it includes mostly oil producing countries such as Oman, Bahrain, Qatar, and UAE but also city-states such as Singapore and Hong Kong and a super power such as the Russian Federation. Greece, also among the sampled countries, now faces an extremely volatile economic situation and its financial governance has been a major source of concern to its European partners. Some countries in the sample are absolute monarchies; others have more democratic forms of government. Is it possible to erase past history, political systems, economic structures, cultural norms under a single variable: level of GDP? And not control for these other factors as independent variables?

I would argue that this procedure is not adequate. The countries in the sample are much more diverse than their GDP. The oil-producing countries draw their wealth primarily from exports in which the knowledge composition of their inhabitants plays a minor role in revenue generation. Although both are OECD members, the US economy is 60 times the size of Czechoslovakia's. Some of the countries have experienced stable regimes (e.g., Australia, Morocco); others have not (e.g., Honduras, Ukraine). In all, the countries in the sample are highly heterogeneous in terms of economic productivity, stability of and respect for institutions, the training and prestige of civil service, among many other factors of importance. When focus is placed on certain countries, the model does not fit. Such is the case of the United States – a major economic power – that has relatively low PISA scores and relatively high growth rates (H&W, 2008). It has also been observed that among the PISA higher-scoring countries, student scores are not related to economic growth rates (Breton, 2015a). Economists who are familiar with estimates of economic returns – which derive from particular forms of earning functions – warn us that such estimates vary widely, depending on the data

sets used, the assumptions made, and the estimation techniques (Dickson & Harmon, 2011). Further, they observe that "a single rate of return may not be very informative if returns to education differ by education level or differ across populations (including the social strata)" (Dickson & Harmon, 2011, p. 1118). None of these nuances appear in H&W's book. H&W claim their projections are "robust" because they include "institutional measures related to the quality of the underlying economic environment" (H&W, 2015, p. 68). But as seen above, the two referenced institutional measures seem quite arbitrary as they address only market forces in very particular ways.

And, can we generalize to other countries? It is an established principle of the social sciences that we can generalize *only* from the sample to the population. Much of the value of the H&W book is being presented in the form of policy recommendations for *poor* countries to follow. This is implicit as the book is produced under the auspices of OECD and with the endorsement of UNESCO and – less formally – of the World Bank. But, can one extrapolate to situations where causal mechanisms may be different? The extrapolation proposed by H&W assumes great stability over time, with no ceiling effects. Does this assumption apply to all countries, regardless of their economic composition, level of industrial development, or production base? It should be noted that since the future is projected solely on assumptions rather than on empirical facts surrounding the sample, the generalization proposed by H&W contains yet another source of error: time. Can we safely make assumptions about the dynamics we will undergo over the next 15 years? One observation we could make is that perhaps the study has too much to say about too few countries classified by level of GDP. At best, then, the results presented in the H&W book should be described as merely suggestive.

The authors are aware that charges of reverse causation (e.g., income growth may cause increased investments in education [Glewwe, Maiga, & Zheng, 2007]) could be raised against the proposed model. They argue that this has been controlled. But for this to be controlled, regressions in which cognitive achievement is now placed as the dependent variable would have to be run – and the results shown. Which they are not. Breton (2011) found that across countries schooling attainment (quantity) explains a greater share of income variation than average test scores. This critique is conveniently disregarded in H&W's subsequent work. Using a more complete model, Breton (2015a) subsequently found that the average test scores could not explain economic growth in countries that had more than 8 years of schooling or countries that had average test scores over 470.

Unsurprisingly, H&W find that the institutional factors they selected contribute to economic growth. They find that on average having an open economy makes a contribution of 1.61 percentage points while having protection against expropriation contributes 0.95 percentage points to the annual GDP (Figure 5.5., H&W, 2015, p. 70). The selection of those two "institutions," however, drowns out the voices of institutions that have significant impact on people's ability to work, produce, and contribute to the economy. This is an example of how scholarship mixes with political beliefs, when researchers can add to a regression function their own variables of convenience.

Conclusions

Despite statistical sophistication, regression analysis cannot escape criteria for determining (a) the appropriateness of the proposed model and (b) the validity of generalizing from it. Models should have a sound theoretical framework, with a well-justified set of variables.

Models are parsimonious efforts to capture reality, which all scientific efforts seek to do by identifying fundamental factors. But sometimes we can stretch this procedure beyond reason. Political and religious contexts that deeply affect some countries cannot be just pushed aside. A similar argument could be made for the economic context. Stefan Dercon (2015), an Oxford University professor and the current DFID chief economist, challenges the view that sees education as the most important sector. He has plainly stated that the argument that education may cause economic growth is flawed as it appears that the supply (of jobs by industrial and commercial firms) creates demand (for jobs) rather than the demand (for jobs) creates supply.

The classification of countries by level of GDP is oblivious to how this GDP is generated. It is bizarre thus to consider Singapore (extremely high in technological manufacture) similar to some Middle East countries (whose revenues derive mostly from the export of a single natural resource). The surgical precision of regression coefficients can thus be very misleading. One *should* be able to generalize because we make advancements in knowledge when we can apply what we have learned in a particular circumstance to other circumstances. But to extrapolate outside the boundaries of the original study requires an extraordinary amount of additional information.

The book by H&W brings some positive points for education. The book's advocacy of the importance of education in fostering economic wellbeing is very much welcomed. Positive also is the authors' demonstration of a strong association between education and GDP growth, which leads them to assert that "arguments against school improvement based on limited funds are indeed short-sighted" (H&W, 2015, p. 82). The preface to the book by OECD and UNESCO leaders makes a strong case for working with teachers: "Nowhere does the quality of a school system exceed the quality of its teachers" (Schleicher & Tang, 2015, p. 13).

On the negative side, while the authors say that both quality and quantity of education are important, their bias for quality shows repeatedly. But quality for them has an intriguing emphasis as it is not connected to greater investment in teachers or the conditions under which teaching takes place. They have made categorical assertions in this regard in a previous work published by the World Bank in 2007 (*Education Quality and Economic Growth*) where they state, for instance, that "Many policies involve substantial flows of resources—direct spending, changes in teacher salaries, reductions in class size, and the like—made within the context of current school organization. The empirical evidence documents the difficulties with such policies. Simply providing more resources gives little assurance that student performance will improve significantly" (p. 15). While they acknowledge that educational systems need to improve, they also go on to argue that there is "no relationship between spending and student performance" (p. 10), a remark that emerges as an invitation not to invest more in education.

H&W offer a very optimistic yet purposefully naïve model of real life events and processes. Analytically, placing education over everything does not make sense. Their model implies that investment in health and social security are less important. But why so much weight on education? A cynical perspective would say that education centers attention on domestic factors and chooses to ignore external dynamics. By denying the role of international economic and political forces, the authors create a world in which self-contained and sovereign nations are the primary agents of their destiny. No need, then, to revisit the current

international order and its complexities and the inequalities it generates. So, I would assert H&W's optimism has a political nature underlying its concentration only on education.

Their book, sponsored and published by OECD, in the end argues for the need for constant "performance measures" and "accurate assessment of performance by international standards" (H&W, 2015, p. 83). This then amounts to a strong endorsement for the use and expansion of international tests, particularly PISA—the test OECD administers throughout the world. And as a claim to continue to equate student test performance with school quality. It certainly would favor OECD to promote and disseminate studies that rely on PISA as a measure of education quality, thus further legitimating testing as a measure of educational quality. At the same time, it must be recognized that OECD has become a institution whose "educational policy work is widely used by national governments to guide their reform agendas" (Rizvi & Lingard, 2006, p. 248), an observation shared by Andere (2015), who holds that PISA has become the "guiding document of choice among many national governments for design and implementation of policy change." H&W's book is printed with a colorful cover and is replete with figures and tables; moreover, it is is accessible free of charge through the Internet. This, plus the explicit endorsement of UNESCO and the implicit endorsement of the World Bank, make the book an instance of soft power being presented as valid academic research.

References

Andere, E. 2015. Are Teachers Crucial for Academic Achievement? Finland Educational Success in a Comparative Perspective. *Education Policy Analysis Archives*, 23(9).

Barro, R. c. 2000. Education and Economic Growth. Cambridge: Harvard University. Manuscript.

Barro, R. & Lee, J. W. 2015. *Education Matters: Global Schooling Gains from the 19th to the 21st Century.* Oxford: Oxford University Press.

Breton, T. 2011. The quality vs. the quantity of schooling: What drives economic growth? *Economics of Education Review*, 30: 765-773.

Breton, T. 2015. Higher Test Scores or More Schooling? Another Look at the Causes of Economic Growth. *Journal of Human Capital*, 9(2): 239-263.

Dercon, S. 2015. Sustainable development and education: New frontiers for research and policy? Keynote speech at UKFIED annual conference, Oxford, 15-17 September.

Dickson, M. & Harmon, C. 2011. Economic returns to education: What We Know, What We Don't Know, and Where We are Going—Some brief pointers. *Economics of Education Review*, 30: 1118-1122.

Glewwe, P., Maiga, E., Zheng, H. 2007. The Contribution of Education to Economic Growth in Sub-Saharan Africa: A Review of the Evidence. Minneapolis: Department of Applied Economics, University of Minnesota, manuscript.

Hanushek, E. 2015 (13 May). Presentation at book launching of *Universal Basic Skills: What Countries Stand to Gain*. Washington, D.C.: World Bank.

Hanushek, E. & Kimko, D. 2000. Schooling, Labor Force Quality and the Growth of Nations. *American Economic Review,* 90: 1184-1208.

Hanushek, E. & Woessmann, L. 2007. *Education Quality and Economic Growth*. Washington, D.C.: World Bank.

Hanushek, E. & Woessmann, L. 2008. The Role of Cognitive Skills in Economic Development. Journal

of Economic Literature, 46:3: 607-668.

Hanushek, E. & Woessmann, L. 2015. *Universal Basic Skills: What Countries Stand to Gain*. Paris: OECD.

Hausmann, R. 2015 (May 31). The Education Myth. Project Syndicate. https://www.project-syndicate.org/commentary/education-economic-growth-by-ricardo-hausmann-2015-05

Kamens, D. 2015. A Maturing Global Testing Regime Meets the World Economy: Test Scores and Economic Growth, 1960-2012. *Comparative Education Review*, 59(3): 420-446.

Klees, S. 2016. Inferences from regression analysis: are they valid? *real-world economics review*, no. 74, pp. 85-97.

Krueger, A. & Lindahl, M. 2000. Education for Growth: Why and For Whom? Working Paper Series. Washington, D.C.: National Bureau for Economic Research.

Levin, H. & Kelley, C. 1994. Can Education Do it Alone? *Economics of Education Review*, 13(2: 97-108.

Rizvi, F. & Lingard, B. 2006. Globalization and the Changing Nature of the OECD's Educational Work. In H. Lauder, P. Brown, J.A. Dillabough, A.H. Halsey (eds.). *Education, Globalization and Social Change*. Oxford: Oxford University Press, pp. 247-260.

Romer, P. 1994. The Origins of Endogenous Growth. *Journal of Economic Perspectives*, 8(1): 3-22.

Sahlgren, G. 2014. Incentive to Invest? How education affects economic growth. Stockholm: Centre for Market Reform, Adam Smith Institute.

Schleicher, A. & Tang, Q. Editorial. In E. Hanushek and L. Woessmann. *Universal Basic Skills: What Countries Stand to Gain*. Paris: OECD, pp. 9-14.

Author contact: stromqui@umd.edu

SUGGESTED CITATION:

Nelly P. Stromquist, "Using regression analysis to predict countries' economic growth: illusion and fact in education policy", *real-world economics review*, issue no. 76, 30 September 2016, pp. 65-74, http://www.paecon.net/PAEReview/issue76/Stromquist76.pdf