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Scale Economies in Public Vocational Education: Empirical Evidence from Thailand

Kaewkwan Tangtipongkul

Faculty of Economics, Thammasat University. 2 Prachan Road, Phranakorn, Bangkok 10200, Thailand. E-mail: kaewkwan@econ.tu.ac.th.

Abstract

The paper investigates the sources of scale economies in the production of public vocational education based on cross-sectional data from 411 vocational schools in Thailand. An empirical analysis is made of the relationship among the following factors: the cost per student, the number of student enrollments, school quality, discretionary allocation of staffing resources, and regional variation affecting demand for public vocational education. It appears that close to 80 per cent of the public vocational schools in Thailand are too small a size to have economies of scale for optimal average cost efficiencies. Thai education public policy should emphasize enrollment expansion of existing vocation schools in order to fulfill the national education policy to sustain the need of the current labor demand as well as in pursuit of cost efficiency.

Keywords: Vocational Education, Thailand, Education Financing

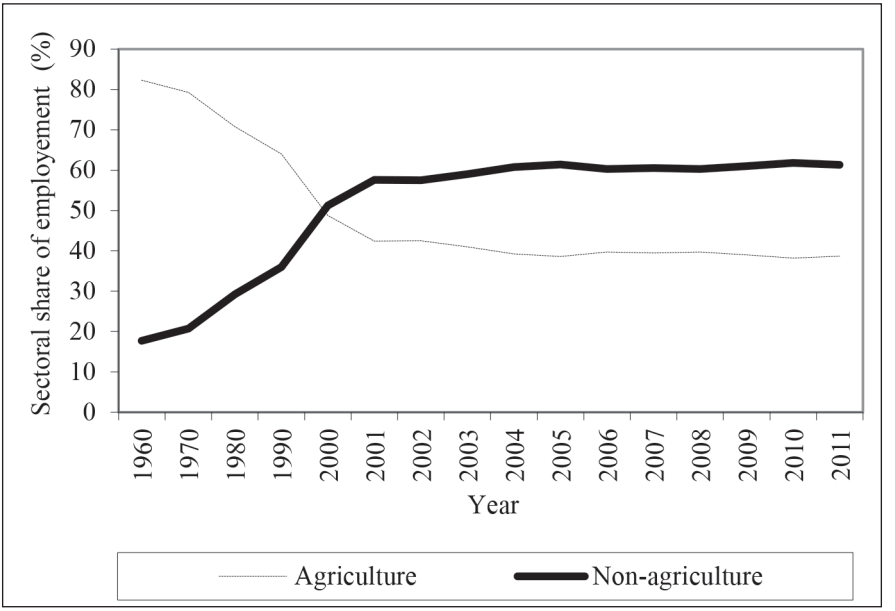
JEL Classification: I20, I21, I22

1. Introduction

The purpose of this study is to examine the cost structure of Thailand's vocational school system. The study estimates average cost functions and examines the degree of economies of scale relative to the production of teaching output in order to determine the most efficient level of enrollments for vocational schools in Thailand. The current public education policy in Thailand is to develop vocational programs to increase educational opportunities for students and lessen the job mismatch in the labor market. More than 50 per cent of the labor force is employed outside agriculture since the year 2000 (figure 1). Economic growth and restructuring have fundamentally changed the Thai labor force. The increasing demand for labor in the manufacturing and services sectors will require workers to gain more human capital. Workers need to apply knowledge and specific skills to operate or perform tasks in the non-agriculture sectors. Thai public vocational schools were distributed throughout the country to supply the training and skill development that is required according to the labor structure change. However, the efficiency and prospects for economies of size are still unexamined.

The study directly examines the following questions: (1) Are there any specific enrollment economies of scale at school levels? If so, which vocational public schools should expand or contract their enrollments to gain efficiency? (2) Does geographic location of vocational schools influence its average costs? (3) What influence does the differential deployment of resources to teaching staff have upon the average costs of instruction in vocational education? (4) How does the quality of vocational school affect its cost? (5) Do fields of study in vocational school influence average costs?

Figure 1. Sectoral share of employment from year 1960 to 2011



Sources: Adapted from Krongkaew, M. and N. Kakwani. 2003. The Growth–Equity Trade-Off in Modern Economic Development: The Case of Thailand. *Journal of Asian Economics.* 14 (5). pp. 735–57; Tinakorn, P. 2002. Income Inequalities during Four Decades of National Development: 1961-2001. *Thammasat Economic Journal.* 20 (2/3). pp. 141-208; Figures for 2001-2011 are from the Government of Thailand, National Statistical Office. http://web.nso.go.th/

2. Background on Thailand's Education System and Policies

Thailand's education reform started in 1999. In 1999, the formal education was based on the National Education Act (revised 2002) and the Compulsory Education Act in 2002, which was divided into two levels: basic and higher education. The basic education includes pre- elementary level, elementary level, and secondary level. The higher education or a post-secondary education includes diploma level and degree levels. Description and goals on each level of education is illustrated in table 1. Based on Thai Ministry of Education' missions, they have provided 1) quality education for every child,

youth, disabled, and disadvantaged equitably from early childhood until year 6 of secondary education and equivalent 2) Thai students at vocational and higher education levels to be professionals, modern citizens of the world with diverse skills, competitiveness in global markets, and living in a knowledge-based society. The National Education Act was imposed on the first phase of education reform, which mandated children at age 7 years old to enroll in primary and secondary education until they turned 16 years old or until they completed 9th grade. In 2009, the implementation of the 15 years free education with quality policy was first initiated, aiming to lessen the financial burden of parents as well as to stimulate the economy. Students covered by the program ranged from kindergarten to 12th grade, including general and vocation education systems. The policy cover tuition fees, expenses for books, utensils, uniforms, school equipment, and extra-curricular activities.

The number of students in public and private institutions by level of education in academic year 2007 to 2010 are illustrated in table 2. The number of students' enrollment at the pre-elementary education increased from 1,780,074 students in year 2009 to 1,811,203 students in year 2010. The number of students' enrollment at the lower and upper-secondary education also increased comparing between year 2009 and 2010. Furthermore, the number of students' enrollment in the higher education increased due to the availability of student loan program and alternative choices at private universities.

Table 1: Description and goal on each level of education

Level of education	Description
Pre-elementary level	A two-year course in public pre-elementary schools or a three-year course in private pre-elementary education Aims to nurture and prepare physical, mental, intellectual and emotional skills for students for their elementary education
Elementary level	Grade 1st to Grade 6th Emphasis on basic literacy, numerical skills and cultivates desirable behavior in students
Lower secondary level	Grade 7th to Grade 9th Allows the students to explore their needs, areas of interests and aptitudes and enables them to meet their appropriate careers.
Upper secondary level	Grade 10th to Grade 12th Aims to prepare students to meet the labor market and to promote their entrepreneurship skills. There are two streams: i) Vocational-oriented is provided in vocational and technical colleges for the students who are good at skills ii) Academic stream is offered in general education schools for the students
Diploma	School offer one to four-year course for the students who have completed upper secondary education. Aims to develop the learners' knowledge and vocational skills at the semi-skills level and to enable them to initiate their entrepreneurships.
Undergraduate level	A four-year course, with an exception of some courses, for instance, Architecture, Medical Science, etc. require five to six year of study. As for students who have been given diploma, after sitting entrance examination can take a two-year course to pursue their first degree in higher technological and educational institutions. Aims to develop the students' abilities and of people. They are encouraged to apply theories to a reality of the nation's development so that they can bring their country up to the international challenges.
Graduate level	Graduate degree offers one to three-year courses to the learners at the graduate diploma, master degree and doctoral degree levels. Students are stimulated to specialize and bring theories to practices. Focuses on the learners' broader vision and better perspectives for looking at the world and bringing the nation to the international competition.

Source: Government of Thailand, Ministry of Education. http://www.moe.go.th/moe.html

Table 2: The number of students in public and private institutions by level of education: academic year 2007-2010

Level of education	The number of students in public and private institutions			
	2007	2008	2009	2010
Total	14,482,194	14,338,146	13,998,328	14,150,863
Pre-elementary	1,758,573	1,770,386	1,780,074	1,811,203
Elementary	5,564,624	5,370,546	5,138,475	5,066,745
Lower secondary	2,782,834	2,794,218	2,792,286	2,802,213
- General Education	2,782,763	2,794,158	2,792,229	2,802,158
- Vocational Education	71	60	57	55
Upper secondary	1,945,929	1,974,980	2,003,534	2,070,566
- General Education	1,166,942	1,205,723	1,250,233	1,313,884
- Vocational Education	776,531	766,718	750,750	754,287
- Other	2,456	2,539	2,551	2,395
Higher Education	2,430,234	2,428,016	2,283,959	2,400,136
- Vocational Education	377,208	375,972	368,263	400,279
- Other	1,125	4,260	4,725	4,716
- Undergraduate Degree and Higher	2,051,901	2,047,784	1,910,971	1,995,141

Source: National Education Information System, Ministry of Education.

All public vocational schools were under the affiliation of the Office of the Vocational Education Commission. The roles of the Office of the Vocational Education Commission are to implement the government policies that related to goals for developing the manpower in the vocational education to match the international trends during 2012 to 2016. There are four goals: 1) to increase the number of students in vocational education 2) to promote the opportunity for students to access to the vocational education and professional training 3) to upgrade the quality of vocational education and 4) to increase efficiency in administration. Figure 2 illustrates the percentage of public vocational schools in different size of institution. The Office of the Vocational Education Commission defines the size of institution base on the number of students: public vocational schools with students below 1,000 were defined as small size; public vocational schools with students between 1,000 and 2,400

were defined as medium size; and public vocational schools with students above 2,400 were defined as large size. The majority of public vocational schools are small institutions.

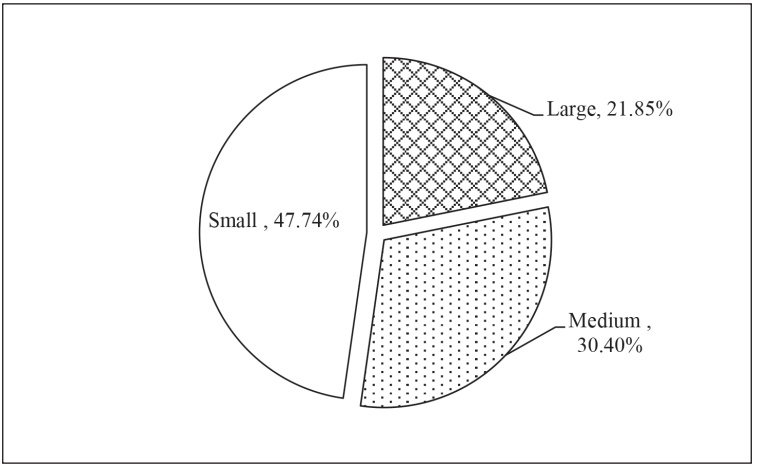
Fields of study can be categorized into five groups based on the annual subsidization rate for upper secondary vocational education under the 15 years free education with quality policy as shown in table 3. The subsidization on school equipment and uniform will be paid directly to students or parents. The percentage of vocational students in particular fields of study in year 2014 is illustrated in figure 3. The percentage of vocational students in industrial, textile or information and communication technology is approximately 55.22 percent. The percentage of vocational students in commerce is approximately 33.92 percent. The percentage of vocational students in home-economics or tourism industry is approximately 5.50 percent. The percentage of vocational students in agriculture or fishery is approximately 3.57 percent. The percentage of vocational students in applied arts is approximately 1.77 percent. The majority of current vocational students are in industrial and commerce.

Table 3: The annual subsidization rate for upper secondary vocational education under the 15 years free education with quality policy

	Baht
1. Tuition fees	
Industrial, Textile or Information and Communication Technology	6,500
Commerce	4,900
Home-Economics or Tourism Industry	5,500
Applied Arts	6,200
Agriculture or Fishery	5,900
2. Expenses for books	2,000
3. School equipment	460
4. Uniform	900
5. Extra-curricular activities.	950

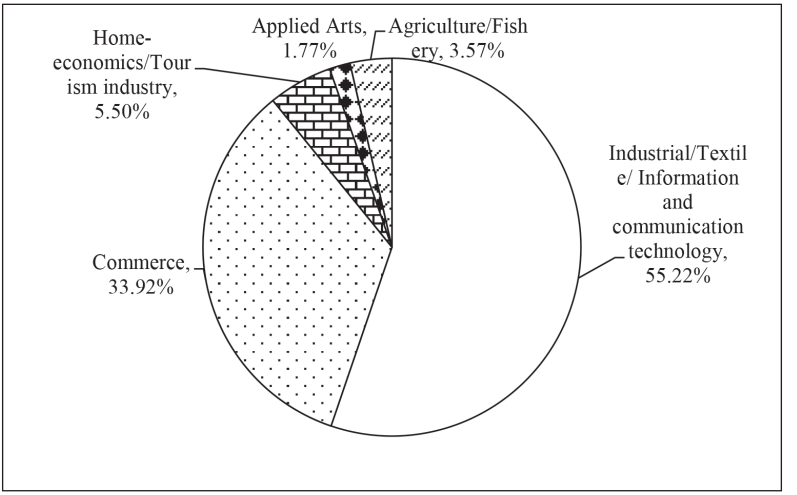
Source: Office of the Vocational Education Commission, Ministry of Education.

Figure 2. The percentage of public vocational schools by size in year 2014



Source: Information Technology and Vocational Manpower Center, Office of the Vocational Education Commission.

Figure 3. The percentage of vocational students in particular fields of study in year 2014



Source: Information Technology and Vocational Manpower Center, Office of the Vocational Education. Commission.

3. Data and Methodology

Estimating cost functions in higher education has been done in numerous studies (Brinkman 1990; Brinkman & Lieslie 1987; Dougherty 1990; Getz, Siegfried & Zhang 1991; Hashimoto & Cohn 1997; Hoenack et al. 1986; Koshal & Koshal 1999; Laband &Lentz 2003; Maynard 1971; Nelson & Hevert 1992 Throsby 1986; Tierney 1980; Tsang, 1988); however, estimating cost functions in vocational education are still limited. Dundar and Lewis (1995) examined the institutional cost structures of the postsecondary vocational education system in Turkey. Tsang (1997) discussed the methodological issues in costing two common types of vocational training programs: institutional vocational training and enterprise-based vocational training. Nevertheless, no attempt has been made to examine the costs and prospective economies of scale for public vocational education in Thailand. This paper estimates the economic modeling and use of quadratic equations for estimating multiproduct production and cost functions based on Baumol et al. (1982). A single output approach in estimating the cost functions of Thai public vocational schools is applied.

The study is based on data from the Office of the Vocational Education Commission in year 2014 with the total number of public vocational school of 421. Due to the limited availability of data on expenditures and the number of faculties, the total number of sample is 411 public vocational schools. Data on expenditures (costs) for the study were derived from the Government Fiscal Management Information System, the Office of the Vocational Education Commission. All data including student enrollments, number of students participating in dual program, faculty members, and fields of study by public vocational schools are obtained from the Information Technology and Vocational Manpower Center.

Variables name, mean, and standard deviations are summarized in table 4. The dependent variables for the estimation are the sum of all forecast annual on-budget expenditure in public vocational schools and total expenditure in public vocational schools. Total expenditure in public vocational schools includes on-budget expenditure, off-budget expenditure, and general fund. Total costs represent the sum of costs for all inputs employed for the production of all activities in an academic year in each school. For each school, these costs comprise the following expenditure categories: (1) annual total faculty, administrator, and other non-academic staff wages and fringe benefits;

(2) annual expenditures for services and supplies; (3) annual expenditures for equipment; (4) other unspecific recurrent expenditures; (5) capital expenditure and annualize the existing fixed capital stock buildings and equipment; and (6) government subsidy from 15 years free education with quality policy.

The explanatory variables include the number of students enrolled in each public vocational school. The single output for the schools are specified as the number of students enrolled in each school. Enrollment data from the 2014 academic year is applied. In addition to the number of students enrolled, Dundar and Lewis (1995) recommended the number of variables to apply in order to control for any prospective variation in costs due to differences such as (1) discretionary deployment of instructional and non-teaching staff, (2) quality of student enrollers, (3) fields of study in vocational schools, and (4) regional variations. Discretionary deployment of instructional resources was measured by individual school students-to-teacher ratios. The percentage of student who participated in dual program was used as a proxy measure quality of student enrollers. Specific fields of study in public vocational school dummy variables represent fields of study in vocational schools. Geographic region dummy variables are used as a measure of control for possible regional variation in resource costs.

Students-to-teacher ratios

The ratio of students to each teaching faculty member at each public vocational school was entered into the model to assess for the possible influence of different resource allocations in the use of personnel. Dundar & Lewis (1995) stated that it is generally true that students-to-teacher ratios will usually increase as large increases in enrollments take place; however it is not always true given that each institution has some discretionary control over its patterns of staffing and teaching loads for program instruction.

The quality of school

There is no standard national examination for students in vocational schools. This paper attempts to use the percentage of student who participated in dual program as an indirect proxy measure for public school quality. Participation in dual program allows students to get real work experiences in their field of study for one or two semesters. The higher percentage of

students who participated in dual program signals that employers accepts the quality of students from particular schools.

Fields of study in vocational school

In order to control for the possible influence of curricular differences between public vocational schools and their related costs, a variable was entered into the model. There are eight major fields of study in Thai public vocational school including: agriculture, home economics, information and communication technology, fishery, textile, applied arts, industrial, and commerce. Technical vocational programs were defined as programs that required the use of large or specialized equipment such as in the preparation of electric, machinery, construction, agriculture, and fishery. Nontechnical vocational programs included commerce, home economics, and applied arts. Fields of study in vocational were generated as dummy variables and were classified into five groups based on the subsidization category that was determined by the Office of the Vocational Education Commission, which includes: i) agriculture and fishery, ii) home economics and tourism industry, iii) industrial, textile, and information and communication Technology, iv) commerce, and v) applied arts.

Regional variation

Geographic region dummy variables are used as a measure of control for possible regional variation in resource costs. There are six geographic regions including the northern, southern, eastern, northeastern, central, and Bangkok metropolitan region. There are two differing hypotheses concerning the geographic region of vocational schools which may affect the cost of public vocational in Thailand. First, some costs variations might exist between public vocational schools in Bangkok metropolitan region compared with other regions. Second, others have argued that the cost of resource inputs might be more expensive in the regions that have high intensity of technical vocational program. It was expected that a geographic region dummy variables coded would control for any differences between school resource costs that might arise from differing funding and resource costs. Geographic region dummy variables are generated as dummy variables and classified into six groups: i) northern region, ii) southern region, iii) northeastern region, iv) eastern region, v) central region, and vi) Bangkok metropolitan region.

Table 4: Descriptive statistics

Variable	Description	Mean (Standard Deviation)
Sample size (N)		411
Dependent variables		
Total expenditure per student	Total expenditure per student	44,902.62 (37,484.91)
On-budget expenditure per student	On-budget expenditure per student	37,201.79 (33,368.84)
Explanatory variables		
Enrollment	Number of student enrollment	1,577.757 (1,319.016)
Enrollment squared	Number of student enrollment squared	4,224,887 (6,889,769)
North	School is located in the north region (Yes=1, No=0)	0.18 (0.38)
South	School is located in the south region (Yes=1, No=0)	0.19 (0.39)
Northeastern	School is located in the northeast region (Yes=1, No=0)	0.27 (0.44)
Bangkok metropolitan	School is located in Bangkok metropolitan region (Yes=1, No=0)	0.08 (0.28)
Eastern	School is located in the eastern region (Yes=1, No=0)	0.09 (0.28)
Central	School is located in the central region (Yes=1, No=0)	0.19 (0.39)
Agriculture	Field of study in agriculture or fishery (Yes=1, No=0)	0.14 (0.35)
Home economics	Field of study in home economics or tourism industry (Yes=1, No=0)	0.24 (0.43)
Industrial	Field of study in industrial, textile, or information and communication technology (Yes=1, No=0)	0.86 (0.35)
Commerce	Field of study in commerce (Yes=1, No=0)	0.83 (0.37)
Applied arts	Field of study in applied arts (Yes=1, No=0)	0.20 (0.40)
Students-teacher ratio	A ratio of students to each teaching faculty member at each public vocational school	39.93 (26.92)
Dual system	The percentage of students in the dual system	0.12 (0.16)

$^{\Psi}$ is dummy variable.

Source: Author's computation.

A single-output average cost quadratic function is applied to analyze the production and cost structures of 411 public vocational schools. Baumol et al. (1988) stated that average cost quadratic functions seem best to serve as the framework for average cost analysis and for estimating scale economies within higher education. However, Baumol et al. (1988) discussed the main shortcoming for using a quadratic model is an acknowledged absence of any explicit theoretical framework for using this form in preference to any other functional form. Similar to Dundar and Lewis (1995) an original quadratic model gave the best fit in explaining the expected relationships between total, average, and marginal costs compared to log-linear cost function.

Economies of scale are assumed to exist if total costs increase proportionately less than output as production is expanded. This will be applied in estimating what the likely effects will be on average costs as enrollments increases. With similar assumption as Dundar and Lewis (1995), some costs will increase as enrollments expand, while other costs and resources will be distributed over the larger number of students permitting economies of scale to arise. The quadratic cost function for the study can be noted in the following generalized form with teaching and enrollment specified as the only output (Dundar & Lewis, 1995):

$$AC = \beta_1 + \beta_2 X + \beta_3 X^2 + \varepsilon \tag{1}$$

where AC represents the average annual recurring costs per students, β_1 is the constant, β_i's are coefficients, X denotes the number of student enrollments, and ε is a disturbance term. The generalized model in equation (1) for estimating average costs is modified to account for these possible influences of student-to-teacher ratios, the percentage of students who participated in dual program, fields of study in vocational school, and geographic region dummy variables as shown in equation (2)

$$AC = \beta_1 + \beta_2 X + \beta_3 X^2 + \beta_3 S + \beta_4 D + \beta_3 F + \beta_3 G + \varepsilon \tag{2}$$

where AC represents average annual recurring costs per students, β_1 is the constant, β_i's are coefficients, X denotes the number of student enrollments, S denotes the student-to-teacher ratio, D represents the percentage of student who participated in dual program, F is a "dummy" variables that indicate fields of study in vocational school, G is a "dummy" variables that indicate geographic region, and is a disturbance term.

4. Empirical Results

The estimation cost function results from four models are reported in table 5. Model 1a and 2a reveal the basic form of average cost function as specified in equation (1). Model 1b and 2b report results from the addition of four control variables as specified in equation (2). The difference between models 1 (1a and 1b) and 2 (2a and 2b) represents the difference between using on-budget expenditure and total expenditure per student. In models 1a and 1b average costs are represented on-budget expenditure, while models 2a and 2b include in average costs an additional allocated amount from the support services costs on the public vocational schools. All four models are statistically significant at 1 percent.

Model 1b and 2b with several additional variables added to the equation explain close to 46 per cent of the total variation in unit costs (table 5). The estimated enrollments and enrollment- squared coefficients are statistically significant and reveal the expected signs on both variables. A negative sign for enrollments and a positive sign for enrollments-squared. These coefficients suggest that average costs are characterized by a typical U-shaped average cost curve. Dundar and Lewis (1995) suggested that the initial cost per student is high due to the presence of small enrollment and the requirement of other relatively fixed education inputs; however, as the number of students increases, average costs decline to a point where marginal cost equal average costs. When marginal cost is equal to average cost, this implies the most efficient scale of operation. This efficient scale of operation can be directly estimated by setting the first derivative of the average cost function equal to zero as shown in equation (3)

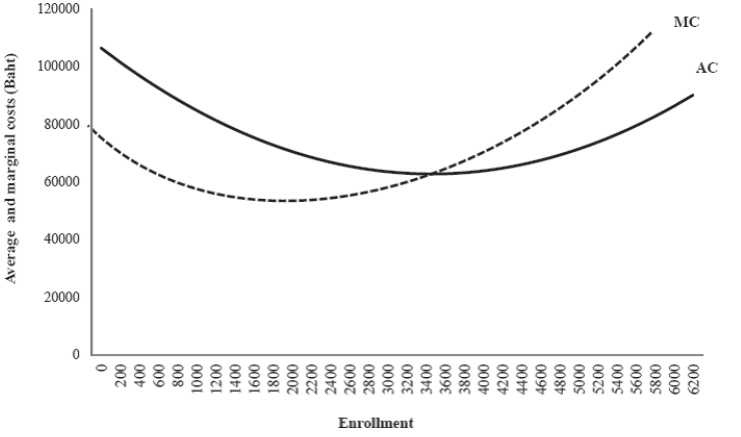
$$\frac{dAC}{dX} = \beta_2 + 2\beta_3 X = 0 \tag{3}$$

This relationship between the estimated average and marginal cost curves that were derived is shown in figure 4. Figure 4 indicates that public vocational schools experience declining average and marginal costs as enrollment rise up to a range of enrollments. It was estimated that the most efficient scale of operations for the average public vocational school in Thailand would occur within the range of 3,200 to 3,600 students. This estimated most efficient scale of operation is above the actual average school size of 1,578 students. After reaching efficient scale of operation, average costs will begin to increase

through the existence of diseconomies of scale as shown in figure 2. In the case of Thai public vocation schools, school directors and their team could work on their enrollment strategic plan. While small size schools could achieve average cost savings through an expansion of their enrollments, large schools would save through enrollment reduction. Furthermore, average cost functions for public vocational schools by geographic regions are shown in table 6 and 7. Average cost functions for public vocational schools by fields of study are shown in table 8 and 9.

Nevertheless, readers need to be reminded that these estimations are based on an aggregation of all programs in Thai public vocational schools. The estimates in figure 4 employ cross-sectional data aggregated for 411 public vocational schools in 2014. This aggregation only indicates results in an average public vocation school representation and does not represent true time-serial data. Such average representations may not be representative for some schools if their instructional requirements and technologies are materially different from most other public schools. As a consequence, their resource requirements can cost profiles vary greatly from these school averages. Readers need to be aware of the fact that these point estimates for both enrollments and costs are approximations; they are not precise targets for all schools. The estimates were relied upon several assumptions, however, they do provide valuable directional policy information.

Figure 4. Average and marginal cost curves



Source: Author's computations.

Table 5: Average cost functions for public vocational schools

Variables	On-budget expenditure per student		Total expenditure per student	
	Model 1a Coefficients (Std. Err.)	Model 2a Coefficients (Std. Err.)	Model 1b Coefficients (Std. Err.)	Model 2b Coefficients (Std. Err.)
Enrollment	-37.14 *** (5.20)	-25.43*** 5.37	-40.79*** (5.81)	-25.49*** (5.94)
Enrollment squared	0.01*** (0.001)	0.003*** (0.001)	0.006*** (0.001)	0.004*** (0.001)
North$^{\Psi}$		-28,173.77** (11,929.54)		-30,036.18** (12,808.15)
South$^{\Psi}$		-23,107.14* (13,060.17)		-21,987.67 (13,966.06)
Northeastern$^{\Psi}$		-27,831.09** (10,882.51)		-30,506.99*** (11,654.84)
Eastern$^{\Psi}$		-26,453.42** (11,347.72)		-25,296.49** (12,207.18)
Central$^{\Psi}$		-28,855.69** (12,399.06)		-31,532.06** (13,276.82)
Agriculture$^{\Psi}$		10,314.46*** (3,690.22)		12,882.08*** (4,429.75)
Home economics$^{\Psi}$		5,445.88** (2,420.62)		5,181.19* (2,871.96)
Commerce$^{\Psi}$		-12,024.81** (5,546.45)		-14,766.33** (6,025.83)
Applied arts$^{\Psi}$		-2,491.49 (3,880.98)		-3,372.14 (4,330.86)
Students-teacher ratio		-371.66*** (55.28)		-449.60*** (66.41)
Dual system		1,901.89 (17,920.38)		2,007.11 (18,468.97)
Constant	72,999.87*** (5,717.71)	109,388.30 (19,736.41)	83,712.47*** (6,350.11)	123,234.20*** (21,301.70)
	28.58	45.97	26.15	45.67
F-Statistic	41.47	19.48	36.86	16.92
N	411	411	411	411

Notes: Robust standard errors in parentheses. $^{\Psi}$ is dummy variable.

*** Significant at the 1% level. ** Significant at the 5% level. * Significant at the 10% level.

Source: Author's computation.

Table 6: Average cost functions for public vocational schools by geographic regions

Variables	On-budget expenditure per student Model 1a Coefficients (Std. Err.)						Total expenditure per student Model 1a Coefficients (Std. Err.)					
Region	North	South	Northeastern	Eastern	Central	BKK	North	South	Northeastern	Eastern	Central	BKK
Enrollment	-25.63***	-47.93***	-19.29***	-20.93***	-21.56***	-132.76***	-27.06***	-53.36***	-20.88***	-23.85***	-24.21***	-137.39***
	(6.18)	(9.48)	(4.08)	(6.39)	(5.07)	(39.59)	(7.89)	(11.34)	(5.25)	(8.55)	(5.88)	(42.80)
Enrollment squared	0.004***	0.008***	0.003***	0.003***	0.003***	0.02***	0.004***	0.009***	0.003***	0.003***	0.003***	0.02***
	(0.001)	(0.002)	(.0007)	(0.001)	(0.001)	(0.007)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.007)
Constant	58005.36***	86262.49***	47070.51***	50841.48***	57544.05***	192910.1***	65510.72***	101128.7***	53301.02***	62998.74***	66100.27***	207403.6***
	(6771.98)	(7918.95)	(5379.60)	(8132.88)	(5492.21)	(47536.1)	(8447.88)	(9692.50)	(6697.56)	(10831.35)	(6464.49)	(51196.3)
R^2	29.23	36.97	29.22	35.02	26.49	54.75	20.31	31.16	21.78	26.06	22.21	53.69
F-Statistic	13.80	26.10	14.37	6.24	16.20	6.32	7.88	19.80	9.56	4.47	13.10	6.17
N	73	79	111	36	78	34	73	79	111	36	78	34

Notes: Robust standard errors in parentheses. $^{\Psi}$ is dummy variable.

*** Significant at the 1% level. ** Significant at the 5% level. * Significant at the 10% level.

Source: Author's computation.

Table 7: Average cost functions for public vocational schools by geographic regions (full specification)

Variables	On-budget expenditure per student Coefficients (Std. Err.)						Total expenditure per student Coefficients (Std. Err.)					
Region	North	South	Northeastern	Eastern	Central	BKK	North	South	Northeastern	Eastern	Central	BKK
Enrollment	-14.04*** (4.24)	-33.92*** (8.18)	-7.17*** (2.45)	-6.49 (5.04)	-9.14*** (2.54)	-141.82*** (43.24)	-11.16** (5.17)	-39.32*** (10.24)	-4.94 (3.34)	0.30 (7.58)	-8.74*** (3.18)	-146.56*** (46.84)
Enrollment squared	0.002*** (0.001)	0.006*** (0.002)	0.001** (0.0003)	0.001 (0.001)	0.001** (0.0004)	0.02*** (0.007)	0.002* (0.001)	0.007*** (0.002)	0.001 (0.001)	-0.0003 (0.001)	0.001** (0.001)	0.02*** (0.008)
Agriculture$^{\psi}$	18868.71** (8947.52)	6250.242 6681.11	11177.36** (5153.40)	23452.22 14070.67	14824.63** (7417.71)	-77158.56 (50776.92)	17411.8 (11305.04)	8175.912 8767.081	13109.77** (6247.38)	32541** (12797.57)	22895.06** (9802.91)	-88391.28 (54765.18)
Home economics$^{\psi}$	6368.64 (5869.87)	4146.942 5249.387	2876.90 (2279.14)	602.0043 4886.192	268.65 (2722.83)	-20745.43 (26661.15)	5217.115 (7469.93)	6233.204 7163.322	2957.88 (2780.46)	1258.18 (6770.93)	-3592.98 (3498.86)	-25736.17 (28936.23)
Commerce$^{\psi}$	-3220.14 (6195.34)	-5852.34 8058.984	-3822.96 (3833.63)	-9140.637 11144.16	-1629.99 (3752.24)	-74474.72* (41050.53)	-5028.57 (8210.67)	-8673.028 10705.67	-6325.26 (4817.17)	-13305.24 (16372.97)	-3106.61 (4615.66)	-82029.79* (43255.67)
Applied arts$^{\psi}$	-7746.33* (3903.58)	5351.996 8182.86	-3857.62 (2743.26)	-2444.285 7174.082	-4132.35 (3270.12)	-5409.025 (27151.68)	-7068.52 (4823.20)	2709.233 11131.62	-6506.47 (3269.62)	-8450.68 (10201.60)	-2070.96 (3641.06)	-4415.93 (28359.89)
Students-teacher ratio	-410.32*** (115.85)	-1390.04*** (474.85)	-285.83*** (45.61)	-276.92*** (78.61)	-778.26*** (141.10)	-90.96747 (173.09)	-564.38*** (150.28)	-1396.10** (589.02)	-360.61*** (58.80)	-451.02*** (123.40)	-880.31*** (170.04)	-116.29 (188.55)
Dual system	-1541.55 (14477.43)	-28742** (13397.77)	1398.78 (5703.22)	-8695.69 (7352.42)	-22691.65** (11259.75)	-87122.73 (90763.79)	-2179.11 (17269.83)	-29110.37 (24634.54)	4562.58 (5497.48)	-19629.4* (9873.46)	-24922.07** (11889.95)	-95333.93 (95866.30)
Constant	64508.71*** (7328.56)	111667.10*** (14103.12)	51067.63*** (5568.17)	57033.84*** (12589.18)	74004.48*** (6789.27)	292780.9*** (84629.32)	76488.02*** (9269.27)	128458.6*** (19874.41)	59177.44*** (6802.58)	73469.34*** (18479.73)	83593.27*** (7440.94)	317194.90*** (91978.04)
R^2	61.67	60.89	59.19	72.31	70.02	68.09	54.60	50.46	54.61	73.80	68.47	68.58
F-Statistic	11.82	9.10	7.67	6.43	10.72	3.08	7.14	6.38	6.60	7.19	8.84	3.14
N	73	79	111	36	78	34	73	79	111	36	78	34

Notes: Robust standard errors in parentheses. $^{\psi}$ is dummy variable.

*** Significant at the 1% level. ** Significant at the 5% level. * Significant at the 10% level.

Source: Author's computation.

Table 8: Average cost functions for public vocational schools by fields of study

Variables	On-budget expenditure per student Model 1a Coefficients (Std. Err.)					Total expenditure per student Model 1a Coefficients (Std. Err.)				
Fields of study	Agriculture	Home economics	Commerce	Applied arts	Industrial	Agriculture	Home economics	Commerce	Applied arts	Industrial
Enrollment	-52.83***	-23.70***	-30.89***	-39.85**	-35.54***	-59.48***	-27.13***	-34.31***	-43.78**	-38.70***
	(8.94)	(4.96)	(3.71)	(19.93)	(5.97)	(11.25)	(6.54)	(4.29)	(21.72)	(6.62)
Enrollment squared	0.008***	0.003***	0.004***	0.006*	0.005***	0.01***	0.004***	0.005***	0.006*	0.006***
	(0.002)	(0.001)	(0.001)	(0.003)	(0.001)	(0.002)	(0.001)	(0.001)	(0.003)	(0.001)
Constant	95948.87***	62408.33***	64883.88***	82782.47***	69279.99***	111588.9***	73035.08***	74933.64***	94205.00***	78892.51***
	7245.64	(7136.09)	(4037.63)	(26520.64)	(6557.42)	(8933.73)	(9376.70)	(4636.08)	(28885.08)	(7221.43)
	49.36	46.23	34.61	21.00	25.14	43.10	38.78	30.91	20.17	23.02
F-Statistic	33.98	17.86	57.54	3.14	27.90	24.78	11.78	50.66	2.70	24.28
N	59	99	342	82	353	59	99	342	82	353

Notes: Robust standard errors in parentheses. $^{\Psi}$ is dummy variable.

*** Significant at the 1% level. ** Significant at the 5% level. * Significant at the 10% level.

Source: Author's computation.

Table 9: Average cost functions for public vocational schools by fields of study (full specification)

Variables	On-budget expenditure per student Coefficients (Std. Err.)					Total expenditure per student Coefficients (Std. Err.)				
Fields of study	Agriculture	Home economics	Commerce	Applied arts	Industrial	Agriculture	Home economics	Commerce	Applied arts	Industrial
Enrollment	-40.24*** (9.01)	-17.29*** 4.336312	-19.88*** (3.01)	-25.09** (12.51)	-22.03*** (5.01)	-44.12*** (10.61)	-19.41*** (5.63)	-20.49*** (3.47)	-27.14* (13.75)	-22.07*** (5.59)
Enrollment squared	0.006*** (0.002)	0.002*** (0.001)	0.003*** (0.001)	0.003* (0.002)	0.003*** (0.001)	0.007*** (0.002)	.003*** (0.0008)	0.003*** (0.0006)	0.004* (0.002)	0.003*** (0.001)
North$^{\psi}$	-7392.94 (15799.33)	-1543.39 (2576.87)	-13903.99** (6095.90)	-50899.82 (43319.89)	-35387.50** (15539.70)	-5488.67 (14736.59)	1889.57 (3406.90)	-15023.16** (6414.76)	-51691.63 (47112.30)	-37429.81** (16664.80)
South$^{\psi}$	-1933.98 (15178.69)	3009.26 (3970.48)	-7675.92 (6978.06)	-41672.31 (47100.42)	-29752.24* (17190.92)	5556.12 (13518.98)	8366.50* (4955.37)	-5135.38 (7297.15)	-42612.74 (51365.09)	-28859.70 (18396.30)
Northeastern$^{\psi}$	-6704.37 (15399.70)	-3356.59 (2743.83)	-14440.41** (5776.41)	-41170.64 (37346.98)	-33815.79** (14323.89)	-3768.40 (14051.44)	-1697.00 (3522.25)	-16041.48*** (6076.43)	-44708.79 (40589.93)	-36937.85** (15324.24)
Eastern$^{\psi}$	-10455.02 (17011.34)	-2246.73 (2961.26)	-14908.47** (6033.73)	-43225.78 (39899.78)	-35589.77** (14910.60)	2770.59 (14061.10)	1531.93 (4681.70)	-13108.45** (6384.90)	-42684.10 (43424.69)	-36050.18** (15991.62)
Central$^{\psi}$	-6278.16 (15640.73)	-1403.94 (2796.04)	-14949.58** (6237.47)	-51850.04 (43746.15)	-37876.79** (16117.17)	2081.89 (14554.74)	-2744.75 (3550.16)	-16747.06*** (6483.92)	-54927.62 (47516.61)	-41507.91** (17240.16)
Students- teacher ratio	-559.50* (297.24)	-252.66*** (62.49)	-355.38*** (51.57)	-647.74** (301.38)	-418.69*** (64.34)	-636.06 (324.19)	-325.39*** (78.98)	-424.63*** (63.63)	-741.64** (328.21)	-497.17*** (74.45)
Dual system	-25788.97 (21372.28)	688.43 (8517.10)	-9747.52 (7628.80)	-96015.46 (81505.02)	4523.89 (19076.97)	-28967.44 (24242.17)	-6332.67 (12489.88)	-9498.63 (8918.81)	-100695.40 (89843.41)	4116.48 (19993.45)
Constant	106735.90*** (16422.26)	65825.51*** (6731.97)	82599.10*** (7799.37)	136525.6** (64015.97)	105445*** (21063.27)	116587.6*** (15383.40)	76262.63*** (8891.45)	93141.61*** (8146.57)	151272.30** (69518.49)	117288.40*** (22703.12)
R^2	61.43	62.96	51.03	37.63	42.06	56.10	59.51	49.08	36.87	41.45
F-Statistic	7.36	12.50	19.73	2.51	15.91	6.05	6.80	18.19	2.25	14.06
N	59	99	342	82	353	59	99	342	82	353

Notes: Robust standard errors in parentheses. $^{\psi}$ is dummy variable.

*** Significant at the 1% level. ** Significant at the 5% level. * Significant at the 10% level.

Source: Author's computation.

Relationship of costs to other factors

Student-to-teacher ratios

The number of teachers include full-time and part-time teacher at each public vocational school. Administrative staffs are not included. Teachers are significant factor affecting costs in public vocational school. As expected, the higher student-to-teacher ratios, the lower were average costs (table 5, 7, and 9).

The quality of school

Since there is no standard national examination for students in vocational schools, the percentage of students who participated in dual program is applied as an indirect proxy measure for public school quality. Bowen (1981) claimed that average student costs in most countries tend to be higher in institutions with higher quality education inputs. The quality of school coefficient is insignificant (table 5, 7, and 9).

Field of study in vocational school

There are five groups on fields of study in Thai public vocational school including: i) agriculture and fishery; ii) home economics and tourism industry; iii) industrial, textile, and information and communication technology; iv) commerce; and v) applied arts. The based dummy variable category is industrial, textile, and information and communication technology. Thai public vocational schools usually have more than one field in the same school. The agriculture and fishery, commerce, and home economics and tourism industry coefficients are positive and significant imply that most of fields of study are more expensive than industrial, textile, and information and communication technology. On average Thai public vocational schools that offer field of study in agriculture and fishery will have approximately 12,882 baht higher in total expenditure per student (table 5). Average cost functions for public vocational school vary across fields of study (table 8 and 9).

Regional variation

Geographic region dummy variables are used as a measure of control for possible regional variation in resource costs. The based dummy variable category is Bangkok metropolitan region. The location of public vocation schools was believed that costs variations might exist between public vocational schools in Bangkok metropolitan region compared with other regions. In addition, others have argued that the cost of resource inputs might be more expensive in the regions that have high intensity of technical vocational program. It was expected that geographic region dummy variables would control for any differences between school resource costs that might arise from differing funding and resource costs. The results suggest that public vocational schools in other provinces face lower average costs compared to public vocational schools in Bangkok metropolitan region. For example, on average public vocational schools that are located in the northeastern region face approximately 30,507 baht lower in total expenditure per student (table 5). Average cost functions for public vocational school vary across geographic regions (table 6 and 7).

5. Conclusion

Findings from the study of public vocational schools in Thailand have meaningful implications for policy makers. It appears that closed to 80 per cent of the public vocational schools in Thailand are small size to have economies of scale for optimal average cost efficiencies. According to goals for developing the manpower in vocational education to match the international trends during 2012 to 2026, four goals include 1) to increase the number of students in vocational education 2) to promote the opportunity for students to access to the vocational education and professional training 3) to upgrade the quality of vocational education and 4) to increase efficiency in administration. Thai education public policy should emphasize on enrollment expansion of existing vocation schools in order to fulfill the national education policy and to sustain the need of the current labor demand as well as pursuit of cost efficiency. In addition to efficiency concerns, the quality of the existing programs should be concerned. The dual program or partnerships with business enterprises and prospect future employers should be strongly emphasized in all public

vocational schools. The high percentage of students who participated in dual program may be a good signal on the skilled approval in the labor market.

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