School Inputs and Student Achievement: The Case of Thailand

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Abstract

Thailand is among the top spenders in education, yet we are lacking behind in dimensions of quality of education system and student achievement. To comprehend this budget puzzle, it is vital to examine how different school inputs translate into student learning. The countrywide school-level dataset from National Education Account (NEA) and household data from National Statistics Office (NSO) provides a way to estimate the correlation between inputs and students' ONET scores. Education Production Function employed in empirical analysis imitates that of a firm's production function where school and household characteristics are seen as inputs and student learning as the output. The main factors of interests are teacher and director experience, student-teacher ratio, and school size. Instrumental Variable (IV) estimation is used to deal with potential endogeneity problem with the structural model. The results show that the impact of teacher experience and student-teacher ratio is significant only i1n the case of primary level, and fade out in higher level of education. Director experience has no significant impact on test scores.

A subgroup analysis was also conducted to investigate small primary schools, where the problem of teacher shortage exists. In these schools, the effect of director experience becomes positive significant. Surprisingly, it is reported that the estimates on the dummy for teacher shortage is positively significant on test scores. It is suspected that this is due to data problem, and controls on household characteristics and child ability has taken most of the explanation in score fluctuations.

I. INTRODUCTION

Since 1972, Thailand has been experiencing constant changes both in political and economic contexts as it went through many different system of government, rapid economic growths, and transformational economic crises. This leads to an inevitable pressure on the development of human capital in the country in order to reach the high growth rate in the sustainable manner through reduction in socio-economic inequality and increasing supply of skilled labor. The first tangible effort from the side of government can be seen in the first National Economic and Social Development plan in 1960s. The role of Education in Thailand not only ceases at reducing socio-economic inequality and boosting competitiveness as it also influence other aspects of quality of life through crime rates, social trusts, and social institutions, all of which are no less important to sustainable development especially in the current atmosphere of internal conflicts.

As a result, the Thai government's budget allocation to education spending ranks first out of all other spending. From the start of 2015 fiscal year until February 2015, Budget Expenditure for Ministry of Education is the highest at 213.08 billion baht, or at 19.73% of total government expenditure.[1] Comparing to countries which are known for their very effective education system, Thailand's public spending on education as percentage of total government expenditure has been higher than Finland, Hong Kong, and France (see figure 1). Figure 2 also tells the similar story for expenditure per student as percentage of GDP per capita, which is a good measure for how much is truly spent upon each student. Our expenditure per head is higher than in Malaysia, who is out-performing us in terms of education achievement, Finland, Japan, Korea, and the best performer in Pisa, Hong Kong. This sends Thailand to be among the top spenders in education.

However, these high numbers do not seem to translate into results. In WEF (World Economic Forum) Global Competitiveness report 2014-2015[2], Thailand ranks 90th out of 144 countries in terms of Quality of primary education, after Malaysia (17th), Indonesia (48th), China (59th), and Philippines (60th). In the aspects of Enrolment in Primary Education, Thailand has not achieved Millennium Development Goals (MDG) of universal primary education, with primary enrolment at 95.6% at the 58th rank. The same story goes along with assessment of overall quality of the educational system, where Thailand rank at 87th.

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[1] Ministry of Finance, dwfoc.mof.go.th, feb 25 2015

[2] WEF Global Competitiveness Report 2014-2015, http://reports.weforum.org/global-competitiveness-report-2014-2015/

Thus, the data seem to suggest that many other countries are paying for a better educational system at the lower price. There is a call for research and analysis into how the money is spent into the two aspects of educational spending, current expenditure and capital expenditure, and how these spending structures play a role in student outcomes and achievements. Table 1 shows that about 90% of the budget has been allocated to the current expenditure since 2000. The latest National Education Account Report provided a diagram that tell the story of how the budget is spent into different activities (see diagram 1). It is easy to see that a large portion is dedicated to salary of government employees and teachers (43%), and grant-in-aids which is also used for salary, operation expenses, and physical investment projects[3] (39%). If we are to look at how expenditure per head is spent, up to 74% of total expenditure is dedicated to 'production of students and graduates', which mainly includes teacher and director salary, school uniforms, textbooks, and academic activities[4].

As a major part of the massive educational budget seems to be spent into school inputs, it is vital to look into how these inputs translate into student learning in reality. This can be seen as a tremendous opportunity cost if the funds are used and spent in the manner which does not align to the goal of improving quality education for all. Hanushek and Wößmann (2007) had mentioned that cognitive skills are widely accepted to be 'the key dimension of school outcomes'. Even though data were not quite available to prove the link between cognitive skills and economic outcomes, newer studies with fuller information have concluded that there exist a strong relationship. While developing countries have been doing quite well in terms of education attainment, underdevelopment in cognitive skills seem to be the reason why outcomes are lacking behind the more developed countries. These analysis are important to locate the structural problems in the Thai Education System that is preventing the education system to deliver better results, which will then allow us to draw vital policy implications or suggestions.

II. RESEARCH QUESTIONS AND OBJECTIVES

The main research purpose of this research paper is to examine fundamental correlation between school inputs and student achievements. These inputs are in terms of school-level characteristics, expenditure per head, teacher experience and credentials. Another objectives of the paper is to attempt to draw some conclusions on why education spending is ineffective in raising

[3] http://audit.obec.go.th/report/total/moneyaud.pdf

[4] refer to figure 3

school quality and what are the policy implications by using the results from the quantitative analysis

Very few research paper has been dedicated to finding causal relationships between school characteristics and achievements since there is a lack of adequate data to analyse at the province level, let alone national level. With this new dataset from NEA, the conclusions from the paper is hoped to be of contribution to the studies of the relationships between school inputs and student learning in the context that is particular to Thailand.

III. LITERATURE REVIEW

Many empirical efforts have gone into defining the relationship between educational spending and educational outcomes. There are many studies that claim a strong connection between school resources and outcomes such as test scores, yet at the same times, as many were rebuttals against the conclusions. As school resources can be seen in three dimensions; real resources (teacher experience, credentials), financial aggregates (expenditure per head, salary), and other external factors (pedagogy, school management). Fuller and Clarke (1994) had summarised the findings of the effects of different school inputs for primary and secondary schools from 1970s to the time of the research. Only half of the studies on expenditure per pupil find significant relationship to outcomes, while 4 out of 11 studies find teacher salary level statistically significant. More recent studies from 1990 to 2010 in developing countries also found a rather inconclusive relationship between teacher experience, level of education, and class size (Glewwe, Hanushek, Humpage, & Ravina, 2011) The majority of studies, however, found significantly positive effect of teacher salaries. As for expenditure per head, Glewwe *et al.* (2011) concluded that there is no evidence of impact of school expenditure as different studies employ different estimation methodology.

Angrist and Lavy (1999) analysed the effect of maximum class size policy in Israeli public schools. After checking fundamental correlation between class size and achievement, they concluded that the positive relationship is mostly explained due to disadvantaged backgrounds of student in smaller classes and schools. However, after using Instrumental Variable analysis, there is a small negative effect of larger class on achievements. Hoxby (2000) used more recent data on American elementary schools and have concluded that there is no significant effect of class size on achievement at all. But as Angrist and Lavy have mentioned in their paper, it is difficult to infer any result further from the context of where the studies were conducted.

Empirical studies in Thailand is very limited due to the availability of data on school inputs even at student level. Lounkaew (2013) pays attention to the student characteristic and PISA test scores, while controlling for school size, teacher-student ratio, government funding, and dummies for school characteristics. The estimates showed that number of computers per student and shortage of learning materials have significant effects on PISA scores, while it is the opposite for level of government funding and teacher-student ratio. But these estimates might not be adequate proxies for national level as PISA includes only 239 schools in the testing procedures, and some choices are not random.

Sasiwuttiwat and Tangkitvanich (2012) also said that financial resources provided by both the Thai government and households are sizeable, and that the problem with the education system is rather how the resources are allocated and spent. And not only that the resources are spent inefficiently, the government policies are forcing teachers from private schools to public school where average salary is constantly growing. Thus, it is more difficult for lower income households to enrol their children in private schools that decline government subsidies as they have to charge higher to keep the teachers in.

With this limited literature on Thai education system, this paper will contribute as a new attempt to find relationship between different resources to development of students by utilising new set of data from National Education Account done by Quality Learning Foundation (QLF) with partnership with Thammasat University, Ministry of Education, and Ministry of Finance.

IV. METHODOLOGY

The main comprehensive conceptual framework for the paper is that of Education Production Function. The framework imitates that of a firm’s production function, but the inputs in educational process are years of schooling, school, family, and student characteristics. The firm, now a school, produces learning measured in terms of outcomes. The relationship between the inputs and student learning are very flexible and tend to vary across different group of population, thus it is safe to assume that a specific education production function always exists just like that of a firm, with the only problem of estimating it.

While the function includes all variables related to the child’s learning process, the paper will focus only on the topic of school resources and its effect on student’s learning since our focus is to evaluate how the expensive education expenditure is spent but seems ineffective or inefficient.

Hence, the variables we are looking at mainly are expenditure per head, teacher and principal's level of education and experience, and other school specific characteristics such as student-teacher ratio, lack of teacher, and so on

The education production function introduced in Glewwe *et al.* 2011 will be the basic foundation of this paper empirical analysis framework. The function is representable by:

$$A = f(S, Q, C, H, I)$$

As aforementioned, the input vectors are as followed: S is the number of years of in school, Q are school and teacher characteristics, C is the child characteristics, H is the household characteristics, I as the other parent-based inputs such as provision of textbooks and supplies. We can also control for community variables which may reflect employment opportunities which may influence household or student decisions to stay or not stay in school and seek employment due to specific return to additional year of education.

The next section will be a descriptive analysis part of the structure of educational spending and how they are distributed across Thailand due to education reform and policies done either directly or indirectly. I will also include some descriptive analysis on the current distribution of resources across provinces and tambon using data from NEA.

V. DATA & DISCRIPTIVE STATISTICS

The dataset that will be used is obtained from the Thai National Education Account (NEA) project that is managed by Faculty of Economics, Thammasat University, and Quality Learning Foundation (QLF). It is a school-level data, consists mainly of information of province, school size, teacher and director average experience and salary, and ONET test scores in the year of 2010 and 2011. The dataset includes about 31,047 public schools, where 21,519 schools are pre-primary and primary schools (specifically only 9 schools are entirely kindergarten). 6,990 schools are lower-primary schools, which mostly also provide kindergarten and primary education. The rest of 2,538 schools are upper-secondary schools where very few provides kindergarten and primary education (148 and 226 upper-secondary schools, respectively).

Table 2 exhibits how schools are distributed across different school-sizes and level of education. OBEC[5] put schools into 3 sets of size; small for less than 120 students, medium for 120 to 500 students, and large for more than 500 students. Out of 21,519 primary schools, 65.16% are

[5] OBEC : Office of the Basic Education Commission of Thailand

small schools, and 25.95% of them have less than 60 students, barely enough to fit 2 classrooms[6]. However, the proportion of small schools is quite low for both lower and higher secondary schools; 5.42% and 1.78% respectively. It is safe to assume that the majority of the small primary schools are located in the rural communities where it may be hard to travel to bigger school due to income or other constraints. Table 3 shows that the top 15 provinces with small primary schools are in North-east region of the country where the rural population is very high.

Table 4, 5, and 6 sums up the average school inputs in terms of principal and teacher characteristics, and Math ONET scores for year 2010-2011. OBEC has a minimum quota for number of director and teachers according to student populations, and for small primary school, it is obvious that they are suffering from shortage. Average number of director for primary schools with less than 120 students is below one, the number they should be having. It turns out that 904 small primary schools across the country do not have any director, and teachers have to play the part. The same story applies for teacher supply in small primary schools. 5.11% of small primary schools are facing teacher supply constraint. As for Math ONET test scores, it is quite hard to determine any potential relationship between school size and test scores for all three school levels.

It is quite easy to point out that, as schools get bigger, average teacher experiences seems to decrease. This could be due to the fact that small schools attract teachers from the local community who are more likely to stay and teach, compared to those in the cities where choices of employment are more various. However, it is the opposite direction for school directors. We observe correlation between school size, years of experiences, and salary. Two-way scatters and fitted lines between salary and experience for both director and teacher seems to suggest positive effect of additional year of experience. Table 7 reports a multiple regression result of log(teacher wage) on teacher experience, school size, and a dummy for lack of teacher. For the entire sample, it turns out that additional year of experience would increase teacher salary by 3.65% on average, and the effect is statistically significant at 1% level. By looking at samples from different level of education, the marginal effect of additional year of teacher experience increases by school levels. School size also leaves a significant positive effect on teacher salary, but only if the size difference is considerably big at 1000 students, where teacher are paid 1.15% more on average of the entire sample.

Figure 6, 7, and 8 shows the average school-level scores for each level of schooling for 3 subjects. Apart from Matthayom 3 level, we can observe some possible correlation between school size and test scores for all 3 subjects. For Mathayom 6 level, there is also a notable jump in test scores for schools with more than 2500 students. This maybe due to the fact that these schools are ‘elite’ schools at the provincial or national level, and thus, students with high innate ability and skills are likely to self-select themselves into these schools. For Mathayom 3 however, test scores increase as the school gets bigger, but decrease again if the size is more than 500 students. Despite some informing correlation from these figures, there is still a need to isolate the impact of school size by controlling for other factors that may also influence these scores. This will be attempted in the empirical analysis section.

VI. EMPIRICAL ANALYSIS

The analysis undergone in this paper attempts to address many questions on the effect of school resources and student achievements. As mentioned earlier in methodology section, Education Production Function is the underlying conceptual framework for the quantitative analysis. Using joined school-level data from National Education Account (NEA), and Tambon-level data from National Statistics Office (NSO), we examined our main variables of interests, that are school inputs, in relation to the ONET test scores. First, simple OLS regression analysis is employed to investigate the possible fundamental relationships between the inputs and scores. Then, IV regression analysis is utilised to deal with possible problem of endogeneity of the main model.

6.1 OLS Estimation

This section of analysis look at how Mathematics, Science, and English ONET score is explained a function of four sets of variables, namely, school inputs, household characteristics, children innate ability, and parent-based inputs on education of their children. It is assumed that each level of education is described by different Education Production Function, and thus the results are shown separately for Prathom 6, Mathayom 3, and Mathayom 6 level.

Table 8, 9, and 10 present the results of OLS estimation with Heteroskedasticity-robust standard errors for each level of education. Note that lagged test scores are included in the model as a proxy for average school-level student ability which is likely to vary across schools and regions.[7] Bernal et al. (2014) also assumed that lagged test scores have information of family and school inputs up to the time when the tests were taken. After checking for possible multicollinearity problem, there seems to be no correlation problem with other variables of school resources and

[7] Bernal et al (2014), Aucejo and Romano (2014), and Goldhaber et al. (2013) are examples of studies that use the same approach to try to control for student ability and parental inputs up to the time the test scores

household characteristics, so I concluded that test scores are good enough proxy to control for student ability and dimensions of parental inputs. Also, proxy for household education expenditure is generated by multiplying 2.5% with monthly household expenditure. The rational is based on a survey conducted by NSO which look at how many percents of monthly household expenditure in spent in to education.

From the OLS regression results, we can see that the average return of additional year of teacher experience to test score is the highest in primary level, which is at 0.459 for Math ONET scores, and 0.14 for Science scores. Statistical significance of the estimates is decreasing as level of education increases. In other words, experience of teachers seem to matter more in lower level of education in predicting test scores. OLS estimates of another dimension of school characteristics, student-teacher ratio, have a negative impact on all test scores at Prathom 6 level. However, the effect fades out for higher level of schooling, following the case of teacher experience. Lastly for school inputs, the estimated impact of director's experience is quite low and not statistically significant except for some, which are Math at P6 level and Math & Science at M6 level.

For dummies of school size, the impacts are divorced for each level of schooling. For primary schools, student performs better on average as school size increases. The story is particular to primary school because, as mentioned in descriptive analysis section, small primary schools seem to have the problem of lacking teachers, or having teachers teaching classes they do not qualify in[8]. The case is in reverse for Mathayom 3 scores, where school with more than 500 students are expected to perform worse on average 1.60 for Math, 1.956 for Science, and 1.496 for English score. It is crucial to observe that, as expected, test scores are most affected by household characteristics and child ability. Overall, schools in urban areas are performing better than those in rural area for Prathom 6 and Mathayom 3 level. However, the effect fades out for upper secondary level, which I suspect that it is due to other characteristics of schools and students that have become more relevant.

6.2 IV Estimation

As mentioned in Glewwe et al. (2011), there exists a potential problem of endogeneity of vector **I**, parent-based inputs, because parents choose the household utility maximising allocation, implying that **I** may also be determined by school characteristics and household characteristics. In general function form;

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[8] Though unrecorded, field experience with local school principals tell the story of how they have to compete for teachers and many times, they get a P.E. teacher instead to fill in the Math position.

$$\mathbf{I} = g(\mathbf{Q}, \mathbf{C}, \mathbf{H}, \mathbf{P})$$

Where **P** is other prices of education such as enrolment fees and school uniforms. However, I assume that vector **P** is negligible as tuition fees in most public schools are quite low apart from big upper-secondary schools in big provinces like Bangkok, or Chiang Mai.

Firstly, parent-based inputs are assumed to be in relationship with school characteristics such that the bigger the school, the higher chance that it is more competitive and there are costs in entering and being enrolled in said schools[9]. Thus, school size may have positive relationship with parents' educational spending. Other school inputs that may influence **I** is the level of salary of director. As shown in descriptive statistics section, as school gets bigger, directors are more experienced and their pays increase substantially. It is intuitively safe to assume that the better and bigger the school, the higher the directors' pays. These schools require parents to invest more in order to get their child enrols, thus the relationship to vector **I**.

To check of endogeneity problem of **I**, in this case a proxy of household educational expenditure, is by estimated the reduced form of *educexpend* on all explanatory variables and IVs, which are *directorwage* and *studentpop* in this case, then add the resulting estimated error terms to the structural equation and check its significance. The result is reported in the Table 11 in the Appendix. As the error term is significant, there exist endogeneity problem of variable *educexpend,* and director wage and school size seems to be adequate Instrumental Variables from their significance.

Table 12 report the result from IV regression analysis of Math scores for different level of schooling. For Prathom 6 Math scores, the average impact of additional year of teacher experience has increased from 0.459 to 1.148 , which is statistically significant at 1% level. Meanwhile, director's experience now has a small negative impact in determining student performance anymore. Also, it is notable that student-teacher ratio's impact on Math scores is smaller.

For Mathayom 3 level, teacher experience remains statistically non-significant. At the mean time, student-teacher ratio has become negatively significant yet minimal at 10% level, where 1 point increase in the ratio would translate to about 0.013 reduction in Math test scores. The effect of school size is of the same story, whereas bigger schools are performing worse on average. Director and teacher experience remain statistical non-significant at Mathayom 6 level Household

[9] see Hanushek, Lavy, and Hitomi 2008

characteristics and student ability still seems to be the most important factor in influencing student performance.

Thus, it is safe to conclude that as teacher experience seems to lose its importance as students progress into higher level of basic education. Also, the negative effect of student-teacher ratio is confined to primary level, which could be contributed from the issues of teacher shortage in small primary schools in the rural area. Director experience does not have any statistical significance in relation to Math scores for all level. For the next part, I will do a subgroup analysis of small primary school to try and investigates the impact of teacher shortage and the return to teacher and director's experience if they are of any different from the one investigated.

6.3 The Story of the Small Primary Schools: Sub-group Analysis

Table 4, 5, and 6 shows that the issue of teacher shortage seems to appear only in schools that are categorised as small primary schools. As most of these school are in rural areas, it is vital to investigate whether the issue of lacking teacher leads to a problem in student learning or not. By using the model already defined above, it is hoped that different impacts are isolated and we can see the true effect of these school characteristics in this sub-group analysis.

Both OLS and IV estimation were performed and the result are presented in Table 13. We can see that the average effect of additional year of teacher experience is quite similar to that of IV regression in the previous part. An additional year of teacher experience would increase test scores by about 0.469 on average, holding other factors constant, and it is significant at 1% level. However, the negative effect of student-teacher ratio intensified, as there are already small number of schools, thus increase in the ratio represents a higher pressure on the teacher workload.

As for the issue of teacher shortage, the effect is surprisingly positively significant at 1% level for both OLS and IV estimation. However, the average test scores for small primary schools with or without teacher shortage problem is very close. Thus, the little difference in the test scores were mostly explained through household characteristics. In my opinion, it is save to assume that in schools of less than 120, having to teach more does not impedes the ability to teach, but rather the workload and thus, the incentive to stay in said schools. This may partially explain the well-known problem of high turnover rate in small schools in the country.

VII. LIMITATIONS

It is in no doubt that the analysis done is this paper is not ideal. First potential problem needed to be mentioned goes to the very fundamental root of the analysis; whether ONET scores truly measure student learning or not. Since these tests as many know, are subjected to criticism every year for its inadequacy, and by using Math subject which is the least controversial as our main interests, it is hoped that this problem is minimised as much as possible. Another issue is the most eminent in studies of school inputs effect; the issue of omitted variable bias. It is in no doubt that it is difficult to draw any conclusions on causal relationships from country-wide panel data analysis. Many variables on children and household characteristics are left uncollected and controlled for, and thus influencing the estimates to be bias. For example, without controls for tutor school enrolment behavior, it is likely that the effect of additional year of teacher experience is overestimated. Or if the government focuses on a particular group of school whose educational problem are unobserved, which may underestimate the impacts of school resources as mentioned in Pitt et al (1993)

VIII. CONCLUSION AND POLICY IMPLICATIONS

By assuming different Education Production Function for each level of education, the paper investigates the change in the impact of different school inputs on student achievement in terms of ONET scores. First of all, it is quite safe to conclude that the marginal return to teacher experience is highest in Prathom level, and diminish as the students progress on to higher level of education. Thus, policies that increase Mathayom teacher salary according to years of experience can be seen as a dimension inefficiency of resource allocation. For example, policy that pays teacher based on their academic standing (In Thai, Withaya-thana), may not deem cost-effective if their promotions are not based upon their ability to improve student learning and outcomes, which is the ultimate goal of the education system.

At the mean time, director experience does not seems to influence student achievement at all. However, it may not mean that director experience is not valuable in school performance in other dimensions. Director experience could influence the turnover rate of teacher, or the ability to gather resources for educational purpose in schools. The data suggests that director salary is based upon the size of the school, which is understandable due to the responsibility and the more complex task of overlooking everything. However, this is a call for an analysis for cost-effectiveness of allocation of directors and their salaries.

Student-teacher ratio seems to leave an impact most in Prathom level, where the negative effect is significant at 1%. But that changes quickly, and become statistically not different from zero in Mathayom 6 level. Thus, the teacher allocation scheme should correspond to this conclusion. Information from OBEC tells that their ideal student-teacher ratio for primary schools is the same as secondary schools, at 40:1 ratio. Perhaps it would be more efficient to reduce the ratio for primary school to 30:1, equals that of Kindergarten schools. Another possible suggestions is that to reduce number of small schools as it cost more to operate at the same student-teacher ratio.

As mentioned in the section that explore limitation, there should be a studies that investigate at the microlevel to study whether the impacts vary across groups of students from different socio-economic status, context, and ethnicities. For instant, the context of the 3 southern provinces of Pattani, Yala, and Narathiwat is possible much different from the context of cities in central or Northeastern region. A specific studies is also warranted for small primary schools as they represent a huge portion of the Thai education system, and about 958,151 students are enrolled in small primary schools which is about 32.90% of the primary student population.

Figures

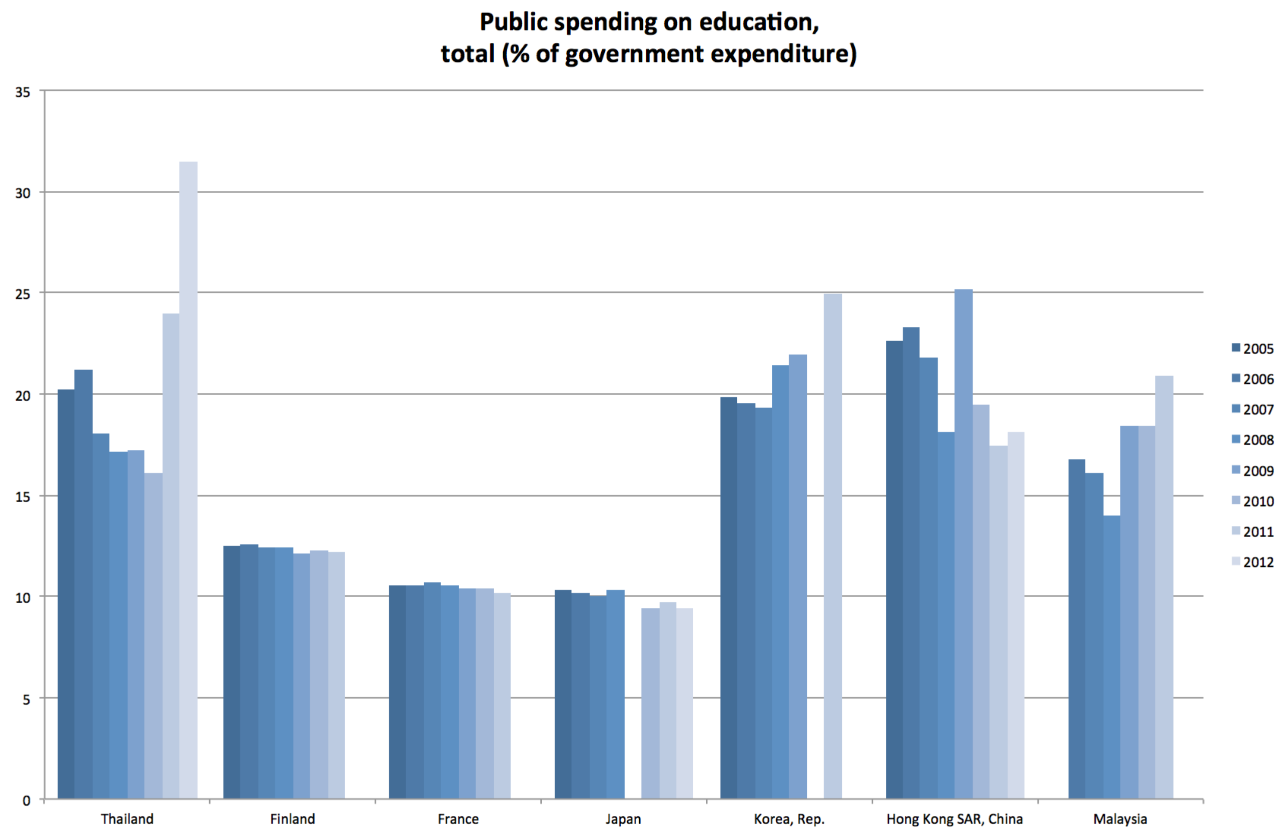

Figure 1. Expenditure per student as percentage of GDP per capita; from 2009 to 2012
World Bank Data

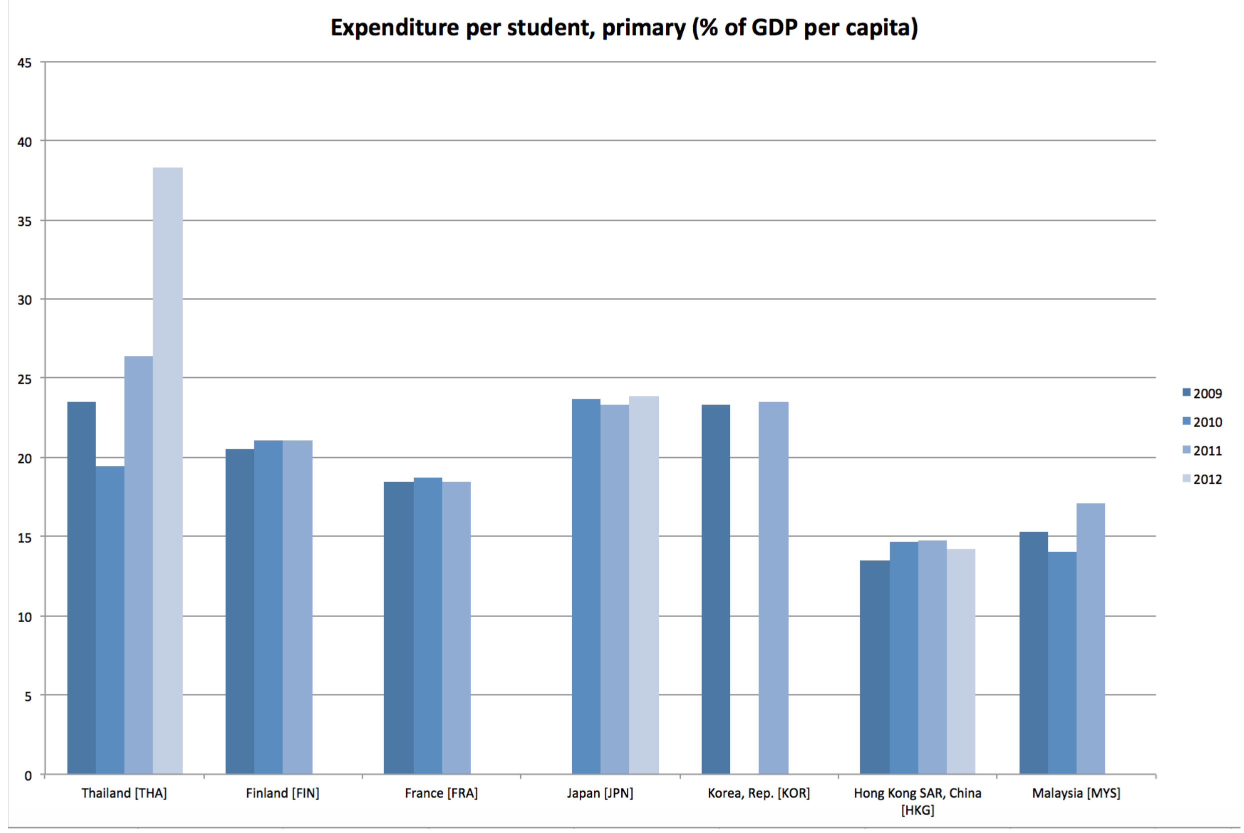

Figure 2: Public Spending on Education (% of Government Expenditure), World Bank Data

รูปที่ 11 รายจ่ายด้านการศึกษารวมจำแนกตามกิจกรรมการใช้จ่าย ปี 2553

จำนวน 589,358 ล้านบาท

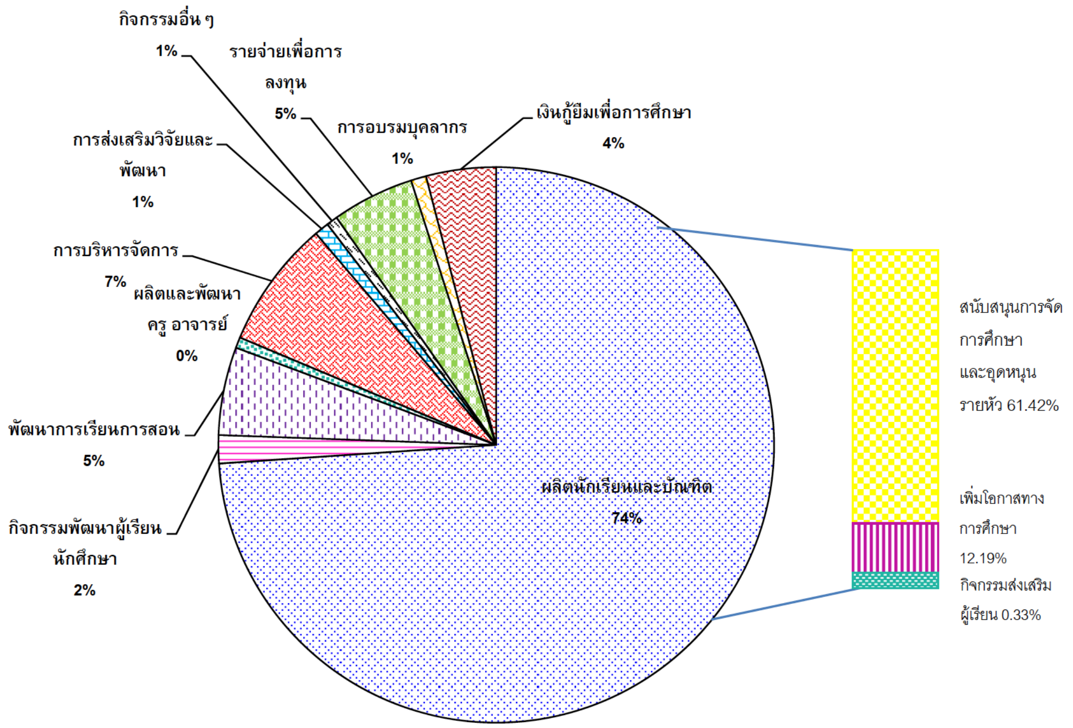

Figure 3: Education Expenditure by type of activities, fiscal year 2010, National Education Account

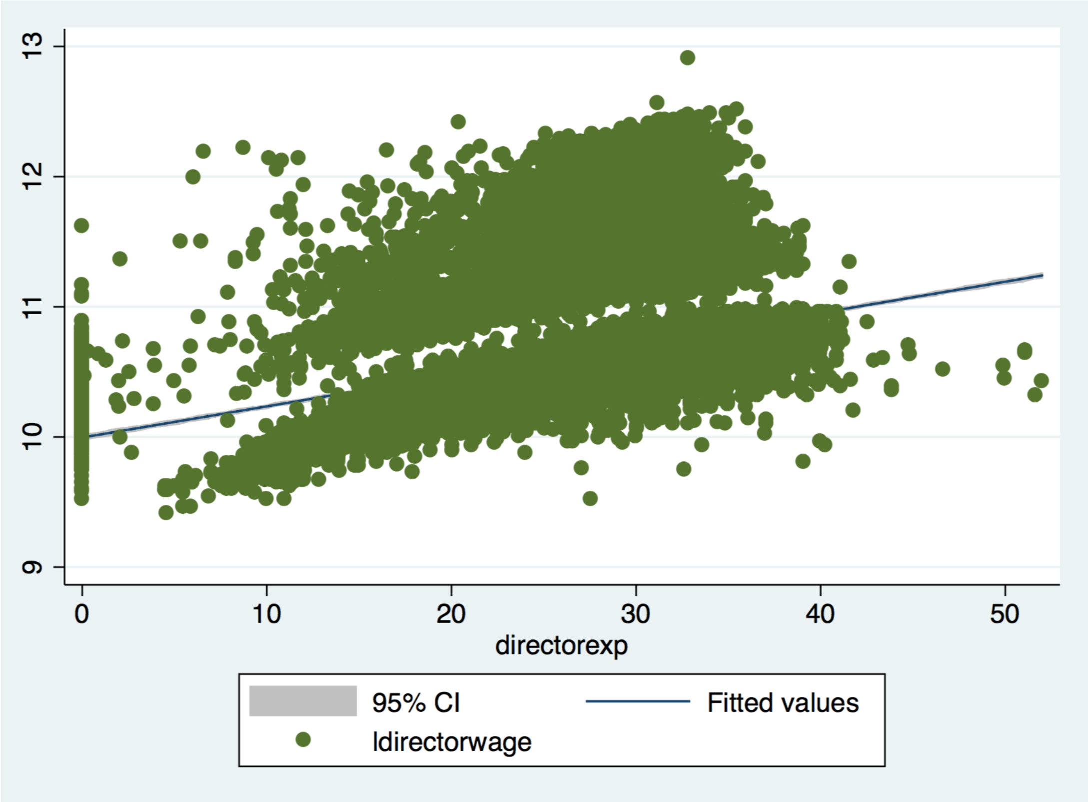

Figure 4: Two-way scatter plot with a fitted line for log(director wage) and director experience of the entire sample

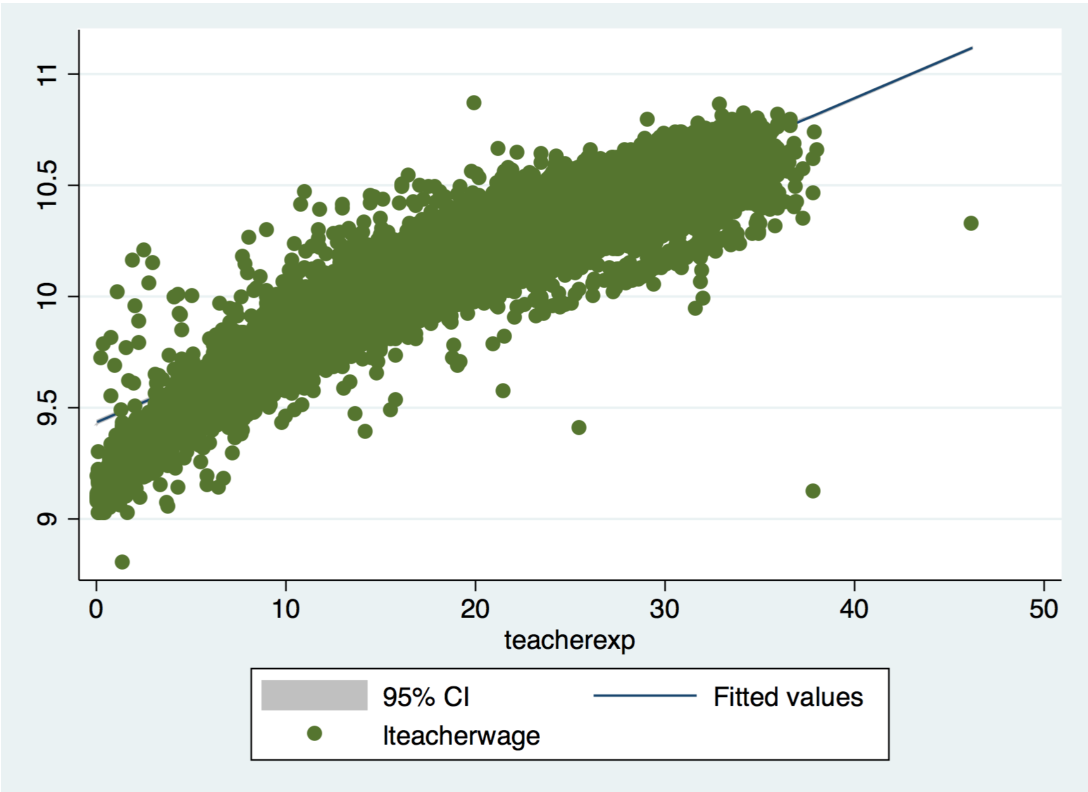

Figure 5: Two-way scatter plot with a fitted line for log(teacher wage) and teacher experience of the entire sample

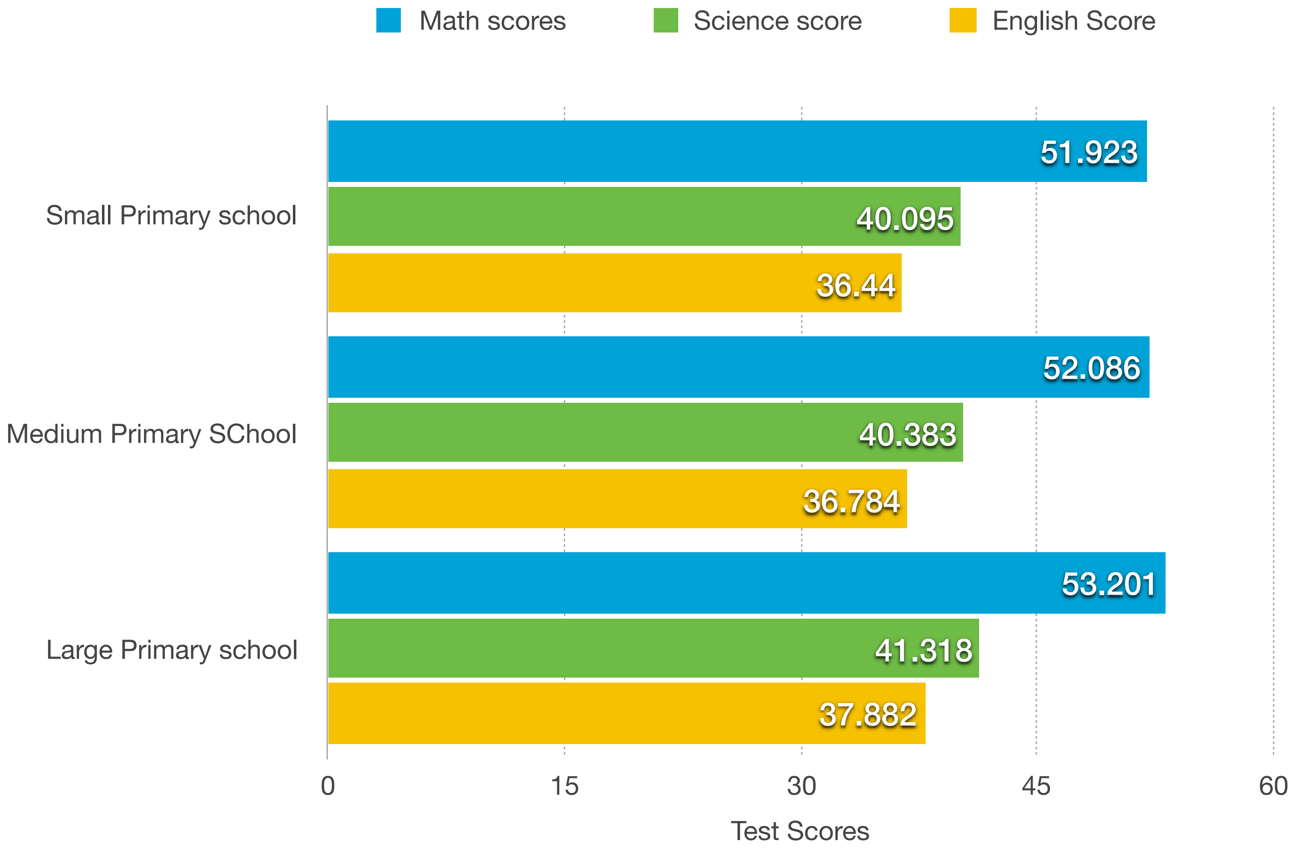

Figure 6: Primary School 2011 ONET scores by school size: Math, Science, and English scores.

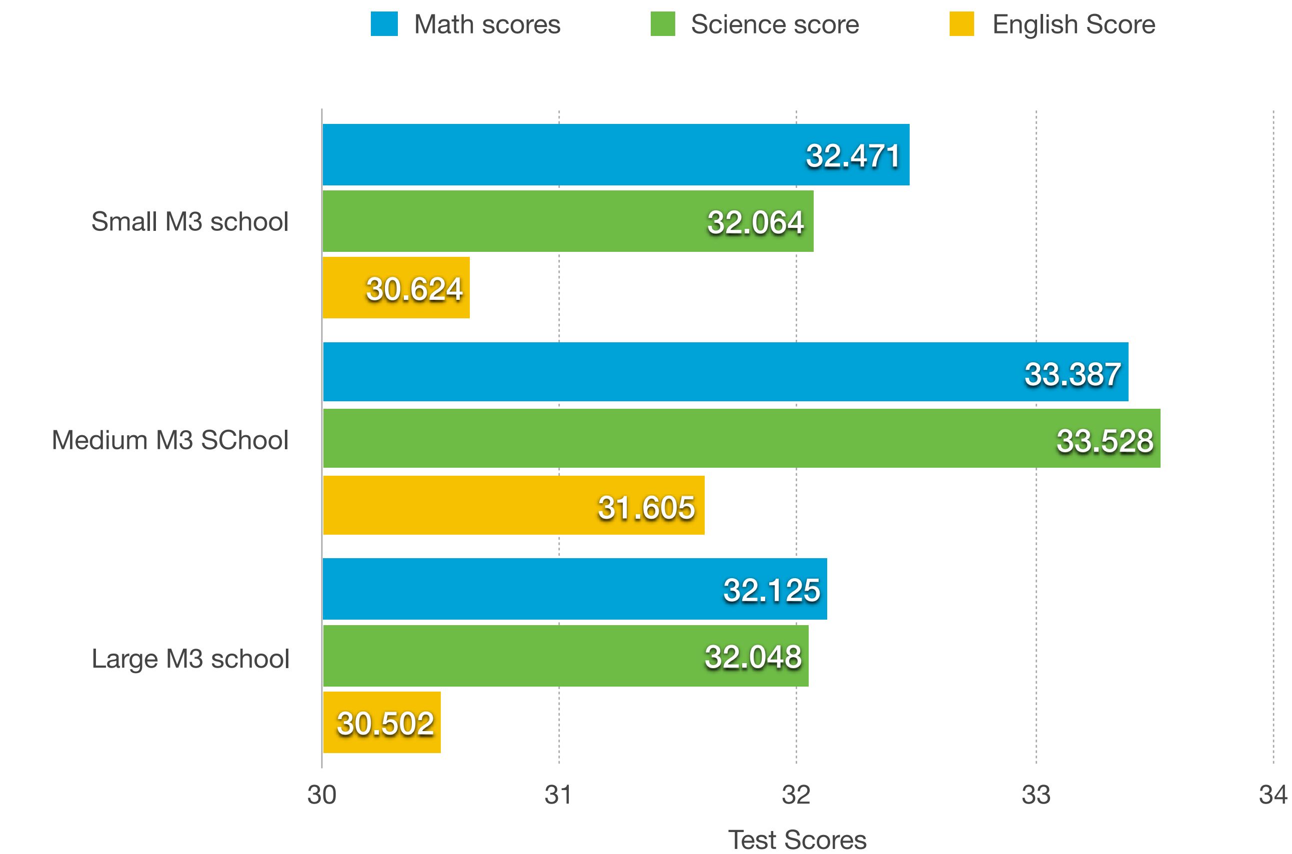

Figure 7: Lower-secondary school 2011 ONET scores by school size: Math, Science, and English scores

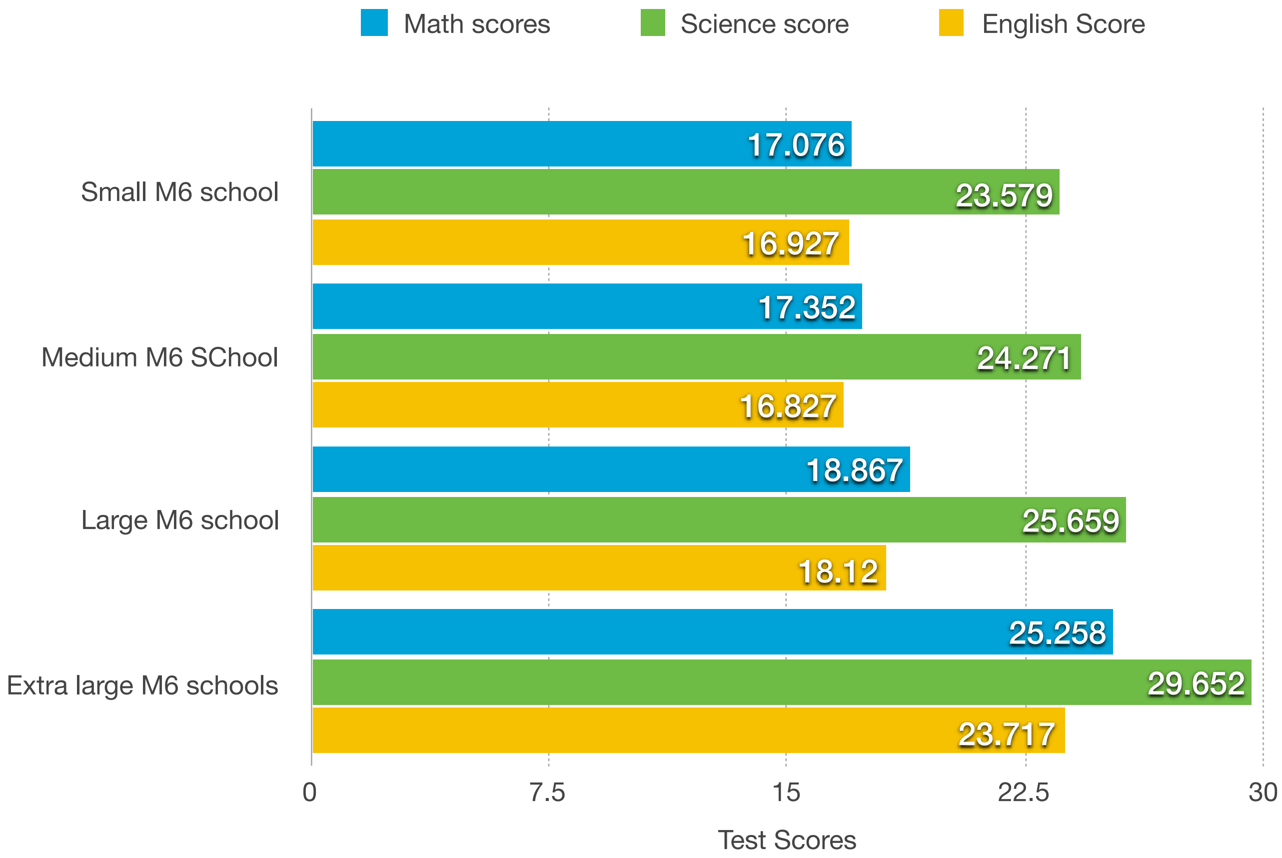

Figure 8: Upper-secondary school 2011 ONET scores by school size: Math, Science, and English scores

หน่วย : ล้านบาท
Unit : Million Baht

ปีงบประมาณ	รวม Total	ลักษณะเศรษฐกิจ Economic Function				Fiscal Year
		รายจ่ายลงทุน Capital Expenditure		รายจ่ายประจำ Current Expenditure		
		จำนวน Amount	ร้อยละ %	จำนวน Amount	ร้อยละ %	
2543	221,051.1	24,530.9	11.1	196,520.2	88.9	2000
2544	221,591.5	19,092.9	8.6	202,498.6	91.4	2001
2545	222,940.4	15,667.6	7.0	207,272.8	93.0	2002
2546	235,444.4	22,065.4	9.4	213,379.0	90.6	2003
2547	251,233.6	29,382.2	11.7	221,851.4	88.3	2004
2548	262,938.3	37,761.5	14.4	225,176.8	85.6	2005
2549	294,954.9	24,375.6	8.3	270,579.3	91.7	2006
2550	355,241.1	46,031.1	13.0	309,210.0	87.0	2007
2551	364,634.2	45,854.9	12.6	318,779.3	87.4	2008
2552	419,233.2	47,661.8	11.4	371,571.4	88.6	2009
2553	403,516.0	38,724.9	9.6	364,791.1	90.4	2010
2554	422,239.9	29,443.6	7.0	392,796.3	93.0	2011
2555	445,527.5	22,835.1	5.1	422,692.4	94.9	2012
2556	493,892.0	36,453.7	7.4	457,438.3	92.6	2013
2557	518,519.1	36,959.0	7.1	481,560.1	92.9	2014

Table 1: Education Expenditure by Economic Function (Capital Expenditure - Current Expenditure): Fiscal Year 2004-2014; Ministry of Education

Student Population	Primary schools		Lower-Secondary schools		Upper-secondary schools	
	# of Schools	%	# of Schools	%	# of schools	%
1-20	463	2.15	0	0.00	0	0.00
20-40	1969	9.15	7	0.10	1	0.04
40-60	3153	14.65	21	0.30	3	0.12
60-80	3342	15.53	60	0.86	8	0.32
80-100	2871	13.34	116	1.66	12	0.47
100-120	2223	10.33	175	2.50	21	0.83
120-500	6855	31.86	5887	84.22	945	37.23
>500	643	2.99	724	10.36	1548	60.99
Total	21519		6990		2538	

Table 2: Distribution of school across level of education and school-sizes.

Province	# of small schools	%
นครราชสีมา	596	4.28%
ขอนแก่น	593	4.26%
อุบลราชธานี	551	3.95%
ร้อยเอ็ด	422	3.03%
ชัยภูมิ	421	3.02%
นครศรีธรรมราช	390	2.80%
ศรีสะเกษ	374	2.68%
อุดรธานี	368	2.64%
เชียงใหม่	342	2.45%
มหาสารคาม	338	2.43%
นครสวรรค์	332	2.38%
บุรีรัมย์	312	2.24%
เพชรบูรณ์	303	2.17%
กาฬสินธุ์	298	2.14%

Table 3: Top 15 provinces with small primary schools

Level of School	Student Population	# of schools	%	No. of director	Director Exp. (yr)	Director salary	No. of teachers	Teacher Exp (yr)	Teacher salary	Lack of teacher	2010 Math Score	2011 Math Score
Primary	1-20	463	2.15	0.658	16.501	22787.250	2.579	26.478	32848.800	59	32.86	49.23
	20-40	1969	9.15	0.860	20.846	29062.550	3.634	24.143	30767.250	115	33.54	50.69
	40-60	3153	14.65	0.930	23.152	32063.900	4.612	24.034	30616.490	102	33.97	51.44
	60-80	3342	15.53	0.962	24.793	34257.020	5.687	23.590	30366.270	117	34.64	52.22
	80-100	2871	13.34	0.972	25.842	35450.730	6.537	22.936	29885.250	158	34.99	52.98
	100-120	2223	10.33	0.981	26.523	36312.710	7.526	22.331	29357.810	165	34.87	52.21
	120-499	6855	31.86	1.064	27.743	41089.060	10.328	21.811	28995.860	-	34.41	52.09
	>499	643	2.99	2.489	27.612	96533.660	39.127	23.556	30931.270	-	35.36	53.20
	Total	**21519**		**1.025**	**25.407**	**37720.920**	**8.276**	**22.965**	**29890.730**	**-**		

Table 4: Average school inputs and Math ONET Scores by size: Primary School

Level of School	Student Population	# of schools	%	No. of director	Director Exp. (yr)	Director salary	No. of teachers	Teacher Exp (yr)	Teacher salary	Lack of teacher	2010 Math Score	2011 Math Score
Lower Secondary	1-20	0	0.00									
	20-40	7	0.10	0.857	25.607	34758.570	7.500	23.619	32123.910	0	20.55	27.99
	40-60	21	0.30	1.048	29.377	41565.240	7.789	22.444	29620.580	0	20.22	29.88
	60-80	60	0.86	0.967	28.540	38045.000	9.717	24.765	31280.740	0	21.51	32.80
	80-100	116	1.66	1.000	28.239	38870.860	10.534	23.073	30032.730	1	24.58	33.52
	100-120	175	2.50	1.023	29.538	40703.940	12.559	21.730	28653.890	2	22.80	32.12
	120-499	5887	84.22	1.208	28.538	47017.970	15.610	19.736	27017.940	-	24.00	33.39
	>499	724	10.36	2.040	26.562	76145.610	31.085	18.094	25816.980	-	22.79	32.11
	Total	**6990**		**1.283**	**28.353**	**49637.070**	**17.058**	**19.727**	**27034.070**	**-**		

Table 5: Average school inputs and Math ONET Scores by size: Lower-secondary school

Level of School	Student Population	# of schools	%	No. of director	Director Exp. (yr)	Director salary	No. of teachers	Teacher Exp (yr)	Teacher salary	Lack of teacher	2010 Math Score	2011 Math Score
Upper Secondary	1-20	0	0.00									
	20-40	1	0.04	1.000	33.000	33540.000	12.000	23.167	28674.550	0	12.50	16.67
	40-60	3	0.12	1.000	27.444	36596.670	8.667	14.556	21148.250	0	11.67	13.71
	60-80	8	0.32	0.875	23.958	30010.000	12.625	19.760	24940.950	0	11.19	17.28
	80-100	12	0.47	1.167	30.160	41910.830	10.750	14.319	20097.720	0	9.49	17.12
	100-120	21	0.83	1.095	27.353	40708.100	12.619	18.163	24174.990	0	9.71	17.35
	120-499	945	37.23	1.492	27.400	54413.320	18.061	14.831	21629.070	-	10.07	17.35
	499-2499	1253	49.37	2.935	26.703	105730.800	47.268	17.430	24222.220	-	11.47	18.86
	>= 2500	295	11.62	4.573	29.260	184290.700	121.969	23.570	30334.040	-	17.04	25.27
	Total	**2538**		**2.555**	**27.276**	**94565.910**	**44.366**	**17.174**	**23947.580**	**-**		

Table 6: Average school inputs and Math ONET Scores by size: Upper-Secondary School

	Primary School	Lower-secondary school	Upper-secondary school	All Levels
Dependent variable	log(teacherwage)			
Teacher Experience	.0356572*** (.0001)	.0386005*** (.0002)	.0397576*** (.0003)	.036479*** (.0001)
Student Population	.0000264*** (.0000)	.0000181*** (.0000)	7.69e-06*** (.0000)	.0000115*** (.0000)
Lack of teachers (dummy)	.009053*** (.0018)			
Constant	9.442274*** (.0027)	9.400177*** (.0042)	9.355198*** (.0053)	9.430516*** (.0020)
Adjusted R2	0.8459	0.8752	0.8836	0.8605
N	21253	6987	2538	30778

Table 7: Regression results of log(teacherwage) for different level of education

Prathom 6 OLS estimation (Heteroskedasticity-robust standard errors)

Explanatory Variable	Dependent Variables			
	Math Score		Science Score	
	Coef.	s.e.	Coef.	s.e.
School Inputs				
Teacher Experience	0.469***	(0.089)	0.142**	(0.062)
Teacher Experience^2	-0.005**	(0.002)	-0.001	(0.001)
Student-Teacher Ratio	-0.057***	(0.017)	-0.047***	(0.011)
Director Experience	0.022**	(0.011)	-0.000	(0.007)
Household Characteristics				
Poverty Rate	-4.796	(4.023)	-1.745	(2.542)
Urban (Dummy: 1 = Urban, 0 = Rural)	0.364	(0.482)	0.409	(0.381)
Child Ability				
Lagged Scores (Proxy: Student ability & other parental inputs)	0.399***	(0.025)	0.269***	(0.012)
Parental Inputs				
2.5%*Monthly household expenditure	-0.017	(0.012)	-0.017*	(0.008)
Other Controls				
Dummies for school size	Yes		Yes	
Region	Yes		Yes	
N	19,204		19,205	
F-statistics	58.76987912		69.7649394	
Adj. R2	0.191443961		0.14424674	
Log-likelihood	-75105.0558		-68479.45787	

Note: .01 - ***; 0.05 - **; .1 -*

Table 8: OLS results with Heteroskedasticity-robust standard errors, Prathom 6 level

Matthayom 3 OLS estimation (Heteroskedasticity-robust standard errors)

Explanatory Variable	Dependent Variables			
	Math Score		Science Score	
	Coef.	s.e.	Coef.	s.e.
School Inputs				
Teacher Experience	-0.014	(0.075)	0.145**	(0.072)
Teacher Experience^2	0.002	(0.002)	-0.001	(0.002)
Student-Teacher Ratio	-0.005	(0.008)	-0.001	(0.009)
Director Experience	-0.003	(0.011)	-0.015	(0.010)
Household Characteristics				
Poverty Rate	1.164	(1.817)	1.440	(1.650)
Urban (Dummy: 1 = Urban, 0 = Rural)	0.378	(0.358)	0.164	(0.334)
Child Ability				
Lagged Scores (Proxy: Student ability & other parental inputs)	0.347***	(0.024)	0.403***	(0.022)
Parental Inputs				
2.5%*Monthly household expenditure	-0.007	(0.007)	-0.007	(0.007)
Other Controls				
Dummies for school size	Yes		Yes	
Region	Yes		Yes	
N	7,675		7,675	
F-statistics	42.60214358		52.79793048	
Adj. R2	0.18108286		0.185026464	
Log-likelihood	-25564.46876		-25565.83704	

Note: .01 - ***; 0.05 - **; .1 -*

Table 9: OLS results with Heteroskedasticity-robust standard errors, Mathayom 3 level

Matthayom 6 OLS estimation (Heteroskedasticity-robust standard errors)

Explanatory Variable	Dependent Variables			
	Math Score		Science Score	
	Coef.	s.e.	Coef.	s.e.
School Inputs				
Teacher Experience	-0.035	0.026	-0.002	0.022
Teacher Experience^2	0.002**	0.001	0.000	0.001
Student-Teacher Ratio	0.001	0.002	-0.003	0.002
Director Experience	0.009*	0.005	0.012**	0.005
Household Characteristics				
Poverty Rate	-0.105	0.310	0.241	0.319
Urban (Dummy: 1 = Urban, 0 = Rural)	0.015	0.070	-0.084	0.063
Child Ability				
Lagged Scores (Proxy: Student ability & other parental inputs)	0.976***	0.025	0.741***	0.033
Parental Inputs				
2.5%*Monthly household expenditure	0.002	0.002	0.002	0.001
Other Controls				
Dummies for school size	Yes		Yes	
Region	Yes		Yes	
N	2,191		2,190	
F-statistics	1,263.298		473.051	
Adj. R2	0.870		0.781	
Log-likelihood	-4,013.96		-3,653.52	

Note: .01 - ***; 0.05 - **; .1 -*

Table 10: OLS results with Heteroskedasticity-robust standard errors, Mathayom 6 level

Endogeneity Test

Explanatory Variable	Dependent Variable	
	Education expenditure	
	coef	se
Instrumental Variable		
Student Population	**0.0073970*** **	**0.000**
Director wage	**0.0000260*** **	**0.000**
Other Exogeneous Variable		
Teacher Experience	-0.317***	0.061
Teacher Experience2	0.010***	0.002
Student-teacher ratio	0.174***	0.017
Director Experience	-0.024*	0.014
Poverty Rate	-141.066***	0.784
Gini Coefficient	167.368***	2.366
Urban (dummy)	20.985***	0.243
More than 60	0.339	0.316
More than 120	-0.428	0.316
More than 500	-1.497***	0.494
North	-1.334***	0.376
Northeast	-4.375***	0.289
West	3.081***	0.487
East	12.259***	0.501
South	11.494***	0.348
Intercept	78.119***	0.958
R-square	0.809	

note: .01 - ***; .05 - **; .1 - *;

Endogeneity Test

Explanatory Variable	Dependent Variable	
	P6 Math Onet score	
	coef	se
Educational Expenditure	0.260***	0.061
Teacher Experience	0.744***	0.058
Teacher Experience2	-0.011***	0.002
Student-teacher ratio	-0.140***	0.021
Director Experience	0.017	0.011
Poverty Rate	34.161***	8.669
Gini coefficient	-53.304***	10.512
Urban	-5.543***	1.317
More than 60	1.839***	0.284
More than 120	0.788***	0.297
More than 500	-0.987*	0.590
North	-0.324	0.368
Northeast	5.150***	0.383
West	0.275	0.489
East	-2.068**	0.876
South	-5.142***	0.767
Residuals	**-0.274*** **	**0.061**
Intercept	22.783***	4.814
R2	0.094	

note: .01 - ***; .05 - **; .1 - *;

Table 11: Test of endogeneity of Educational Expenditure

IV estimation (Heteroskedasticity-robust standard errors)

Explanatory Variable	Dependent Variables					
	P6 Math Score		M3 Math Score		M6 Math Score	
	Coef.	s.e.	Coef.	s.e.	Coef.	s.e.
School Inputs						
Teacher Experience	0.172***	(0.061)	0.011	(0.023)	0.033**	(0.015)
Teacher Experience^2	0.488***	(0.111)	-0.012	(0.074)	-0.004	(0.032)
Student-Teacher Ratio	-0.006**	(0.003)	0.002	(0.002)	0.000	(0.001)
Director Experience	-0.096***	(0.031)	-0.010	(0.009)	-0.001	(0.002)
Household Characteristics						
Poverty Rate	0.014	(0.011)	-0.003	(0.011)	0.016**	(0.008)
Urban (Dummy: 1 = Urban, 0 = Rural)	20.338**	(9.314)	3.708	(3.740)	5.078**	(2.453)
Child Ability						
Lagged Scores (Proxy: Student ability & other parental inputs)	1.187***	(0.372)	0.347***	(0.023)	0.944***	(0.036)
Parental Inputs						
2.5%*Monthly household expenditure	-0.017	(0.012)	-0.007	(0.007)	0.001507	(0.002)
Other Controls						
Dummies for school size	Yes		Yes		Yes	
Region	Yes		Yes		Yes	
N	19,204		7,675		2,191	
Wald Chi2	694.19		505.37		7005.22	
Adj. R2	0.1424		0.1807		0.8462	

Note: .01 - ***; 0.05 - **; .1 -*

Table 12: Instrumental Variable Estimations of Math scores on different level of schooling.

Subgroup Analysis: Small Primary Schools (Heteroskedasticity-robust standard errors)

Explanatory Variable	Dependent Variables			
	OLS Estimation		IV Estimation	
	Coef.	s.e.	Coef.	s.e.
School Inputs				
Teacher Experience	0.466***	(0.063)	0.485***	(0.150)
Teacher Experience^2	-0.006***	(0.002)	-0.008**	(0.004)
Student-Teacher Ratio	-0.112***	(0.023)	-0.235***	(0.051)
Director Experience	0.024**	(0.012)	0.010	(0.013)
Household Characteristics				
Poverty Rate	-6.297***	(1.185)	33.107***	(10.670)
Urban (Dummy: 1 = Urban, 0 = Rural)	0.224	(0.288)	-7.557***	(2.035)
Child Ability				
Lagged Scores (Proxy: Student ability & other parental inputs)	0.391***	(0.010)	0.396***	(0.024)
Parental Inputs				
2.5%*Monthly household expenditure	-0.021***	(0.006)	0.272***	(0.070)
Other Controls				
Dummies for school size	Yes		Yes	
Region	Yes		Yes	
N	14,170		14,170	
F-statistics / Wald Chi2	42.42467422		451.63	
Adj. R2	0.178564871		0.0628	

Note: .01 - ***; 0.05 - **; .1 -*

Table 13: Sub-group Analysis: Small Primary School: OLS and IV estimations

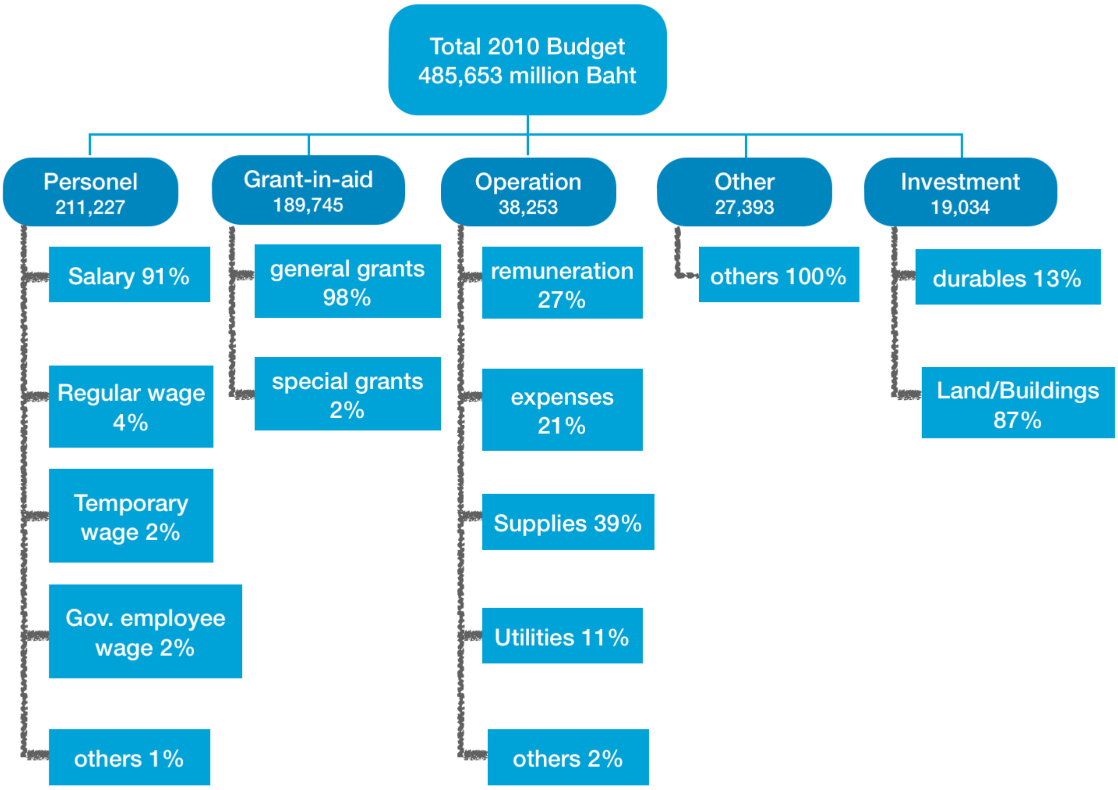

Diagram 1: Government's Education Budget Expenditure (Central and local government) Fiscal year 2010; translated from National Education Account Report 2013

Bibliography

Angrist, J.D., Lavy, V. (2001). Using Maimonades' rule to estimate the effect of class size on scholastic achievement, *The Quarterly Journal of Economics*, 114, 533-75.

Aucejo, E.M., Romano, T.F. (2014). Assessing the effect of school day and absences on test score performance, *Centre of Economic Performance*

Bernal, P., Mittag N, Qureshi J. (2014). Identifying the effect of school quality on student achievement using multiple proxies, Working Paper

Fuller, B., Clarke, P. (1994). Raising School Effects While Ignoring Culture? Local Conditions and the Influence of Classroom, Tools, Rules, and Pedagogy, *Review of Educational Research,* 64, 119-157. Retrieved from http://www.jstor.org/stable/1170747

Goldhaber, D.D., Goldschmidt, P., Tseng, F. (2011). Teacher value-added at the High-School level: different models, different answers?, *Educational Evaluation and Policy Analysis*

Glewwe, P.W., Hanushek, E.A., Humpage, S.D., Ravina, R. (2011). School Resources and Educational Outcomes in Developing Countries: A review of the Literature from 1990 to 2010, *National Bureau of Economic Research,* Working Paper, 17554. Retrieved from http://www.nber.org/papers/w17554

Hanushek, E.A. (2008). Education Production Function, In Steven N. Durlauf and Lawrence E. Blume (eds.), The New Palgrave Dictionary of Economics, Basingstoke: Palgrave Macmillan

Hanushek E.A., Wößmann, L. (2007). The role of education quality in economic growth, *World Bank Policy Research.* Working Paper 4122, February 2007. Retrieved from https://openknowledge.worldbank.org/bitstream/handle/10986/7154/wps4122.pdf

Hoxby, C. (2000). The effect of class size on student achievement: new evidence from population variation, *The Quarterly Journal of Economics,* November 2000

Lounkaew, K. (2013). Explaning Urbal-Rural Differences in Educational Achievement in Thailand: Evidence from PISA Literacy Data, *Economics of Education Review,* 37, 213-225, doi: 10.1016/j.econedurev.2013.09.003

Pitt, M. M., Rosenzweig, M.R., Gibbons, D.M. (1993). The determinants and consequences of the placement of government programs in Indonesia, *The World Bank Economic Review 7*, No. 3, 319−348

Sasiwuttiwat, S., Tangkitvanich, S. (2012). Revamping the Thai education system: quality for all, *TDRI Quarterly Review*, 27, 3-12.