ประสิทธิภาพทางเทคนิคของศูนย์สาธารณสุขชุมชนในเขตชนบท สามเหลี่ยมปากแม่น้ำแดงของประเทศเวียดนาม

นางลัน โด ธิ เฟือง

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต
สาขาวิชาเศรษฐศาสตร์สาธารณสุขและการจัดการบริการสุขภาพ
คณะเศรษฐศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย
ปีการศึกษา 2552

TECHNICAL EFFICIENCY OF COMMUNE HEALTH CENTERS IN RURAL RED RIVER DELTA OF VIETNAM

Mrs. Lan Do Thi Phuong

A Thesis Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Science Program in Health Economics and Health Care Management
Faculty of Economics
Chulalongkorn University
Academic Year 2009

Thesis Title	TECHNICAL EFFICIENCY OF COMMUNE HEALTH CENTERS IN RURAL RED RIVER DELTA OF VIETNAM
By	Mrs. Lan Do Thi Phuong
Field of Study	Health Economics and Health Care Management
Thesis Advisor	Associate Professor Sothitorn Mallikamas, Ph.D.

Accepted by the Faculty of Economics, Chulalongkorn University in Partial Fulfillment of the Requirement for the Master's Degree

....Dean of the Faculty of Economics
(Professor Teerana Bhongmakapat, Ph.D.)

THESIS COMMITTEE

....Chairman
(Associate Professor Pongsa Pornchaiwiseskul, Ph.D.)

....Thesis Advisor
(Associate Professor Sothitorn Mallikamas, Ph.D)

.... Examiner
(Associate Professor Isra Sarntisart, Ph.D.)

....External Examiner
(Associate Professor Manisri Puntularp)

นางลัน โด ธิ เฟือง: ประสิทธิภาพทางเทคนิคของศูนย์สาธารณสุขชุมชนในเขตชนบทสามเหลี่ยมปากแม่น้ำแดงของประเทศเวียดนาม. (TECHNICAL EFFICIENCY OF COMMUNE HEALTH CENTERS IN RURAL RED RIVER DELTA OF VIETNAM) อ. ที่ปรึกษาวิทยานิพนธ์หลัก: รศ. ดร. โสตถิธร มัลลิกะมาส, 72 หน้า.

การศึกษานี้มีวัตถุประสงค์เพื่อวัดประสิทธิภาพทางเทคนิคของศูนย์สาธารณสุขชุมชนในเขตชนบทบริเวณสามเหลี่ยมปากแม่น้ำแดงในปี 2549 ซึ่งรวมถึงศูนย์สาธารณสุขชุมชน 495 ศูนย์ใน 11 จังหวัด การศึกษาวิเคราะห์ระดับประสิทธิภาพทางเทคนิคโดยใช้แบบจำลอง DEA และวิเคราะห์ปัจจัยกำหนดประสิทธิภาพโดยอาศัยแบบจำลอง OLS

ผลการวัดระดับประสิทธิภาพทางเทคนิคพบว่า ค่าเฉลี่ยของประสิทธิภาพทางเทคนิคภายใต้ข้อสมมติ constant return to scale เท่ากับ 0.472 ในขณะที่ค่าเฉลี่ยของประสิทธิภาพทางเทคนิค ภายใต้ข้อสมมติ variable return to scale มีค่าเท่ากับ 0.518 การศึกษาปัจจัยกำหนดประสิทธิภาพทางเทคนิคพบว่า ระดับเงินเดือนและยาฟรีมีผลทางด้านบวกต่อประสิทธิภาพทางด้านเทคนิค ในขณะที่ศูนย์สาธารณสุขในเขตเมืองฮานอย มีระดับประสิทธิภาพต่ำกว่าเขตอื่น ภายใต้ข้อสมมติ constant return to scale

ดังนั้น การเพิ่มค่าตอบแทนเพื่อสร้างกำลังใจแก่เจ้าหน้าที่สาธารณสุข และการขยายโครงการยาฟรี เพื่อดึงดูดผู้ป่วยให้มาใช้ศูนย์สาธารณสุขชุมชน จึงเป็นข้อเสนอทางเลือกทางนโยบาย

สาขาวิชา เศรษฐศาสตร์สาธารณสุขและการจัดการบริการสุขภาพ ลายมือชื่อนิสิต...............................

ปีการศึกษา 2552 ลายมือชื่อ อ.ที่ปรึกษาวิทยานิพนธ์หลัก...............................

5285727229: MAJOR HEALTH ECONOMICS AND HEALTH CARE MANAGEMENT
KEYWORDS: COMMUNE HEALTH CENTER/ TECHNICAL EFFICIENCY/ DEA/ RED RIVER DELTA

LAN DO THI PHUONG: TECHNICAL EFFICIENCY OF COMMUNE HEALTH CENTERS IN RURAL RED RIVER DELTA OF VIETNAM. THESIS ADVISOR: ASSOC. PROF. SOTHITORN MALLIKAMAS, Ph.D., 72 pp.

This study aims to measure the technical efficiency of commune health centers in rural Red river delta region in 2006, including 495 commune health centers (CHCs) from the 11 provinces. Data envelopment analysis (DEA) method is used to analyze technical efficiency and ordinary least square regression is used to determine inefficiency score.

DEA results showed the average constant return to scale technical efficiency score was 0.472 and the average variable return to scale technical efficiency score was 0.518. The results indicate that the level of technical efficiency in health center is rather low. Regarding the determination of technical efficiency, it is found that staff salary and free-in charge drugs has a positive impact on technical efficiency. Health center in Hanoi has lower technical efficiency than others under constant return to scale assumption.

As a result, an increase in compensation to rise motivation of health staffs as an expansion of free of charge drug to attract more patients to utilize CHCs are suggested on policy options.

Field of Study: Health Economics and Health Care Management Student's Signature. ....

Academic Year: 2009 Advisor's Signature. S. Malli Malla

ACKNOWLEDGEMENTS

I would like to express my deepest thanks and appreciation to my thesis advisor, Associate Professor Sothitorn Mallikamas, Ph.D for his expert and enthusiastic guidance, profound and constructive feedbacks, and great encouragement through the whole process of this study.

I would like to express my gratitude to my committee at Chulalongkorn University, Associate Professor Pongsa Pornchaiwiseskul, Ph.D., Associate Professor Isra Sarntisart Ph.D. and Associate Professor Manisri Puntularp for their worthful supports and revisions for my thesis.

I also would like to express many sincere thanks to Faculty of Economics, Center for Health Economics and staff for their understanding, kindness, helpfulness during my study time.

I would like to thank Vietnam General Statistic Office for their permission and support data collection.

I would like to extend my thanks to Thailand International Development Cooperation Agency (TICA), managerial board and my colleagues in Planning and Finance department of Vietnam Ministry of Health for giving me the opportunity to attend this program.

Lastly but not least, at the bottom of my heart, I would like to express my gratitude and love to my family. Their constant love, care and encouragement have motivated me to complete this program.

CONTENTS

LIST OF TABLES

Page

LIST OF FIGURES

Page

LIST OF ABBREVIATIONS

CHC	Commune health center
CRS	Constant return to scale
DEA	Data envelopment analysis
DMU	Decision making unit
GSO	General Statistic Office
HCFP	Heath care fund for poor
LNCRSTE	Logarithm of constant return to scale technical efficiency score
LNVRSTE	Logarithm of variable return to scale technical efficiency score
OLS	Ordinary least square
S.D.	Standard deviation
SE	Scale efficiency
TE	Technical efficiency
VRS	Variable technical efficiency

CHAPTER I
INTRODUCTION

1.1 Problem and its significance

Although Vietnam is one of the low - income countries in Asian region, the health care sectors have been considered as a very important factor in economic and social targets in recent years. The fact is that Vietnam's health care sector has been contributing a lot in human development. The people's health has clearly and comprehensively improved. Many diseases have been controlled and eliminated. The health system has been strengthened and expanded to achieve equity, efficiency, and development – increasingly satisfy the population's healthcare needs in terms of quantity and quality. These achievements have been contributed with provision of basic health services by means of more than 10,000 Commune Health Centers (CHCs) distributed over rural areas. But there was little demonstrable impact on the incentives and pressures faced by CHC staffs and local authorities.

Many low-income people are being benefited by the promulgation of Decision No. 139 which is the Health Care Fund for the Poor (HCFP). This program covers 14.3 million people that accounted for about 17.5% of the general population. In 2003, there were 11.0 million low-income people benefited by the Decision No. 139, which increased threefold when compared with the number reported in the previous period. The HCFP has had a positive effect on the health services by the poor. A higher share of the rich's choice to use governmental hospitals for outpatient care was showed as 34.3% versus 19% among the poor quintile. About 34.8% of the poor use CHCs for outpatient care while this number was 11.2% among the rich.

Utilization of health services by children presents some particularities. Children are more prone to illness, especially to diseases such as acute respiratory infection, diarrhea, etc. At the same time, children are the prioritized concern by families. Despite the governmental assistance policies on child health care, economic factors have a remarkable effect on the use of health services by children. Hence, when children are ill, the children in high-income groups have greater access to higher-level hospitals than those in the low-income group who seek care mainly at the CHC by Health insurance for children under 6 years of age.

The CHCs are the primary units for delivery of health care in the public health system. These health centers are responsible for implementing primary health care and delivering technical health services for local people, and for carrying out the operational management and direction of village health.

The decision to develop a network of “grassroots” health services, as the foundation for the people’s health care, has achieved many benefits. It has contributed on attainment of national healthcare goals for the entire population. However, the grassroots healthcare network developed during the period before the Renovation (1986) when all health services were provided free of charge is now encountering difficult challenges.

In many other countries like China, Cuba, Indonesia and Sri Lanka, the health center system has been working very well under the sponsor of their Governments, Vietnam is also the same case even after the innovation in 1986. Vietnam’s health care system still gets supporting from the Government, nevertheless, it also enters in the account by itself by offering health services which the patients have to pay money. In fact, the CHCs in Vietnam has worked effectively in general; however, there is few papers about the efficiency of a specific health center. Also some other papers examined this topic but they just used some traditional methods in which statistical reports are usually reviewed. In the world, there are many technical efficiency researches applied in health economics to estimation of efficiency in hospitals but rare study applied technical efficiency to commune health centers in Vietnam. From these concerns, it is necessary to do this research concentrating on the evaluation of the technical efficiency (TE) levels of commune health centers in rural Red river delta region. The Red river delta region that is the extremely important socio-economic region in the north of Vietnam includes 11 provinces, 114 districts and 2,256 communes. The Prime minister of Government promulgated Decision No.677-TTg in 1997 approving the 1996-2010 master plan for socio-economic development in the Red river delta. In which, “to expand the network of primary healthcare and medical examination and treatment for the people” is one of the major development tasks. In 2006, immunization coverage among under 1 year fully vaccination of this region is 98.5% that is the highest rate. The proportion of prenatal care with more than three times was 98.48%, the proportion of births attended by health worker was 99.92%, the proportion of postnatal care rate was 97.02% and the proportion of postnatal care rate more than 2 times was 87.85%. They are also the highest rate over all country.

The population of this region is 18207.9 thousand people. In this region, there are 2250 commune health centers, the biggest health center system in Vietnam. The basic healthcare network is organized under people committees at the district and commune levels. The Communes of Vietnam in rural areas, town/ward in urban areas are the third-level administrative units in Vietnam after Districts which is the second-level. In Vietnam a rural commune is referred to as a commune and urban communes are referred to as ward, urban townships. However if a city, particularly if it has provincial status and is largely urban then often they will be divided into wards.

By the end of 2006, Vietnam had 64 provinces, 673 districts and 10925 communes/wards serving a population of more than 84 million people.

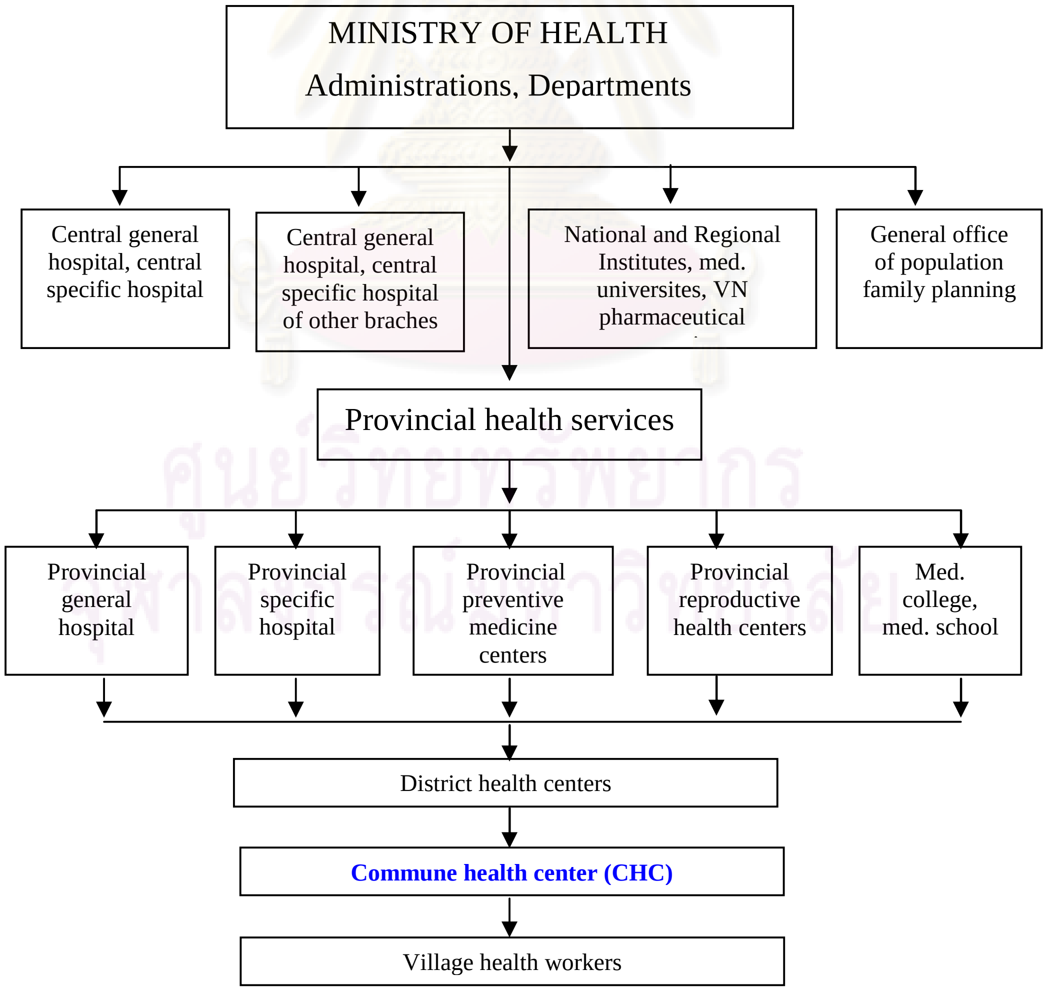


Figure 1 Organizational chart of the Vietnam health network

1.2 Questions

Primary question:

What are the technical efficiency (TE) levels of commune health centers in rural Red river delta region?

Secondary questions:

– What are the technical efficiency scores (TE scores) of commune health centers in rural Red river delta region?
– What is the difference of technical efficiency among commune health center groups, by provinces in rural Red river delta region?
– What factors determining the technical inefficiency or efficiency of commune health centers in rural Red river delta region?

1.3 Objectives

General objective:

To measure the technical efficiency of commune health centers in rural Red river delta region.

Specific objectives:

– To evaluate technical efficiency and its factors of commune health centers in rural Red river delta region.
– To compare the technical efficiency among commune health center groups by provinces in rural Red river delta region.
– To identify the factors effecting on the efficiency or inefficiency of commune health centers in rural Red river delta region.

1.4 Scope

This paper employs Data envelopment analysis (DEA) to evaluate the technical efficiency and its determinants of 495 CHCs in Rural Red river delta. DEA is one of very effective methods to measure technical efficiency for individual commune health center. The DEA method admits multiple outputs and multiple inputs that is appropriate for health care services with no assumptions, no production function or the distribution of errors. Beside, this paper also uses ordinary least square

(OLS) method to analyze the factors effecting technical inefficiency score. The data comes from secondary sources of cross - sectional data of year 2006.

1.5 Possible Benefits

This study will offer key factors effecting on commune health care services and efficiency of each commune health centers. If they are significant, it is necessary for policy makers to strengthen grass root level in health systems. Moreover, the results are useful when we discuss the difference among of health care activities at the CHCs. The results are hoped to contribute understandings and true impacts for policy makers and managers of commune health centers to improve efficiency performance.

In this limited study, it is not expected to explain about overall analysis because the very important part is not concerned about the results of treatment. Moreover, the medical care at grass root level is only the lowest level of health care system with scarcity resources. Nevertheless, the results would be useful for understanding relationships between CHCs’ medical care and some factors.

CHAPTER II

COMMUNE HEALTH CENTERS IN VIETNAM

At the grassroots level, health care is the low standard. The physical infrastructure at the commune level is being upgraded to meet national benchmarks for commune health services, which focus on achieving basic minimum standards regarding the workforce and medical equipment. Policies to encourage doctors to work in remote areas are insufficiently attractive to bring in health workers where needed, or to improve the standard of care at the commune level. Government and Ministry of Health call for a strengthening of primary health care. However, statistical findings indicate a low level of effectiveness in the primary healthcare system in preventing and treating communicable and non-communicable diseases. A more realistic action plan is needed to develop the primary level of health care. It is necessary as a basis for orienting investments in physical infrastructure, staff training, development of managerial institutions, and organizational restructuring.

The Master Plan for 2010 on health system development in Vietnam was promulgated in 2006. According to the plan, communes with more than 10 000 inhabitants are allowed to have more permanent staff or recruit contracted staff. Each CHC must have at least 5 staff and an expanded force of village health workers. By 2006, 98% of the communes had commune health centers with an average of 4 beds each. Human resources at the commune level have been strengthened, and on average each commune health center has 4.8 health workers. In total, 6574 full-time medical doctors staff the commune health centers. Midwives and obstetric/pediatric assistant doctors play an important role in delivering reproductive health services, and 93% of commune health centers have at least 1 of these 2 key staff members (most with technical high school or junior college level training). The incentive policy for commune health workers has been improved, bringing their benefit levels up to levels similar to other government staff, including social insurance, pensions, and compensatory allowances for working in dangerous conditions. However, implementing these policies is difficult because the financing of these benefits must come from the inadequate commune budget. Decision 58/TTg (February 3, 1994) and Circular 08/TTLB (April 20, 1995) established the CHC workforce norms: Midland

and delta areas: 3 to 4 staff in communes with up to 8000 inhabitants; 4 to 5 staff in communes with 8000 to 12 000 inhabitants; 6 staff in communes with more than 12 000 inhabitants. National benchmarks for health care at the commune level during the 2001-2010 period, enacted by Decision 370/2002/QD-BYT (February 7, 2002), stipulate targets for human resources. A sufficient number of staff should be ensured according to the existing regulation on workforce norms. Each CHC has at least 3 staff, including: Doctor or assistant doctor (doctor required in delta areas), Midwife or obstetric-pediatric assistant doctor (secondary midwife or obstetric-pediatric assistant doctor required in lowland areas), Nurse (secondary nurse or higher required in lowland areas).

In the Vietnam health system, the district and commune health levels are the first services that people access when they become ill. Health care at the commune level has been fairly well implemented, reduced the healthcare burden on higher levels, and effectively checked diseases, reduced poverty, promoted social stability, and decreased healthcare costs, especially among the poor. The CHC have widened their focus, from examination and treatment not only at the CHC, but also at home. However, this network has faced limitations in staff quality and quantity, physical condition of the facility, and service prices. The strategy on public health care and protection in the 2001-2010, 80% of communes will have doctors, 80% of all CHC will have secondary midwives, all CHC will have assistant pharmacists in charge of pharmacies and some medical staff trained in traditional medicine.

The number of commune health workers has increased annually. From 2005 to 2006, the number of commune health workers increased by 1569 staff, achieving a level of 60.8 staff per 100 000 inhabitants. The health sector is making a major effort to assure that every CHC has a doctor. The trend in meeting this objective, illustrating that 65.1% of communes had a doctor by 2006 in which Red river delta region had 79.2%. Government objectives are that 80% of delta communes and 60% of mountainous communes should have a doctor at the CHC. Nationally, 39 provinces report that at least 65% of all communes have a doctor, 7 provinces had a doctor in 100% of their communes (Red river delta region had 2 provinces). The greater number of doctors in the basic healthcare network has facilitated people’s access to doctors for health care. According to the findings of Vietnam national health survey 2001-2002, the percentage of health service contacts provided by doctor is 25% at the CHC.

In general, health services at the commune level do not respond well to healthcare needs of risk groups. The elderly, children, and mothers/newborns are groups with major needs for health care at the commune level. Aside from prevention activities, health centers in the future must enhance their performance in treating diseases, focusing primarily on vulnerable groups. The commune level must be able to treat common acute diseases in children, inform people about reproductive health, provide prenatal care, and be capable to assist in childbirth. Moreover, the commune level must be able to manage healthcare for the elderly and treat chronic diseases that are common in the elderly. The basic healthcare network provides both curative and preventive care. Of total outpatient visits to the CHC, nearly 40% relate to immunization or preventive health, over 40% relate to health care for people aged 6 years and older, and nearly 15% relate to prenatal care and children younger than 6 years, including rehabilitation, health examinations, and other services.

In forthcoming years, improvements in living standards will enable people to choose different healthcare facilities and levels of quality. The gradually improving transportation infrastructure will promote easy and quick access to higher-level health facilities. The private health sector will continue to develop in terms of the number of facilities and beds and improved quality of care. The need to decrease costs by enhancing efficiency in using health technology, e.g., laboratory testing, ultrasound and radiography, will require organizing these services in new ways. To achieve economies of scale, communes in close proximity should provide healthcare services requiring high-tech equipment.

On the other hand, as the socioeconomic situation improves people with higher incomes are willing to pay for health care in high-technology facilities, which leads to overloading higher-level care and reducing efficiency in the healthcare network. The Ministry of Health developed an essential medical equipment list for CHC in 2002. To further enhance the professional capacity of doctors, the essential medical equipment list for CHC was supplemented in 2004. Project and state budgets have enabled many CHC to acquire basic sets of equipment and instruments for general health care, reproductive health care, and instrument sterilization. However, due to the lack of funds for procurement, replacement, and repair, there is still a shortage, especially in specialization equipment.

Compensation packages for commune health workers are important factors in attracting health staff and encouraging them to perform well. In 1994, compensating commune health staff changed from subsistence expenses to paying salary. This represented an important turning-point in the operation of commune health services since it allowed staff to achieve greater stability in life and focus more on work performance, quality, and efficiency. In 2001, Decision 97 supplemented the compensation regulations for staff in the health sector. In 2004, the Prime Minister promulgated Decision on calculation of working time for commune health workers to receive social insurance. In 2004, Decree 204 adjusted the salary system for government employees. In 2005, Decision 276 regulating compensation for commune staff providing health care services directly to patients, compensation varies by 20% to 30% depending on the area where they work: urban, rural, mountainous, island, or remote.

Regarding the recurrent budget of the commune health station, 80% of communes receive some funds from the commune budget and 72% collect user fees. According to the health insurance regulations under Decree 63, health insurance reimbursements are paid to health service providers on a fee-for-service basis, which is most profitable for service providers. At the same time, payment ceilings for outpatient services have been removed, and if providers overspend their insurance fund, they can request payment from the reserve fund of health insurance. However, the healthcare providers are not satisfied when providing services for insured patients. These impacts negatively on the quality of services provided for insured patients. The main reason for this problem is that the reimbursement level is set according to a user fee scale issued over 10 years ago (1995), which has not been updated to cover increases in service prices. In 2006, a Ministry of Health and Ministry of Finance joint circular supplemented the price scale for services that were not yet included on the list of services issued in 1995, but the old prices were still not updated. Clearly, when the fee is lower than the cost of providing the service, healthcare providers will hesitate to provide those services, or try to charge the difference to patients.

For many years, the healthcare sector and localities have been taking important steps toward increasing the number and quality of healthcare staff at the commune level. First, the healthcare sector has organized training of various types, for example local selection, technology transfer, and continuous training and re-training, to develop the workforce based on human resources already in place. Second, well-qualified health staff, particularly doctors, have been transferred to work at the commune level. Third, some localities have arranged attractive compensation packages for doctors to work at their health facilities.

The Master Plan to develop Vietnam’s health system by 2010, with a vision for 2020, and a 5-year plan (2006-2010) for health protection and promotion, affirmed that the basic healthcare network must ensure primary health care. To fulfill this task, the Master Plan developed targets, and the plan proposed training projects, investing in necessary physical facilities to ensure early diagnosis and timely treatment of common diseases, first aid, emergency care for accidents and injuries in populated areas, and gradually developing the ability to implement basic procedures in diagnosing and treating more specialized areas, e.g., eye disorders, dental care, ear-nose-throat, reproductive health, and pediatrics. In addition to the government budget, some training facilities are funded by international, governmental and nongovernmental organizations. These financial resources have provided effective support for training and education in the health sector for example reform of training programs, development of the training curriculum, preparation of training instruments, application of active training methods, and investments in new equipment.

In 2004, about 420 000 people moved out of their provinces into cities and concentrated industrial zones, including Hochiminh (111 438 immigrants), Hanoi (43 565 immigrants), Binhduong (24 696 immigrants) and Danang (6672 immigrants). However, due to increasing migration, in many regions health planning based on the number of permanent residents may be incapable of satisfying the healthcare needs of the factor population in the locality.

Demographic and epidemiological transitions have resulted in changes in healthcare needs at the commune level. People in remote areas have limited access to healthcare facilities beyond the commune health station. In contrast, commune/ward health centers in the delta and urban areas provide fewer curative care services due to competition from private facilities and hospitals.

Population density in the Red River Delta is 17 times higher than in the Northwest region, where it is lowest. A survey conducted in 2005 indicates that while the combined area of the Red River Delta and Mekong Delta accounts for only 17% of total land area of Vietnam, it accounts for up to 42% of the national population. Population distribution not in line with the natural and other resources available in each region will have major effects on socioeconomic development. A high population density in some regions, but a widely dispersed population in others, creates major challenges for healthcare policymaking and resource distribution.

The number of communes achieving national benchmarks for health care at commune level remains low. By the end of 2006, only 38.5% of communes had met the standards. Compared to the delta areas, the communes in mountainous and remote areas face many difficulties in achieving national standards (Red river delta region is 56.3%). The main items of benchmark were as follows:

Benchmark 1: Social mobilization in health care and health information, education and communication

Benchmark 2: Preventive health care

Benchmark 3: Health care and rehabilitation

Benchmark 4: Traditional medicine

Benchmark 5: Child health care

Benchmark 6: Reproductive health care

Benchmark 7: Infrastructure and equipment

Benchmark 8: Health personnel

Benchmark 9: Plan and budget for CHC activities

Benchmark 10: Essential drugs; rational and safe use of drugs

Achieving 10 national benchmarks for health care at the commune level will be difficult. Since economic conditions differ between regions, the support, facilitation, and investments for reaching the 10 benchmarks vary. Also, because of the inappropriate distribution and mix of health workers, and limited sense of duty of the community to participate and take responsibility after 2 years of implementation, the results achieved are not high. Government and local authorities should pay greater attention to investing in health and the environment. The healthcare sector is considering targets adapted to the situations in different regions and areas. Government levels, community and social organizations must address and coordinate with health sector to implement national benchmarks for health care at the commune level.

CHAPTER III
LITERATURE REVIEW

The first person who represents the inception of DEA, Farrell (1957) was motivated by the need for developing better methods and models for evaluating productivity. He argued that while attempts to solve the problem usually produced careful measurements, they were also very restrictive because they failed to combine the measurements of multiple inputs into any satisfactory overall measure of efficiency. Responding to these inadequacies of separate indices of labor productivity, capital productivity, etc., Farrell proposed an activity analysis approach that could more adequately deal with the problem. His measures were intended to be applicable to any productive organization. In the process, he extended the concept of “productivity” to the more general. He proposed that the productive efficiency of a firm consists of two components: Technical efficiency and allocative efficiency. Technical efficiency reflects the ability of a firm to obtain maximum of output from given set of input. And allocative efficiency reflects the ability of a firm to use the input in optimal proportion, given their prices. Technical efficiency was defined by Farrell's (1957) leading to the development of methods for estimating the relative technical efficiency of firms.

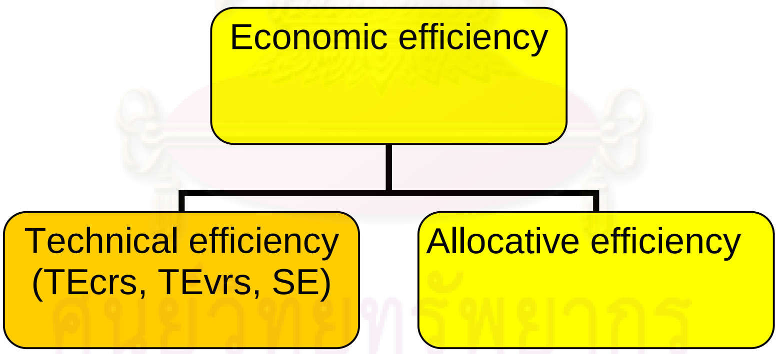


Figure 2 Concept of efficiency measurement

Basic Data envelopment analysis (DEA) models for measuring the efficiency of a DMU relative to similar decision making units (DMUs) in order to estimate a ‘best practice’ frontier. The initial DEA model, as originally presented in Charnes, Cooper, and Rhodes (CCR) (1978), built on the earlier work of Farrell (1957).

BCC (Banker, Charnes and Cooper, 1984) model is also referred to as the VRS (Variable Returns to scale) model and distinguished form the CCR model which is referred to as the CRS (Constant Returns to Scale) model. TE scores obtained from a DEA into two components scale efficiency (SE) and pure technical efficiency:

$$\text{TEcrs} = TEvrs \times SE$$

In which: TEcrs: Technical efficiency score on constant return scale

TEvrs: Technical efficiency score on variable return scale or pure technical efficiency score

SE: Scale efficiency score can be calculated from difference between technical efficiency and pure technical efficiency.

2.1 Technical efficiency definition

Definition (Pareto-Koopmans Definition): “Full (100%) efficiency is attained by any decision making units (DMUs) if and only if none of its inputs or outputs can be improved without worsening some of its other inputs or outputs.”

In economics, the term “efficiency” refers to the best use of resources in production. “Technical efficiency” is producing the maximum amount of output from a given amount of input or minimum input quantities with a given output. (Hollingsworth, Dawsonand Maniadakis, 1998)

Table 1 Analytical methods to efficiency measurement are summarized by Hollingsworth et al. (1998).

	Parametric	Non-parametric
Deterministic	Parametric mathematical programming	Data envelopment analysis (DEA)
	Deterministic (econometric) frontier analysis	
Stochastic	Stochastic (econometric) frontier analysis	Stochastic data envelopment analysis

According to Hollingsworth et al. (1998), the reason why people usually choose DEA to apply in health services. First, parametric programming is built on the linear programming which uses econometric techniques to estimate a deterministic or a stochastic frontier function. A smooth parametric frontier is inappropriate structure on the technology. Also, the results are sensitive to outside factors. Both parametric and deterministic approaches are disadvantaged, but stochastic has the advantage of accounts for error. Though, parametric structure requires the production function and the distribution of efficiency. There are few parametric health care applications. Second, the DEA method is a non-parametric technique which uses linear programming. It also has efficiency frontier that is linear segmented and sensitive to outliers. One of important advantages is simple assumptions made in activity analysis. The DEA method admits multiple outputs and multiple inputs that is appropriate for health care services with no assumptions, no production function or the distribution of errors. After all, the DEA method has strong points in health services performance measurement.

The common feature of these estimation techniques is that information is extracted from the extreme observations from a data body to determine the best practice production frontier (Lewin and Lovell 1990). From this the relative measure of technical efficiency for the individual firm can be derived. Despite this similarity, the approaches for estimating technical efficiency can be generally categorized under the distinctly opposing techniques of parametric and non-parametric methods (Seiford and Thrall 1990). Herrero and Pascoe (2001) specified the linear programming technique of data envelopment analysis (DEA) does not impose any assumptions about the functional form. Hence, it is less prone to mis-specification. DEA is a non-parametric mathematical programming approach to frontier estimation

In short, Data Envelopment Analysis method has following strengths:

DEA offers more accurate estimates of margin. It is not subsequently subject to the problems of assuming an underlying distribution about the error term. However, since DEA cannot take account of such statistical noise, the efficiency estimates may be biased if the production process is largely characterized by stochastic elements all values of inputs or outputs provided it offers no negligible marginal value for any variable.

DEA offers efficient rather than average marginal values of inputs or outputs.

DEA allows for variable marginal values for different input-output mixes.

DEA estimates of marginal values do not suffer inaccuracy due to multicolinear or strong correlations between explanatory variables.

DEA offers more appropriate individual maximum (minimum) targets where outputs (inputs) cannot vary independently of one another.

DEA normally yields more accurate targets because it is a boundary method.

The application of DEA method in many fields likes bank, industry, agriculture, especially in health sector. Many applications of DEA method in previous health economics study used the input factors including capital and labor resources. Almost their output factors are outpatient visits, inpatient day and some special results are graduate student. Watcharasriroj and Tang (2004) study is “The effects of size and information technology on hospital efficiency”. They are the same with Kornpob, (2008), Watchai (2007), Gantugs

(2006) used number of beds or bed day a proxy of capital input factors. They also used physicians, nurses, dentist and other staffs which are proxies of labor input factors.

In summary, the DEA approach has become the principal approach to measure the performance of many economic sectors. One of the strong characteristics of this approach is that it can deal easily with multiple outputs and inputs. DEA is a non-parametric approach, so it does not require any assumption about the functional form of the production or cost frontier. Therefore, DEA concentrates on taking into account and classifying variables that can be inputs or outputs of the production function. Technical efficiency may be defined as the ability of a firm to produce as much output as possible, given a certain level of inputs and certain technology in term of output oriented. The DMUs, lie on the line frontier for the production process, are technical efficiency. Conversely, inefficiency units lie below the frontier. There exists a line from the origin tangent to the frontier at the highest DMUs. This line represents the constant returns to scale of the technology represented by the data of those observations. The relationship among technical efficiency, purely technically efficiency and scale efficiency depend on its location on the frontier and the property of constant returns to scale. Although a unit is technically efficient in an overall sense, it may be inefficiency in scale. Observations are purely technically efficient because they belong to the frontier, but they are scale inefficiencies. Some of observations are both scale and technically inefficient because they lie below the frontier. Theoretically, the same level of input could be used to achieve a higher level of output, which would allow the firm to move forward to the frontier. This measurement attains two different types of scale behavior: constant returns to scale (CRS) and variable returns to scale (VRS).

2.2 Analysis of factors effecting technical efficiency scores

Cooper et al summarized that the TE score depends on the selection of inputs and outputs. The best way to validate or confirm variations in TE scores is to regression the TE scores against explanatory and control variables. If TE scores are used in a two-stage regression analysis to explain efficiency, a model ordinary least square (OLS) is required. Standard multiple regression assumes a normal and homocedastic distribution of the disturbance and the dependent variable; however, in the case of a limited dependent variable the expected errors will not equal zero. The standard regression will lead to a biased estimate (Maddala, 1983). Despite these drawbacks, blending DEA with OLS model's estimates can be informative. The distribution of TE scores is never normally distributed, and often skewed. Taking the reciprocal of the efficiency scalar, (1/TE score), helps to normalize the TE distribution (Chilingerian, 1995).

The ordinary least square estimated method has some advantages which were concluded in many econometric books. Firstly, the OLS estimators are expressed solely in term of the quantitative observation, so they can be easily computed. Secondly, the goal of minimizing sum of square residuals is quite appropriate from theoretical point of view. This cause of OLS estimates to be as close as possible to the observation data. Thirdly, the OLS estimates have a number of useful characteristics: the regression line goes through the mean of estimated model; the sum of residuals is exactly zero; it can be the best estimator possible under a set of specific assumption.

There are 5 main common factors effecting on the technical efficiency scores.

Firstly, capital and high technology factors were mentioned in Minh and Giang (2004). Despite differences in the results of testing the impact of net capital-labor ratio on efficiency for hospitals and medical centers, these organizations appear to operate in labor-intensive ways. They analyzed the efficiency performance of the hospitals and medical centers in Vietnam by using the data envelopment analysis approach. The data consists of 44 observations in 2002. The results indicate that is positive relationship between technical efficiency score and capital-labor variable. Watchai (2007) used the DEA approach to measure public hospital efficiency in Thailand. In this study he did two stages. The first stage is to measure hospital efficiency and total factor productivity index before and after universal coverage using DEA. The second stage is to identify determinants of hospital efficiency using Tobit regression analysis. His research's sample is 805 public hospitals. The result is the large hospitals are more efficient than small ones.

Secondly, input output mix factors Kornpob (2008) measured the university hospital efficiency and identified its determinants. He estimated ordinary least square regression. His result are bed-physician ratio, pharmacist-physician ratio and outpatient per visist related to scale efficiency scores; occupancy rate, outpatient visits per physician and number of student 6^{th} year related to technical efficiency scores. Linna, Nordblad, and Koivu (2003) measured the productive efficiency of public dental health provision across Finland. The analysis was based on data envelopment analysis (DEA) using linear programming. In addition, they investigated various factors explaining the technical and cost efficiency of public dental care using a parametric Tobit model. Their results, individual efficiency scores were negative with percentage of total dentists to total other personnel. They also concerned about Resources per capita used for primary care and health education.

Thirdly, locations in Hanoi and Ho Chi Minh cities had no influence on either overall technical efficiency or scale efficiency. These were concerned in Minh and Giang (2004) study and the result is negative with technical efficiency scores. Watchai (2007) used the region dummy variables which is one kind of location factors.

Fourthly, population factor was concerned with Linna, Nordbladand Koivu (2003) by variable of size of the municipal population or population square.

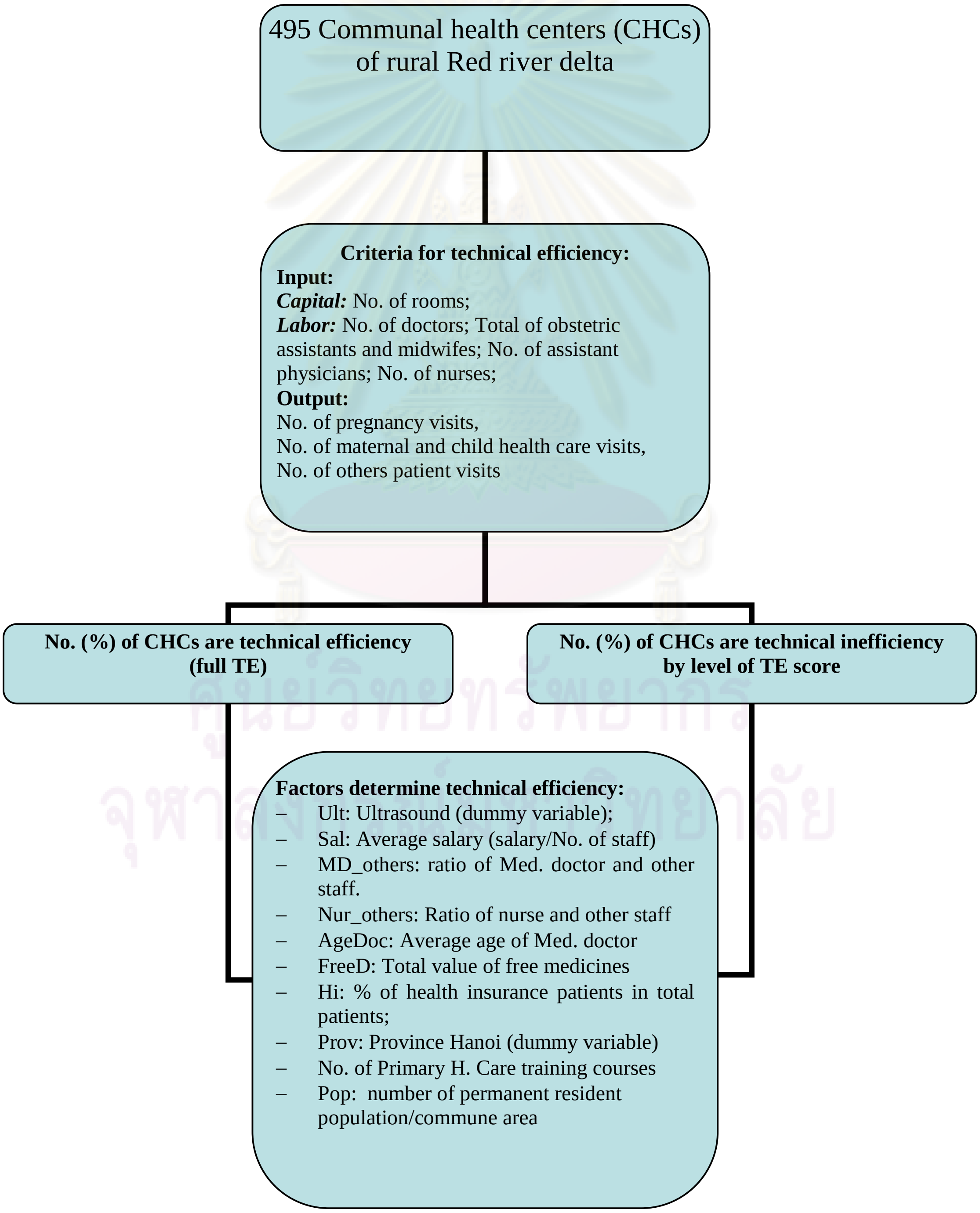
Lastly, budget factors Linna, Nordbladand Koivu (2003) mentioned about Municipality's rating for state subsidies, Percentage of material expenditure to total operating costs. Watchai (2007) also conclusion about universal coverage related with technical efficiency to be negative.

CHAPTER III

RESEARCH METHOD

This chapter describes the research method which includes stages of the study for instance conceptual framework, DEA model and OLS regression. This is one of main sections of the study that decided the possible result as well as possible benefit.

3.1 Conceptual framework:



3.2 Data envelopment analysis method

In this paper I use the data envelopment analysis method to evaluate the technical efficiency of commune health centers. This method was introduced by a lot of previous researchers.

A DMU (in our case, a CHC) is technically efficient (TE) if it operates on its production frontier. There are two types of technical efficiency which are input oriented or output oriented. In Vietnam, commune health center is the lowest level public facility to care the population health. They are very scarcity resources while health care demands are increasing. To evaluate efficiency of them this study using multi output and input in term of output oriented and variable return to scale assumption. It is means that this study interested in maximum number of outpatient visits.

TE score = OA/OB

Technical inefficiency = 1-OA/OB=AB/OB

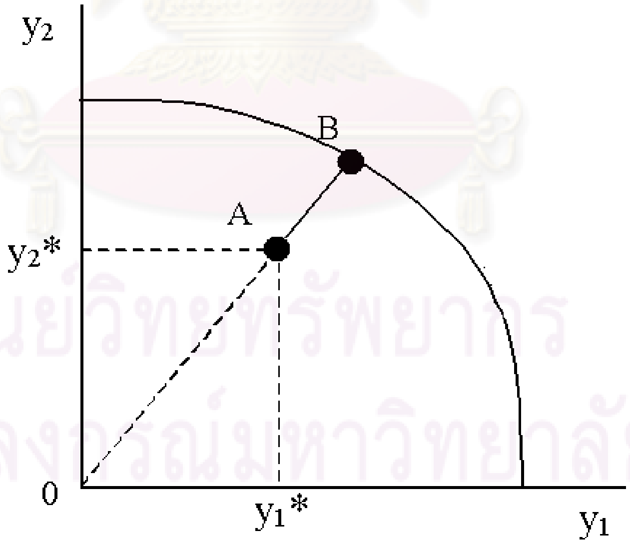


Figure 3 An output-orientation with 2 outputs

According to Herrero and Pascoe (2001) the production possibility frontier for a given set of inputs is illustrated in Figure an output-orientation. If the inputs employed by the firm were used efficiently, the output of the firm, producing at point A, can be expanded radially to point B. In this paper the firm is commune health center. The output oriented measure of technical efficiency ($TE_O(y, x)$), can be given by 0A/0B. This is the measurement of technical efficiency under conditions of constant returns to scale while point B is technically efficient.

This is known as CCR (Charnes, Cooper, Rhodes, 1978) model. Output oriented multiplier model defined by linear programming:

$$\max z = \sum_{r=1}^{n} u_r y_{r0} - u_0$$

Subject to

$$\sum_{r=1}^{n} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} \le 0$$

$$\sum_{i=1}^{m} v_i x_{i0} = 1$$

$u_r, v_i \ge \varepsilon > 0, u_0$ free sign

$x_{ij}, y_{ij} \ge 0 \forall i, r, j$

This simple model is based on constant returns to scale (CRS), implying that the size of a CHC is not related when assessing efficiency. It is likely that the size of the CHC will affect its ability to produce services more efficiently and CRS assumption is not cover all. A variable returns to scale frontier allows best practice level of outputs to inputs to vary with size of CHCs. The scale efficiency can be determined by comparing technical efficiency scores of each CHC under CRS and variable returns to scale. This method assumes constant returns to scale, but there may be diseconomies of scale or economies of scale. If we include variable returns to scale in the model, then there is an additional constraint that the weights should equal to 1. This has the effect of pulling a tighter frontier to envelope the data. The measure of scale efficiency is then derived by the ratio of constant returns to variable returns efficiency scores. If this ratio is less than 1, then the CHC is too small or too large relative to its optimum size. The final scores on technical efficiency indicate how efficient a CHC is relative to best practice.

The output orientation measures TE, SE in the simplest example: single input (x) and single output (y).

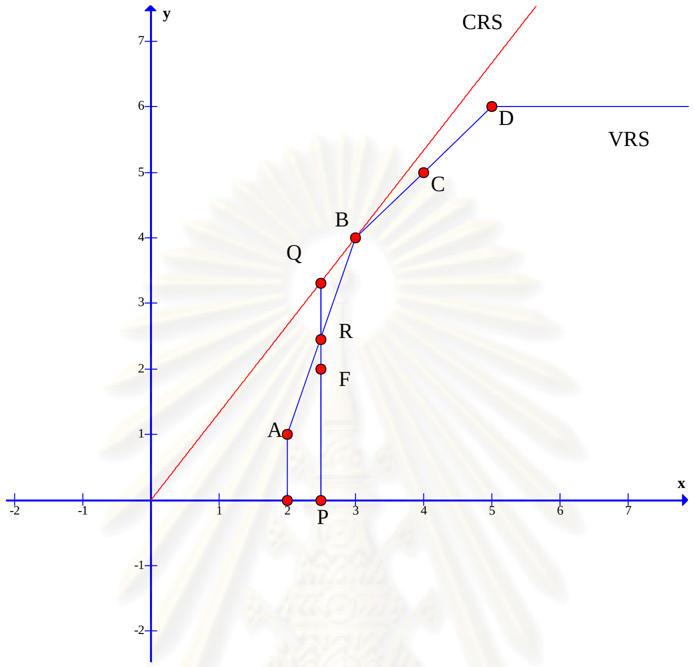


Figure 4 An output-orientation with single input and single output

B is DMU which belongs to both of the boundary frontier CRS and VRS. According to CCR only B is efficiency .

A, C, D are on the boundary frontier VRS and efficiency in accordance with BCC model.

F is inefficiency DMU.

$\mathrm{TE}_{\mathrm{F}}\mathrm{crs} = PF/PQ$

$\mathrm{TE}_{\mathrm{F}}\mathrm{vrs} = PF/PR$

$$\mathrm{SE}_{\mathrm{F}} = PR/PQ = \frac{PR \times PF}{PQ \times PF} = \frac{PF}{PQ} \times \frac{PR}{PF} = \frac{PF}{PQ} \div \frac{PF}{PR} = TE_F crs/TE_F vrs$$

The output-oriented BCC envelopment model for $\mathrm{F}(x_o, y_o)$ is defined in linear programming, where $X=X_P$, $Y=Y_R$:

$Max\,\eta$

Subject to

$$X\lambda \le x_o$$
$$\eta y_o - Y\lambda \le 0$$
$$e\lambda = 1$$
$$\lambda \ge 0$$

The output-oriented BCC multiplier model for $\mathrm{F}(x_o, y_o)$ is defined by linear programming:

Min $\quad z = vx_o - v_o$

Subject to $\quad uy_o = 1$

$$vX - uY - v_o e \ge 0$$

$v \ge 0, u \ge 0, v_o$ free in sign

in which v_o is the scalar associate with eλ=1. This model can be express:

$$Min \frac{vx_o - v_o}{uy_o}$$

Subject to $\quad \frac{vx_j - v_o}{uy_j} \ge 1 (j = 1,...,n)$

$v \ge 0$, $u \ge 0$, v_o free sign

3.3 The DEA output oriented model using here constructed by 5 inputs and 3 outputs

Inputs:

- Number of room is a proxy of capital factor. It indicates the size of CHC.
- Number of doctor; total of obstetric assistants and midwifes; Number of assistant physicians; Number of nurses are proxies of labor factors.

Outputs:

- Number of pregnancy visits;
- Number of maternal and child health care visits;
- Number of others patient visits.

This analysis concerns only some of important proxies and data available. Number of pharmacist and other staff are examples these are not important as five used variables above. Some studies used number of bed is proxy of capital input (Gantugs, 2006) (Kornpob, 2008), but this study uses number of rooms. Because the individual observations are commune health centers which the product are number of outpatient visits. They are different with the hospitals which outputs are both inpatient and outpatient. The proxies of outputs are used in this study these are immediate outputs. Other one is preventive activity what is unavailable data. Obstetric assistants and midwifes do the same common task so they are joined together. The outcome of DEA in variable return to scale are technical efficiency scores and scale efficiency.

3.4 Analysis the factors determine technical efficiency scores

The first part would begin by running the some DEA models and the second part by regression the TE scores against the case mix and patient characteristic variables using an OLS model. If the goodness of fit test is significant, adjust each health care provider outputs by multiplying them by the ratio of the original TE score to the model predicted TE scores

One of the DEA results, TE score that is used as dependent variable to identify the factors affecting on technical efficiency of commune health center. Though, DEA method is made with the assumption of homogenous inputs, outputs and operating characteristics. But they are various respects. To put a health care application into this form, the TE scores can be transformed with the formula:

Technical efficiency score = TE score/(TE score – 1)

Thus, the TE score can become a dependent variable in the OLS model is estimated following form:

$$\begin{aligned}\text{Ln(Technical efficiency score}_i) = {} & \beta_0 + \beta_1 Ult_i + \beta_2 Sal_i + \beta_3 MD\_others_i + \beta_4 Nur\_others \\ & + \beta_5 AgeDoc_i + \beta_6 FreeD_i + \beta_7 Hi_i + \beta_8 Prov_i \\ & + \beta_9 Pri_i + \beta_{10} Pop_i + u_i \\ & i = 1,..,N, \text{ if efficiency score} \neq 0\end{aligned}$$

Ln(Technical efficiency score) = 0 otherwise

Variable	Name	Definition, Unit	Hypothesis
Ult	Ultrasound	Ult = 1 if the commune health centers has at least one usable ultrasound scan, Ult = 0 otherwise	Positive
Sal	Average salary	Total salary divide by number of staffs 1000 Vietnam Dong (VND)	Positive
MD_others	Ratio of medical doctor to other staffs	Number of medical doctors divide by total of other staffs	Positive
Nur_others	Ratio of nurse to other staffs	Number of nurses divide by total of other staffs	Positive
AgeDoc	Average age of medical doctor	a proxy of labor factor (year)	Positive
FreeD	Free of charge medicine	Proportion of value of free medicines in total budget	Positive
Hi	Percentage of public health insurance patients	Number of public health insurance patients multiply by 100 and divide by total visiting patients	Negative
Prov	Hanoi province	Prov = 1 if province is Hanoi; Prov = 0 otherwise	Negative
Pri	Number of primary health care training courses per staffs	Number of primary health care training courses divide by total of staffs	Positive
Pop	Population density	Ratio between number of permanent resident population and commune area (persons/km2).	Positive

The explanatory variables are represented for the factors which are able to determine technical efficiency performance of commune health centers. This model uses above the variables because of some main reasons.

First of all, for Ultrasound factor which represents for the high technology aspect. This factor will directly improve the quality of health services offering for patients. In general, if a health center has ultrasound scan, it attracts more patients than others because of the service quality. Nevertheless, because of limited budget in Vietnamese commune health centers there are few commune health centers which have ultrasound scan. Besides, this variable also one of the factors effecting the cost of capital with deteriorated the technical efficiency score.

Second, about the average salary, it is very clear that an appropriate salary is an incentive for staffs to do better their task. This is as an indirect advantage for the center in terms of attracting patients. Also, high salary indicates that these staffs are able to receive seniority allowance. However, the fact is that in CHCs in Vietnam, salary for health centers' staffs is predetermined by the Government. Therefore, the regression of this paper may show that the average salary variable may not significant affect on the number of patient visits. Moreover, the salary is not only stimulus the visiting patients but also increases the cost and the technical efficiency score.

Third, the ratio of medical doctor to other staffs is a proxy of input factors. This variable related with technical efficiency in term of management performance. This ratio is high that means the doctor can manage better and this commune health center is more efficiency.

Fourth, ratio of nurse to other staffs is a proxy of input factors. If the health centers have more nurses, the patients can get help very conveniently. The doctor will have more time to provide consultations. This means that the technical efficiency score will be improved.

Next, the reason to choose the age of medical doctor as a variable effecting on the number of patient visits since it can effect on patients' choices. The experience of doctors is a factor that directly related to quality of commune health centers' services. In general, the patients set their belief on the experience or enthusiasm of the doctors, therefore, the case that in Vietnam, health centers which have more experienced doctors have more visiting patients. On the other hand, a lot of patients prefer young doctors because these doctors are considered as more adapting high technology level. Therefore in this paper, the results can be support of against the point that the age of doctors can have positive impacts on the number of visiting patients.

Generally, people like a lot health centers which give free of charge medicine. But this variable affects on spending of commune health center to product services. In Vietnam, there are two payment methods it can be paid by cash or by insurance card. Normally, health insurance pays cheaper than out of pocket patients it means they have to provide more services to be efficiency. This variable effecting on both input and output of commune health center because this paper focuses on rural area which may lean towards more output or more efficiency.

Another variable in this model is the percentage of public health insurance patients in total patients. This factor was mentioned a lot in other studies for example in the form of Universal coverage, one type of health insurance in Thailand, in Wathchai's thesis (2007). However the results he shows that the Universal coverage using has a positive impact on the TE score because of limited scope for insurance registers. If insurance patients come to commune health centers are increase, this may decrease the return of those centers. Therefore the result is that the technical efficiency score will be decreased.

On more dummy variable is chosen. This is concerned as an allocation advantage. In Vietnam, there are many central hospitals and other health facilities in Hanoi. It is easy to access with higher professional skill and technology equipments than commune health centers there. They have more competitive advantage in attracting patients. As a result, there will be a decrease in the number of visits to commune health centers. As a result, the numbers of visiting patients in Hanoi CHCs less than other provinces' which may decrease the technical efficiency score. Discussing about the impacts of this dummy variable on the TE score, there was the paper of Minh and Long (2004) which used the dummy variable for locations in Hanoi and Ho Chi Minh.

One of the very important variables is used here is primary health care training courses per staff. This factor refers an education advantage of the commune health centers. It is obvious that the training courses will help staffs have more opportunities and environment to improve their knowledge and speciality. As the results, the quality of services will be improved. That attracts visiting patients as well as directly increases the numbers of cured patients in a period of time. Most of these courses are sponsored by Government’s projects. As a result that technical efficiency score will be ameliorated thanks to these training courses.

The next variable is the ratio between number of permanent resident population and commune area, as a proxy of population density. Population density in this region is highest in Vietnam that is reason of overloading in health system, including the CHCs. It makes the number of visits increases as well as technical efficiency scores.

According to Luu Hoai Chuan, Vu Thi Minh Hanh et al (2003) Doctors coming to work at the commune/ward health centers have made positive changes: improving people's health situation, increasing the indicators of the national health programs and especially increasing the use of technical services at the health centers, increasing the indicator of patient attraction. However, only 49,1% of the doctors are satisfied with the present work, 80% are facing difficulties in life, 70% feel the lack of knowledge, 60% - lack of equipments, 40% - lack of medicine... In order to increase working effectiveness of commune/ward doctors, it is necessary to focus the resource training on local people, apply flexible modes of recruitment and training modes suitable for this group; apply prioritized allowances, reasonable personnel organization at commune/ward health centers, adjust regulations about technical responsibilities of health levels and improve facilities and equipments of the health centers.

As the resulted study of Björn Ekman et al (2008), Vietnam is undertaking health financing reform with a view to achieve universal coverage of health insurance within the coming years. The main lessons from the Vietnamese experiences, from which other reforming countries may draw, are the need for sustained resource mobilization, comprehensive reform involving all functions of the health financing system, and to adopt a long-term view of health insurance reform.

The results of Minh and Long (2004) indicate that the average scale efficiency of the hospitals was 77.4 percent, while that of the medical centers was 58.7 percent. Further, hospitals were clearly more efficient than medical centers due to some possible factors. Locations in Hanoi and Ho Chi Minh city had no influence on either overall technical efficiency or scale efficiency. Despite differences in the results of testing the impact of net capital-labor ratio on efficiency for hospitals and medical centers, these organizations appear to operate in labor-intensive ways.

To measure efficiency and productivity, and to explain the relationships between hospital efficiency and regulatory changes and hospital characteristics, key findings of Pinar and Linh (2008) were an increase in average pure technical efficiency from 70% in 1998 to 80.1% in 2006. The average pure technical efficiency of central hospitals increased from 66.1% in 1998 to 81.8% in 2006; the average pure technical efficiency of provincial hospitals increased by 8.4% over the sample period. The application of user fees not only encourages health service provision but also leads to some additional technical efficiency. Hospitals that provide a lot of health services through the user fees method seem to be more careful not to waste resources because the charges for health services provided are less than the actual costs. However, the provision of health care under the health insurance schemes is inversely associated with hospital efficiency. This may be due to a number of factors: demand levels, insurance payment delays, or undefined insurance policies. The granting of autonomy to public hospitals is correlated with a higher level of hospital efficiency. It appears to have created a more favorable management environment and is likely to have encouraged hospitals to try to make more efficient use of their human resources, to control expenditure more tightly and to provide higher service quality.

The objective study of Daniel O., et al. (2005) based on data collected in 2000, were: (i) to estimate the relative technical efficiency (TE) and scale efficiency (SE) of a sample of public hospitals and health centers in Ghana; and (ii) to demonstrate policy implications for health sector policy-makers. Thus, an input-oriented DEA model was used for hospital analysis and the output-oriented DEA model was used for the health centre analysis. Their results were 47% hospital technically inefficient, with an average TE score of 61%. 59% hospitals were scale inefficient, manifesting an average SE of 81%. Out of the 17 health centers, 3 were technically inefficient, with a mean TE score of 49%. Eight health centers were scale inefficiency with an average SE score of 84%.

The study of Renner et al. (2005) applied the Data Envelopment Analysis approach to investigate the TE and SE among a sample of 37 peripheral health units in Sierra Leone. Twenty-two (59%) of the 37 health units analyzed were found to be technically inefficient, with an average score of 63% and 65% health units were found to be scale inefficient, with an average scale efficiency score of 72%.

Akinci, F. and Campbell, C.R. (1999) estimated the relative technical efficiency of Section 330 federally-funded community health centers (CHCs) and investigated characteristics that influence their estimated technical efficiency, with a particular emphasis on the impact of managed care arrangements. Their study suggests that opportunities exist for improving operational efficiencies of some CHCs included in the sample. Improving the operational efficiencies of the inefficient CHCs is essential if they are to remain financially viable and competitive in a managed care environment. The preliminary findings suggest that capitation, and not discounted fee for service managed care arrangements, is associated with more technically efficient centers. Also the results suggest that health centers that serve a greater number of the uninsured will be less efficient, making them less able to survive. Efficient CHCs identified by the DEA analysis in this study provide examples of best practices. Managers of less efficient centers can benefit by examining the production processes of these more efficient centers. In addition, this study highlights the centers that are likely to need additional technical support under arrangements and continued financial subsidies if they serve a disproportionate share of the uninsured.

3.5 Data source

The population target of this study is 2256 CHCs of Rural Red river delta in Vietnam. The sample size is 495 CHCs of Rural Red river delta. The data of Vietnam Household Living Standard Survey 2006 (VHLSS) what was conducted by General Statistic Office including 2307 CHCs over the whole country. This sample is selected from the master frame designed for Vietnam household living standard surveys in the period 2000-2010 which contains 3,063 communes/wards. The master frame framework was designed in two important steps. First, the stratification was done for urban and rural areas in each province, bringing the total number of strata to 128 over total of 64 provinces. Second, the sampling framework was based on the master list from the 1999 Population and Housing Census. Communes within each stratum were selected with a probability proportional to the square root of its population.

Communes/wards will be selected rotationally, specifically: re-select 50% areas of the 2004 VHLSS (in which haft of the areas was surveyed in the 2002 and 2004 VHLSS and another half was only surveyed in the 2006 VHLSS) and the other 50% areas will be newly selected from the sample frame, which were not selected in the 2002 and 2004 VHLSS

The Department of Social and Environmental Statistics Department is responsible for selecting areas and send list of selected areas to Provincial Statistics Offices for reviewing and updating attached with the map and list of areas of the 1999 Population and Housing Census. Provincial Statistics Offices review and propose to change some areas for more suitability with geographical, socio-economic characteristics of provinces with less than the change of 5% of total number of provinces' areas with an agreement of the GSO (the Department of Social and Environmental Statistics Department) before the survey.

This survey used the Communal health center/ Polyclinic questionaire (Form 2C-PVX/KSMS06). The respondents of the questionaire may be the Chairman or Vice Chairman of the commune, or a health officer. Time period of this paper is 2006.

CHAPTER IV

RESULTS AND DISCUSSIONS

This chapter will present the results and discussions of the data envelopment analysis method to evaluate the technical efficiency of commune health centers and the ordinary least square model to analyze the factors effecting technical efficiency scores. The characteristic data of 495 CHCs in Rural Red river delta from Vietnam Household Living Standard Survey 2006 and the result will be showed as follows.

4.1 General description of data

The Red river delta region includes 11 provinces. Each province has sub-system of health care management which is under of the Ministry of Health and the provincial administrative committee.

Table 2 Number of Commune health center by province

Provincial code	Province	Observed CHC
101	Ha Noi	23
103	Hai Phong	35
104	Vinh Phuc	39
105	Ha Tay	66
106	Bac Ninh	39
107	Hai Duong	54
109	Hung Yen	41
111	Ha Nam	42
113	Nam Dinh	56
115	Thai Binh	64
117	Ninh Binh	36
	Total	495

These commune health centers were located and coded by sample size designed by General Statistics Office.

Descriptive statistics for output and input variables of data envelopment analysis are presented by following table:

Table 3 Descriptive statistics for output and input variables

	Mean	Median	Maximum	Minimum	S.D.
CB10: No. of pregnancy visits	57.78	38.00	1,069.00	2.00	81.03
CB11: No. of maternal and child health care visits	52.46	22.00	847.00	0.00	78.77
CB12: No. of other patient visits	393.24	350.50	2,250.00	0.00	275.21
ROOM: No. of rooms	9.19	9.00	26.00	2.00	3.19
DOC: No. of doctors	0.83	1.00	4.00	0.00	0.66
OBS_MID: Total of obstetric assistants and midwives	1.96	2.00	8.00	0.00	1.30
PHY: No. of assistant physicians	0.77	0.00	10.00	0.00	1.10
NUR: No. of nurses	1.36	1.00	5.00	0.00	0.95

The table 3 showed that the average numbers of pregnancy visits and maternal and child health care visits were relatively equal (57.78 and 52.46 in turn) with standard deviation (S.D.) of 81.03 and 78.77 respectively. The average number of other medical examination visits was about 7 times (393.24) higher than those of pregnancy visits and maternal and child health care visits above mentioned ones with S.D. of 275.21.

The average number of CHC rooms in the Read river delta region was 9.19 with S.D. of 3.19 and rage from 2 rooms to 26 rooms. The average number of doctors and nurses were less than 1 (0.83 and 0.77 in turn) with S.D. of 0.66 and 1.10 respectively. The average number obstetric assistants-midwives and assistant physicians were a little higher.

Table 4 Descriptive Statistics for output variables by province

Province	No. of pregnancy visits			No. of maternal and child health care			No. of others patient visits		
	Mean	Sum.	%	Mean	Sum.	%	Mean	Sum.	%
Ha Noi	90.2	2,074.0	21.0	36.9	848.0	8.6	301.7	6,940.0	70.4
Hai Phong	39.4	1,379.0	9.9	40.2	1,407.0	10.1	329.8	11,213.0	80.1
Vinh Phuc	59.0	2,300.0	8.3	47.1	1,838.0	6.6	622.3	23,648.0	85.1
Ha Tay	49.3	3,256.0	13.4	47.0	3,105.0	12.8	284.2	17,902.0	73.8
Bac Ninh	49.3	1,923.0	8.9	70.6	2,752.0	12.7	434.7	16,952.0	78.4
Hai Duong	44.3	2,390.0	10.5	35.1	1,898.0	8.3	349.9	18,545.0	81.2
Hung Yen	55.2	2,263.0	14.9	47.3	1,941.0	12.8	268.7	11,015.0	72.4
Ha Nam	63.1	2,649.0	12.5	48.5	2,039.0	9.6	392.9	16,503.0	77.9
Nam Dinh	57.9	3,245.0	8.9	68.1	3,815.0	10.5	533.0	29,317.0	80.6
Thai Binh	91.3	5,846.0	16.1	78.2	5,002.0	13.8	398.8	25,520.0	70.2
Ninh Binh	34.8	1,252.0	6.3	39.8	1,433.0	7.2	479.9	17,277.0	86.5
Total	57.7	28,577.0	11.5	52.7	26,078.0	10.5	399.2	194,832.0	78.1

Table 5 Descriptive Statistics for input variables by province

Provincial	Room				Doc				
	Mean	Max	Min.	S.D.	Mean	Max	Min.	Sum.	S.D.
Ha Noi	11.70	19	6	3.18	0.74	1	0	0.45	0.74
Hai Phong	9.11	18	2	3.60	0.89	4	0	0.80	0.89
Vinh Phuc	11.10	26	4	4.90	0.74	3	0	0.68	0.74
Ha Tay	8.74	17	2	3.21	0.80	2	0	0.53	0.80
Bac Ninh	9.18	14	4	2.49	0.97	4	0	0.67	0.97
Hai Duong	8.04	12	4	2.31	0.76	3	0	0.67	0.76
Hung Yen	7.20	15	2	3.30	0.83	2	0	0.63	0.83
Ha Nam	9.12	16	4	3.10	0.69	2	0	0.56	0.69
Nam Dinh	10.56	16	5	2.35	0.93	4	0	0.81	0.93
Thai Binh	9.28	14	4	2.15	0.98	3	0	0.63	0.98
Ninh Binh	8.25	13	5	2.13	0.64	3	0	0.72	0.64
Total	9.19	26	2	3.19	0.83	4	0	0.66	0.83

Provincial	Phy					Nur				
	Mean	Max	Min.	Sum.	S.D.	Mean	Max	Min.	Sum.	S.D.
Ha Noi	1.91	4	0	1.04	1.91	1.09	2	0	0.73	1.09
Hai Phong	1.66	4	0	1.35	1.66	1.66	6	0	1.47	1.66
Vinh Phuc	2.77	8	0	1.77	2.77	1.31	10	0	1.76	1.31
Ha Tay	2.44	5	0	1.36	2.44	0.17	3	0	0.51	0.17
Bac Ninh	1.95	4	0	1.02	1.95	0.10	1	0	0.31	0.10
Hai Duong	1.43	4	0	1.14	1.43	1.06	7	0	1.11	1.06
Hung Yen	1.44	3	0	0.81	1.44	0.90	2	0	0.74	0.90
Ha Nam	2.07	4	0	1.09	2.07	0.67	3	0	0.79	0.67
Nam Dinh	1.41	5	0	1.25	1.41	1.29	6	0	1.25	1.29
Thai Binh	1.84	4	0	1.04	1.84	0.14	1	0	0.35	0.14
Ninh Binh	2.75	5	0	1.36	2.75	0.81	5	0	1.09	0.81
Total	1.95	8	0	1.30	1.95	0.77	10	0	1.10	0.77

Provincial	Obs_mid				
	Mean	Max	Min.	Sum.	S.D.
Ha Noi	1.39	3	0	0.66	1.39
Hai Phong	1.51	4	0	1.09	1.51
Vinh Phuc	1.21	4	0	0.86	1.21
Ha Tay	1.64	5	0	1.24	1.64
Bac Ninh	1.82	5	0	1.02	1.82
Hai Duong	1.57	3	0	0.79	1.57
Hung Yen	1.49	3	0	0.75	1.49
Ha Nam	1.02	3	0	0.72	1.02
Nam Dinh	1.20	4	0	0.96	1.20
Thai Binh	1.17	4	0	0.81	1.17
Ninh Binh	0.92	4	0	0.81	0.92
Total	1.36	5	0	0.95	1.36

By province, it was found that there was difference of input and output among them. For example, in Hanoi, the average numbers of inputs including room, doctor, assistant physician, nurse, obstetric assistants and midwives were 11.70, 0.74, 1.91, 1.09, 1.39 respectively that led to the outputs consisting of average numbers of pregnancy visits, maternal and child health care visits and other medical examination visits as 90.2, 36.9, 301.7, in turn. Meanwhile, in Ninhbinh province, the average numbers of inputs, namely, room, doctor, assistant physician, nurse, obstetric assistants and midwives, were 8.25, 0.64, 2.75, 0.81 and 0.92 that resulted in the average numbers of outputs (see table 4 and 5).

4.2 Technical efficiency from DEA model

Table 6 Descriptive Statistics for CRSTE, VRSTE and SE

	Mean	Median	Max	Min.	S.D.	Observed CHC
CRSTE	0.472	0.416	1.000	0.002	0.277	495
VRSTE	0.518	0.476	1.000	0.002	0.289	495
SE	0.914	0.954	1.000	0.350	0.107	495

A summary of technical efficiency scores is given in the table 6. The result of constant returns to scale, variable returns to scale and scale efficiency in the estimated DEA model indicating the average technical efficiency scores that equal to 47.2%, 51.8% and 91.4% respectively. The results indicate that the level of technical efficiency in health center is rather low. This result may be affected by some reasons, as following,

First, people in the delta region are convenient for access to higher healthcare facilities beyond the commune health center for instance district, provincial and central hospital.

Second, the commune health centers provide fewer curative care services due to competition from private facilities and hospitals.

Third, the commune health centers have limited resources, for instance lack of human resource, finance resource, equipment and accommodations.

Last, the estimated results from DEA were sensitive to the sample size that the average of efficiency score was not high when the sample size was large.

The average scale efficiencies of commune health centers are 0.9138 (or 91.38%). This means that, on average, these commune health centers might have needed only 91.38% of the current inputs to get the current outputs (in 2006). In other words, their average operation inefficiency was 8.62% on that year.

Table 7 Tabulation of return to scale

Value	Count	Percent
CRS (constant return to scale)	95	19.19
DRS (decreasing return to scale)	253	51.11
IRS (increasing return to scale)	147	29.70
Total	495	100.00

The table 7 indicated a half of CHCs in Read river delta that were decreasing return to scale. There are only 95 CRS out of 495 CHCs. About one-third of them are increasing return to scale. A well-founded result to suggest that reduce resources of CHCs which had DRS towards those facing IRS would give up efficiency.

Table 8 shows scores of constant return to scale technical efficiency (CRSTE), variable return to scale technical efficiency (VRSTE) and scale efficiency (SE) by interval.

Table 8 Description for CRSTE, VRSTE and SE by interval of score

Score	CRSTE		VRSTE		SE	
	Observed CHC	%	Observed CHC	%	Observed CHC	%
[0, 0.2)	71	14.3	63	12.7	0	0.0
[0.2, 0.4)	169	34.1	152	30.7	3	0.6
[0.4, 0.6)	122	24.7	113	22.8	7	1.4
[0.6, 0.8)	49	9.9	64	12.9	59	11.9
[0.8, 1)	28	5.7	22	4.4	345	69.7
[1]	56	11.3	81	16.4	81	16.4

From the above results, we see that only 56 CHCs (11.31 %) out of total 495 CHCs are constant return to scale technical efficiency units that were located on the frontier. There is 5.66 % of inefficiency CHCs which have CRSTE scores more than 80%. And the number of CHCs which have scores less than 60% is 73.13%. However, VRSTE was realized a little higher rate (16.4%) compared to CRSTE (11.3%),

In addition, 147 out of 495 (29.70%) commune health centers of the studied showed that they were operating under increasing returns to scale (IRS), meaning that they could have improved their efficiency levels if they had increased inputs. Conversely, 253 out of 495 (51.11%) commune health centers were shown to be operating under decreasing returns to scale (DRS), meaning that these commune health centers should reduce inputs to achieve better efficiency. The remaining commune health centers were operating under constant returns to scale (CRS), so they did not need to change inputs because doing so would not yield any increase in efficiency scores (see appendix).

More detail was presented in the following tables (9 to 11):

Table 9 Descriptive Statistics for CRSTE by province

Province	Mean	Median	Max	Min.	S.D.	Observed CHC
Ha Noi	0.324	0.307	1	0.041	0.213	23
Hai Phong	0.436	0.313	1	0.075	0.295	35
Vinh Phuc	0.535	0.512	1	0.133	0.228	39
Ha Tay	0.374	0.300	1	0.002	0.278	66
Bac Ninh	0.423	0.375	1	0.071	0.232	39
Hai Duong	0.386	0.319	1	0.020	0.232	54
Hung Yen	0.428	0.328	1	0.091	0.281	41
Ha Nam	0.508	0.460	1	0.047	0.263	42
Nam Dinh	0.600	0.568	1	0.081	0.279	56
Thai Binh	0.559	0.492	1	0.072	0.295	64
Ninh Binh	0.549	0.473	1	0.128	0.273	36
Total	0.472	0.416	1	0.002	0.277	495

From the table 9, with constant return to scale assumption, we can see that CHCs in Hanoi province have the lowest technical efficiency scores (0.32) in Red river delta region . Contrarily, Namdinh province is the best one (0.6).

Table 10 Descriptive Statistics for VRSTE

Province	Mean	Median	Max	Min.	S.D.	Observed CHC
Ha Noi	0.355	0.322	1	0.048	0.221	23
Hai Phong	0.492	0.350	1	0.087	0.312	35
Vinh Phuc	0.617	0.606	1	0.133	0.247	39
Ha Tay	0.400	0.329	1	0.002	0.278	66
Bac Ninh	0.456	0.407	1	0.075	0.248	39
Hai Duong	0.428	0.351	1	0.030	0.247	54
Hung Yen	0.481	0.378	1	0.104	0.315	41
Ha Nam	0.570	0.497	1	0.057	0.292	42
Nam Dinh	0.643	0.636	1	0.084	0.270	56
Thai Binh	0.601	0.542	1	0.089	0.300	64
Ninh Binh	0.593	0.529	1	0.129	0.279	36
Total	0.518	0.476	1	0.002	0.289	495

Similarly to table 9, technical efficiency scores of Hanoi and Namdinh were 0.35 and 0.64 that resulted in the variable return to scale assumption. All of the provinces had the higher VRSTE scores than the CRSTE scores. These obtained results demonstrated the assertion that, on average, Namdinh province usually has better conditions than other provinces in terms of size, technology, and number of professional staff (see table 9 and 10).

Table 11 Descriptive Statistics for SCALE

Province	Mean	Median	Max	Min.	S.D.	Observed CHC
Ha Noi	0.910	0.901	1	0.715	0.075	23
Hai Phong	0.895	0.940	1	0.367	0.132	35
Vinh Phuc	0.871	0.898	1	0.654	0.109	39
Ha Tay	0.925	0.962	1	0.640	0.094	66
Bac Ninh	0.935	0.973	1	0.680	0.087	39
Hai Duong	0.908	0.951	1	0.532	0.110	54
Hung Yen	0.906	0.953	1	0.350	0.121	41
Ha Nam	0.903	0.960	1	0.575	0.119	42
Nam Dinh	0.920	0.945	1	0.681	0.089	56
Thai Binh	0.931	0.974	1	0.369	0.116	64
Ninh Binh	0.927	0.960	1	0.400	0.111	36
Total	0.914	0.954	1	0.350	0.107	495

Differently from over all technical efficiency (CRSTE) and pure technical efficiency (VRSTE), most of provinces in Red river delta have scale efficiency scores around 0.9. This mean that this means that, on average, they have needed about 90% of the current inputs to get the current outputs.

4.3 OLS regression

Table 12 Summary of dependent and independent variables

	Mean	Maximum	Minimum	S.D.
LNCRSTE: ln(CRSTE/(1-CRSTE))	-0.386	5.293	-6.213	1.153
LNVRSTE: ln(VRSTE/(1-VRSTE))	-0.307	3.999	-6.213	1.053
ULT: Ultrasound	0.055	1.000	0.000	0.227
SAL: Average salary	10,087.0	68,796.2	1,200.0	4,292.6
MD_OTHERS: Ratio of medical doctors to other staffs	0.220	2.000	0.000	0.242
NURSE_OTHERS: Ratio of nurses to other staffs	0.159	1.000	0.000	0.198
AGEDOC: Average age of medical doctor	28.314	63.000	27.000	18.788
FREED: Free of charge medicine	0.147	0.590	0.000	0.119
HI: Percentage of health insurance patients	40.182	100.000	0.000	32.826
PROV: Hanoi province	0.046	1.000	0.000	0.211
POP: Population density	1226.029	4,925.9	8.6	554.943
PRI: Primary health care training courses per staff	1.974	5.000	0.500	0.585

Table 12 summarizes statistical information of all the mentioned variables in the model. A wide gap can be seen between the observations in terms of all indicators. For example, the average salary varied between 1200 and 68,796, and Average age of medical doctor ranged from 27 to 63.

A detailed decomposition of the data for commune health centers in appendix also shows that Hanoi and Hatay are the least efficiency provinces in opposition that Vinh Phuc was the best one.

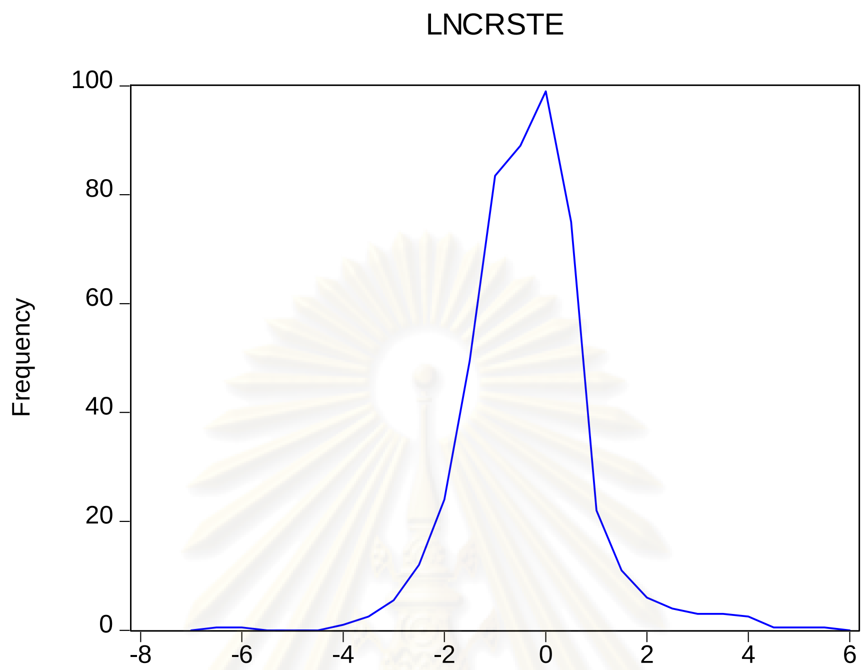


Figure 5 Distribution of CRS technical efficiency scores in log from

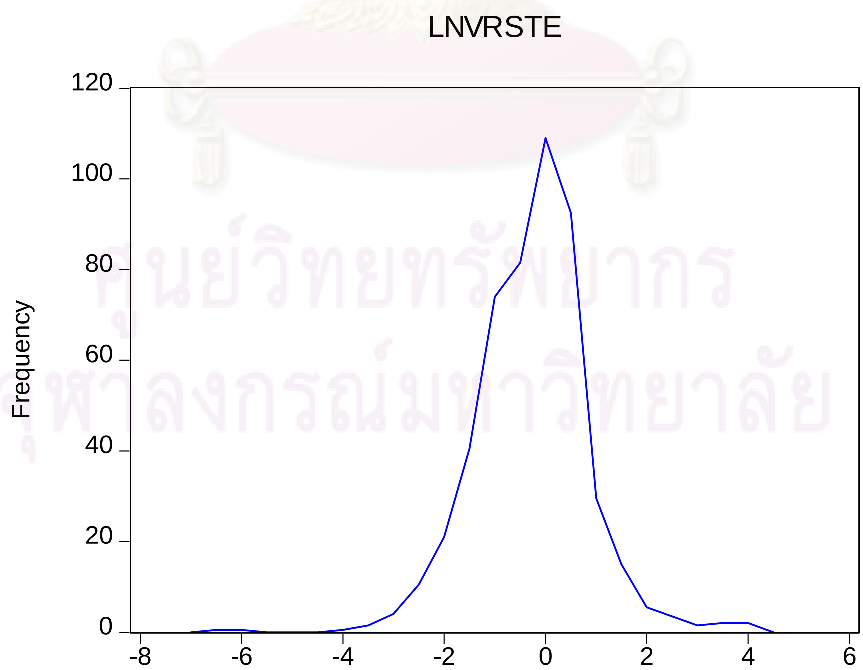


Figure 6 Distribution of VRS technical efficiency scores in log from

Table 13 OLS regression result

	Model I	Model II
Dependent variable	ln(CRSTE/(1-CRSTE))	ln(VRSTE/(1-VRSTE))
Independent variables:		
C	-0.684496	-0.429735
	-2.67*	-1.74
ULT: Ultrasound	-0.203508	-0.242400
	-0.77	-1.02
MD_OTHERS: Ratio of medical doctors to other staffs	-0.130917	-0.126089
	-0.45	-0.51
NURSE_OTHERS: Ratio of nurses to other staffs	0.131340	0.179333
	0.50	0.82
AGEDOC: Average age of medical doctor	-0.003960	-0.005365
	-1.13	-1.66
PRI: Primary health care training courses per staff	-0.081059	-0.095430
	-0.90	-1.05
SAL: Average salary	0.000041	0.000031
	2.88*	3.12*
FREED: Free of charge medicine	1.686336	1.775833
	4.06*	4.45*
HI: Percentage of health insurance patients	0.002727	0.000958
	1.73	0.64
PROV: Hanoi province	-0.520322	-0.387283
	-2.15*	-1.65
POP: Population density	0.095994	0.095830
	0.00	0.00
R-squared	0.10	0.10
F-statistic	5.14	5.13

As above result of multiple regressions, the explanatory variables are represented for the factors which determine technical efficiency performance of commune health centers. In this model, it was found that some of the variables effecting on technical efficiency scores.

From the hypothesis, the Ultrasound factor which represents for the high technology aspect was expected to have a positive relationship with efficiency score. However, the OLS result led to a decrease in the technical efficiency score and is insignificant.

Next group is human resource that included ratio of medical doctors to other staffs, ratio of nurses to other staffs, average age of medical doctor variables. For the ratio of medical doctors and other staffs we see that it has negative relationship with efficiency score which contrasts with the beginning expectation. However, the result of these variables is insignificant for both of models.

Ratio of nurse and other staff which is a proxy of labor factors was expected to have a positive relationship with efficiency score. As a result, the health centers have more nurse, the patients can get help very conveniently. The doctor will have more time to provide consultations. This means that the technical efficiency score will be improved. But this variable is insignificant.

Average age of medical doctors, is expected to have a positive relationship with efficiency score. But they are not expected, the patients set their belief on the experience or enthusiasm of the doctors, therefore, average age of medical doctor is insignificant at level of 95%.

Another group is incentive partial. The variable of primary health care training courses per staff was expected to have a positive relationship with efficiency score. For this result, it is insignificant.

In this group, it seems that the average salary is very important for explanation the technical efficiency scores of CHCs in Vietnam. This variable has the same side as expectation which means that the salary is an incentive for staffs to do better their task. Average salary is significant in both of model I and II at level of 95%.

As expected, the ratio of value of free medicines and total budget is positive associated with efficiency score. It means that people prefer the health centers which give free medicine. The result showed that the model I and II is the same expectation. In this study, free of charge medicine is the unique variable that was significant in both of the models.

The last group is socio factors which included percentage of health insurance patients, Hanoi province and population density variables. The percentage of health insurance patients in total patients which was expected to have a negative relationship with efficiency score. However, the result shows that the health insurance has a positive impact on the efficiency score. We can see that the number of visiting patients increases when they have health insurance because they want to make the best of their health insurance. In other words, health insurance is a positive factor to make CHC operations more efficiency. This variable is also insignificant.

As expected, the dummy variable Hanoi province has a negative relationship with efficiency score in the model I. In Vietnam, there are many central hospitals and other health facilities in Hanoi. People are easy to access with higher professional skill and technology equipments than commune health centers there. As a result, this variable decreases the technical efficiency score. And the result from the estimating equation is very good at explaining this situation.

The result also indicates that population density has a negative relationship with efficiency score. This is unexpected result but it also demonstrates this variable is not important in the determining the efficiency score of CHCs because there are possibly other factors like big hospital, high level of health facilities concentration which compete in attracting the patients. This variable is not significant at level of 95%.

From the result, it is very clear to see that the value of R-squared is quite low (0.1), but such low value are typically observed in cross-section data with a large number of observations. However, this low R-squared value is statistically significant because the F statistic is very high which shows the very low probability of the F-statistic less than 0.05.

Firstly, I check whether the data is heteroskedasticity or not by using White test, the result showed that the Obs*R-squared has Prob. Chi- Square (63) is higher than 0.05; therefore, the null hypothesis that the variance of the disturbance term is not Heteroskedasticity is accepted. In other words, there is no Heteroskedasticity problem in the model (see appendix).

Next, I checked the data, existed the autocorrelation problem or not by using the covariance analysis (the result is in appendix). The variables are not correlated because all of the values of correlation in this table are less than 0.8.

Average salary and free of charge medicine variables are statistically significant and different from 0 for CRSTE OR VRSTE. This means that these variables had an impact on the overall technical efficiency or pure technical efficiency of the studied commune health centers. In other words, these commune health centers might be operating in incentive labors and patients, and thus investments in human would be better than physical expansion for improving their efficiency performance. Similarly, the coefficient of Hanoi province variable is statistically significant, so locations of the commune health centers in Hanoi have impacts on the overall technical efficiency (CRSTE). Percentage of health insurance patients, average age of medical doctors are insignificant at level 95% but they can be the explained variables at lower level that health insurance has a positive impact on the efficiency score and average age of doctors has a negative impact on the efficiency score.

In the above estimated table are not all independent variables are statistically significant, this can be explained that some variables like ultrasound, ratio of medical doctors to other staffs, the ratio of nurses to other staffs are not very important in explaining the technical inefficiency score of the commune health centers.

CHAPTER V
CONCLUSION AND RECOMMENDATION

Based on the results and discussions, it is possible to give a number of main conclusions and suggest a number of recommendations. Regarding recommendations, for strengthening technical efficiency of CHCs and ensuring community benefits as well, it is necessary to think about both short-term and long-term strategies.

5.1 Conclusion

This study aims to measure the technical efficiency of commune health centers in rural Red river delta region with target population of 2,256 CHCs. 495 CHCs of the 11 provinces were enrolled for observing and exploring in 2006 by GSO. Questionnaires were used to interview respondents for required information. DEA method was used to analyze technical efficiency and OLS regression was applied to determine inefficiency score.

DEA results showed the average constant return to scale technical efficiency score was 0.472 with S.D. of 0.277, the average variable return to scale technical efficiency score was 0.518 with S.D. of 0.289 and the average scale efficiency score was 0.914 with S.D. of 0.107. The results indicate that the level of technical efficiency in health center is rather low. The provinces with better health system at higher levels had lower technical efficiency of CHCs than others (Hanoi and Hatay). Out of 495 CHCs, more than one-tenth (11.3%) gained constant return to scale technical efficiency, about one-sixth (16.4%) achieved variable return to scale technical efficiency and scale efficiency. Besides, the number of inefficiency CHCs that were nearly gained constant return to scale technical efficiency and variable return to scale technical efficiency and scale efficiency (between 0.6 and 1.0) accounted for about one-sixth of all CHCs while the number of inefficiency ones that were nearly gained scale efficiency (between 0.6 and 1.0) accounted for more than the majority (81.6%).

There were insignificant associations between human resources, health insurance, population density, primary training courses, high-tech machine (ultrasound) and efficiency scores. Meanwhile, it was found significant associations between free of charge drugs, staff salary and technical scores in both of model I and model II. Variable of location (Hanoi) was significant for model I (Table 13). However, it is impossible to ignore the aspect of human resource in relation to efficiency score of CHCs and reinforcing this needed to pay proper attention by policy makers.

5.2. Recommendation

Arisen from the findings of the study, a number of activities should be conducted as follows:

5.2.1. For CHC implementation:

1. It is necessary to use resources related to manpower and equipment effectively.
2. Community awareness should be improved so that they understand the necessity of primary health care at primary level and increase frequency of CHC visits.

5.2.2. For policy:

1. It is essential to develop short-term and long-term orientation for CHCs, carry out the specific and clear decentralization of health system.
2. The prioritized policy needed to expand is to provide community with free of charge drugs at CHCs so as to encourage them to visit CHCs for medical examination and treatment.
3. The health insurance policy should be popularized at commune level with convenient payment mechanism.
4. In order to motivate CHC staffs, it is necessary the Ministry of Health should work with Ministry of Labor, Invalid and Social Affair to reach better compensation for health staffs at commune level.

Depending on the results of OLS model to estimate the cost and the change of technical efficiency with the best explanatory variable are presented in the following table.

Table 14 Priority evaluation for further activities:

			Model I	Model II
		Total cost	% changed LNCRSTE	% changed LNVRSTE
SAL increase	Cost per staff			
5%	504.35	1354684.70	0.00021	0.000156
10%	1008.70	2709369.39	0.00042	0.000313
FREED increase	Cost per CHC			
5%	764.67	378511.15	12.89489	13.579244
10%	1529.34	757022.30	25.78978	27.15849

If average salary increases 5% LNCRSTE, LNVRSTE will increase 0.00021%, 0.000156% in turn. Similarly, if budget for free medicine increases 5% LNCRSTE, LNVRSTE will increase 12.89%, 13.58% respectively. The result showed that increasing budget for free-of-charge drugs would bring more effective than increasing staff salary, which means that improving community access and awareness is more essential in the facing period. However, ensuring health staff's benefit also need paying attention for ensuring sustainable development of health system.

Actually, free of charge medicine and average salary does not only effect on technical efficiency but also relate with allocative efficiency. Nevertheless, in this study they are focused on respects of technical efficiency. Analyzing these factors indicated that the results are appropriate to recent health economic policy, for instance the Prime Minister enacted Decision 276 (2005) regulating compensation for commune staff providing health care services directly to patients, the Prime Minister promulgated Decision 182/2004/QD-TTg on calculation of working time for commune health workers to receive social insurance. In 2004, Decree 204/2004/ND-CP adjusted the salary system for government employees. In 2001, Decision 97/2001/QD-TTg supplemented the compensation regulations for staff in the health sector. In 2003, Decision 155/2003/QD-TTg modified and supplemented certain compensation regulations for work in the health sector. Regarding the recurrent budget of the commune health centers, 80% of communes receive some funds from the commune budget and 72% collect user fees. The recent policy of using part of the health insurance fund or the Health Care Fund for the Poor to pay for services at the commune level has led to positive changes in operating budgets of commune health centers.

In economic point of view, the investment in free-of-charge drugs in national health programs control HIV, TB, leprosy, etc that effect technical efficiency of CHC in an indirect manner and additional result. It does not mean spend more for technical efficiency. It means that invests in preventive activities will be more efficiency in curative outputs. Average salary effect the technical efficiency to encourage health workers to increase labor productivity. In long run, if the salary policy is not appropriate CHCs will face short of human resource. They are in competition with private health clinics for efficiency activities.

These conclusion and recommendation are made from the results of this study. The following table indicates that.

Table 15 Summary of conclusions and recommendations

Conclusion	Recommendation	Variable	Coefficient
The level of technical efficiency in health center is rather low	It is necessary to use resources related to manpower and equipment effectively	ROOM: No. of rooms DOC: No. of doctors OBS_MID: Total of obstetric assistants and midwives PHY: No. of assistant physicians NUR: No. of nurses	Input variables of DEA model (-)

Conclusion	Recommendation	Variable	Coefficient
Finding significant associations between free-in-charge drugs and technical efficiency score	The prioritized policy needed to expand is to provide community with free-of-charge drugs at CHCs so as to encourage them to visit CHCs for medical examination and treatment.	FREED: Ratio of free medicines and total budget	1.675949 (model I) 1.775026 (model II)
Finding significant associations between average of salary and technical efficiency score	In order to motivate CHC staffs, it is necessary the Ministry of Health should work with Ministry of Labor, Invalid and Social Affair to reach better compensation for health staffs at the commune level.	SAL: Average salary	0.000041 (model I) 0.000031 (model II)
The associations between percentage of health insurance patients and CRSTE score	The health insurance policy should be popularized at commune level with convenient payment mechanism.	HI: Percentage of health insurance patients	0.002702 (model I) 0.000967 (model II)

Conclusion	Recommendation	Variable	Coefficient
The associations between Average age of medical doctor and VRSTE score	Sending young medical doctors to commune level	AGEDOC: Average age of medical doctor	-0.005365 (model II)
The provinces with better health system at higher levels had lower technical efficiency of CHCs than others	Community awareness should be improved so that they understand the necessity of primary health care at primary level and increase frequency of CHC visits It is essential to develop short-term and long-term orientation for CHCs, carry out the specific and clear decentralization of health system	PROV: Hanoi province	-0.515213 (model I) -0.390068 (model II)

5.3 Limitation

This study could not avoid some limitations because all the observations in the sample were from the public sector and this paper could not measure the technical efficiency of CHCs in preventive activities as a result. Some other limitations of this paper were derived from the approach itself. First, DEA did not take multi stages, so the option in measuring efficiency scores was two stages only. Second, the estimated results from DEA were sensitive to the sample size that the average of efficiency score was not high when the sample size was large.

This study was used quantitative method that led to limitations for exploring the CHC health staff's aspiration and thinking; therefore, for the further studies in this study area, it is necessary to supplement qualitative study for target groups and expand respondents that should be not only CHC staff but also policy makers and people.

REFERENCES

Akinci, F. and Campbell, C.R. (1999). **Technical efficiency in federally-funded community health center (CHCs): the role of managed care**. King's College, The William G. McGowan School of Business, Wilkes-Barre, PA 18711, USA.

Banker, R., Charnes, A. and Cooper, William.W. (1984). Some models for estimating technical and scale inefficiencies in data envelopment analysis. **Management Science** 30: 1078-109.

Björn Ekman, Nguyen Thanh Liem, Ha Anh Duc and Henrik Axelson. (2008). **Health insurance reform in Vietnam: a review of recent developments and future challenges.** Published by Oxford University Press in association with The London School of Hygiene and Tropical Medicine

Charnes, A., Cooper,W.,W. and Rhodes, E. (1978). Measuring the efficiency of decision-making units. **European Journal of Operations Research** 3: 429-444.

Charnes, A., Cooper, W.W., Lewin, A.Y. and Seiford, L.M. (1994). **Data Envelopment Analysis: Theory, Methodology and Applications**. Kluwer academic publishers New york, Boston, Dordrecht, London, Mosco.

Chilingerian, J. A. (1995). Evaluating physician efficiency in hospitals: A multivariate analysis of best practices. **European Journal of Operational Research** 80: 548-574.

Chua,C. L. , Palangkaraya, A. and Yong, J. (2009). Hospital Competition, Technical Efficiency, and Quality. Melbourne Institute of Applied Economic and Social Research, The University of Melbourne, **Melbourne Institute Working Paper** No. 16/09

Chuan, L. H., Hanh, V. T. M. et al. (2003). **Evaluating working effectiveness of commune/ward doctors at some localities.** Department of science and training – Vietnam Ministry of Health

Cooper, W.,W., Lawrence, Seiford, M., Zhu, Joe. (2004). **Handbook on data envelopment analysis**. University of Texas at Austin, University of Michigan at Ann Arbor, Worcester Polytechnic Institute, U.S.A..

Cooper, W., W. , Seiford, Lawrence, M. and Tone, Kaoru. (2002). **Data Envelopment Analysis: A Comprehensive Text with Models, Applications, References and DEA-Solver Software**. University of Texas at Austin, University of Massachusetts at Amherst and National Science Foundation, U.S.A. National Graduate Institute for Policy Studies, Japan.

Daniel O. et al. (2005). **Technical efficiency of public district hospitals and health centres in Ghana: a pilot study**. BioMed Central Ltd, 2005, Ghana

Førqsund, Finn, R., Lovell, Knox, C.A. and Schmidt, Peter. (1980). **A survey of frontier production functions and of their relationship to efficiency measurement.** University of Oslo - Norway, University of North Curolina - USA, Michigan State University – U.S.A..

Farrell, M. J. (1957). The measurement of productive efficiency, **Journal of the Royal Statistical Society**, 120, 252-90.

Gantugs, Yundendorj. (2006). **Technical and scale efficiencies of province and district level hospital in Mogolia**. Economics Faculty, Chulalongkorn University.

Group authors. (2006). **Result of the survey on household living standards 2006**. Vietnam General Statistics Office.

Group authors. (2006). **Vietnam Health Report 2006**. Vietnam Ministry of Health.

Group authors. (2006). **Vietnam Health Statistic Yearbook 2006**. Vietnam Ministry of Health.

Gujarati, Damodar, N. and Porter, Dawn, C. (2009). **Basic Econometrics**. United State Military Academy, West Point, University of Southern California, USA.

Herrero, I. and Pascoe, Sean. (2001). **Estimation of technical efficiency: a review of some of the stochastic frontier and DEA software.**University of Huelva and University of Portsmouth, UK.

Hollingsworth, Bruce, Dawson, P.J. and Maniadakis, N. (1998). Efficiency measurement of health care: a review of non-parametric methods and applications. University of Newcastle upon Tyne,UK, **Health Care Management Science** 2 (1999) 161–172 161

Kornpob, Bhirombhakdi. (2008). **Technical efficiency of university hospitals in Thailand**. Economics Faculty, Chulalongkorn University.

Linna, Miika , Nordblad, Anne and Koivu, Matti. (2003) Technical and cost efficiency of oral health care provision in Finnish health centres. National Research and Development Centre for Welfare and Health, Siltasaarenkatu Helsinki School of Economics, Finland. **Social Science and Medicine** 56 (2003): 343–353

Maddala, G.S. 1983. **Limited dependent and qualitative variables in econometrics**. Cambridge University Press, New York.

Minh, Nguyen, Khac and Long, Giang, Thanh (2004). **Efficiency Performance of Hospitals and Medical Centers in Vietnam** [Online]. National Economics University, Hanoi, Available from: http://mpra.ub.uni-muenchen.de/1533/ MPRA Paper [19/03/2010, 22:31:14]

Pinar, G.U. and Linh, P.T. (2008). **Effects of Changes in Public Policy on Efficiency and Productivity of General Hospitals in Vietnam**. University of East Anglia, UK

Renner et al. (2005). **Technical efficiency of peripheral health units in Pujehun district of Sierra Leone: a DEA application**. BioMed Central Ltd

Sherman, David, H. (1984). Hospital Efficiency Measurement and Evaluation: Empirical Test of a New Technique Source. **Medical Care**: 922-938. Vol. 22, No. 10 (Oct., 1984)

Watchai, Charunwatthana. (2007). **Meansuring hospital efficiency of public hospitals under office of permanent secretary of MoPH in Thailand: A data envelopment analysis approach**. Economics Faculty, Chulalongkorn University.

Watcharasriroj, Budsakorn and Tang, John C. S. (2004). The effects of size and information technology on hospital efficiency. **The Journal of High Technology Management Research** Volume 15, Issue 1 (February 2004): 1-16

APPENDIX

Output orientated DEA

Scale assumption: VRS

Two-stage DEA method

EFFICIENCY SUMMARY:

firm	crste	vrste	scale	
1	0.318	0.331	0.961	drs
2	0.445	0.545	0.817	drs
3	0.544	0.607	0.896	drs
4	0.441	0.475	0.927	drs
5	0.142	0.167	0.849	irs
6	0.508	0.580	0.877	drs
7	0.312	0.314	0.994	drs
8	0.242	0.248	0.974	drs
9	0.158	0.176	0.901	drs
10	0.162	0.163	0.995	drs
11	0.308	0.391	0.786	drs
12	1.000	1.000	1.000	-
13	0.506	0.574	0.882	drs
14	0.307	0.317	0.968	drs
15	0.230	0.322	0.715	drs
16	0.299	0.346	0.863	drs
17	0.108	0.114	0.953	drs
18	0.140	0.141	0.988	drs
19	0.492	0.502	0.979	drs
20	0.069	0.077	0.900	drs
21	0.208	0.239	0.870	drs
22	0.041	0.048	0.860	drs
23	0.474	0.485	0.977	drs
24	1.000	1.000	1.000	-
25	0.222	0.251	0.885	drs
26	0.109	0.111	0.987	drs
27	0.283	0.294	0.963	drs
28	0.319	0.340	0.940	drs
29	0.224	0.299	0.748	drs
30	0.206	0.209	0.988	irs
31	0.431	0.567	0.760	drs
32	0.178	0.197	0.904	drs
33	0.259	0.267	0.967	irs
34	0.313	0.315	0.994	drs
35	0.544	0.559	0.972	drs
36	0.273	0.350	0.779	drs
37	1.000	1.000	1.000	-
38	0.488	0.573	0.852	drs
39	0.163	0.167	0.976	drs
40	0.221	0.235	0.938	irs
41	0.503	0.532	0.945	irs
42	1.000	1.000	1.000	-
43	0.869	0.972	0.894	irs
44	1.000	1.000	1.000	-
45	0.563	0.575	0.978	drs
46	0.367	1.000	0.367	irs
47	0.471	0.557	0.846	drs
48	0.188	0.210	0.897	drs
49	0.853	0.927	0.920	irs
50	0.560	0.734	0.763	drs
51	0.288	0.360	0.801	drs
52	0.307	0.316	0.972	drs
53	0.323	0.328	0.986	irs
54	0.302	0.508	0.594	drs
55	0.181	0.186	0.972	irs
56	1.000	1.000	1.000	-
57	0.075	0.087	0.867	drs
58	0.168	0.192	0.877	drs
59	0.456	0.553	0.825	drs
60	0.615	0.681	0.902	irs
61	0.531	0.544	0.978	drs
62	0.558	0.606	0.921	irs
63	0.635	0.640	0.993	irs
64	1.000	1.000	1.000	-
65	0.425	0.439	0.970	drs
66	0.587	0.648	0.906	irs
67	0.350	0.476	0.735	drs
68	0.273	0.305	0.896	drs
69	0.633	0.790	0.802	drs
70	0.310	0.334	0.927	drs
71	0.885	0.890	0.995	irs
72	1.000	1.000	1.000	-
73	0.465	0.510	0.912	drs
74	0.840	1.000	0.840	drs
75	0.408	0.525	0.777	drs
76	0.425	0.473	0.898	irs
77	0.456	0.534	0.855	drs
78	0.512	0.514	0.996	irs

79	0.613	0.614	0.999	-
80	1.000	1.000	1.000	-
81	0.798	1.000	0.798	drs
82	0.810	1.000	0.810	drs
83	0.636	0.971	0.654	drs
84	0.769	0.879	0.875	drs
85	0.668	0.726	0.920	drs
86	0.436	0.640	0.682	drs
87	0.283	0.338	0.836	drs
88	0.133	0.133	0.999	-
89	0.546	0.595	0.918	drs
90	0.418	0.493	0.847	drs
91	0.157	0.225	0.701	drs
92	0.411	0.608	0.676	drs
93	0.462	0.674	0.686	drs
94	0.184	0.190	0.972	irs
95	0.277	0.280	0.988	irs
96	0.564	0.751	0.751	drs
97	0.353	0.484	0.728	drs
98	0.002	0.002	1.000	-
99	0.057	0.075	0.757	drs
100	0.266	0.293	0.908	irs
101	0.117	0.129	0.907	irs
102	0.277	0.277	1.000	-
103	1.000	1.000	1.000	-
104	0.022	0.022	0.994	-
105	0.524	0.524	1.000	-
106	0.307	0.307	1.000	-
107	0.326	0.330	0.988	irs
108	0.345	0.365	0.946	drs
109	0.373	0.583	0.640	irs
110	0.381	0.389	0.978	irs
111	0.306	0.321	0.955	drs
112	1.000	1.000	1.000	-
113	0.576	0.738	0.780	drs
114	0.263	0.280	0.937	drs
115	0.309	0.327	0.944	irs
116	0.328	0.332	0.986	drs
117	0.115	0.124	0.929	drs
118	0.268	0.331	0.809	irs
119	0.051	0.053	0.965	drs
120	0.262	0.280	0.936	irs
121	0.205	0.218	0.942	drs
122	0.440	0.480	0.917	drs
123	0.671	0.730	0.919	irs
124	0.545	0.564	0.965	drs
125	0.344	0.446	0.772	irs
126	1.000	1.000	1.000	-
127	1.000	1.000	1.000	-
128	0.249	0.250	0.996	irs
129	0.122	0.123	0.991	drs
130	0.465	0.470	0.989	drs
131	1.000	1.000	1.000	-
132	0.718	0.724	0.991	irs
133	0.266	0.295	0.902	irs
134	0.267	0.273	0.978	irs
135	0.293	0.319	0.920	drs
136	0.509	0.565	0.900	irs
137	0.293	0.453	0.648	irs
138	0.314	0.360	0.872	drs
139	0.371	0.375	0.990	irs
140	0.111	0.139	0.800	drs
141	0.158	0.220	0.721	irs
142	0.359	0.406	0.885	drs
143	0.606	0.636	0.953	irs
144	0.170	0.171	0.993	irs
145	0.262	0.262	0.999	-
146	0.215	0.270	0.796	irs
147	0.424	0.450	0.943	irs
148	0.375	0.387	0.968	drs
149	0.052	0.053	0.976	irs
150	0.416	0.421	0.989	drs
151	1.000	1.000	1.000	-
152	0.155	0.159	0.975	drs
153	1.000	1.000	1.000	-
154	1.000	1.000	1.000	-
155	0.105	0.151	0.698	drs
156	0.364	0.414	0.878	irs
157	0.264	0.267	0.990	drs
158	0.238	0.341	0.697	drs
159	0.111	0.119	0.930	drs
160	0.183	0.206	0.889	drs
161	0.089	0.093	0.958	irs
162	0.204	0.205	0.998	-
163	0.287	0.297	0.966	irs
164	0.122	0.150	0.811	drs
165	0.510	0.671	0.760	irs
166	0.291	0.299	0.974	irs
167	0.467	0.479	0.975	drs
168	0.584	0.587	0.995	irs
169	0.255	0.256	0.996	drs
170	0.208	0.214	0.973	irs
171	0.598	0.600	0.998	drs
172	0.377	0.448	0.843	irs

173	0.508	0.673	0.756	irs
174	0.405	0.407	0.996	drs
175	0.201	0.210	0.956	drs
176	0.252	0.252	1.000	-
177	0.783	0.825	0.949	drs
178	0.318	0.326	0.974	drs
179	0.505	0.520	0.971	drs
180	0.268	0.271	0.988	drs
181	0.242	0.242	0.999	-
182	0.375	0.395	0.949	drs
183	0.095	0.098	0.973	drs
184	0.656	0.662	0.992	irs
185	0.071	0.075	0.948	drs
186	0.663	0.722	0.919	drs
187	0.852	0.920	0.926	drs
188	1.000	1.000	1.000	-
189	0.373	0.456	0.819	drs
190	0.385	0.385	0.999	-
191	0.714	0.729	0.979	irs
192	0.486	0.490	0.991	drs
193	0.848	0.870	0.974	irs
194	0.342	0.354	0.966	irs
195	0.559	0.788	0.709	irs
196	0.270	0.300	0.901	irs
197	0.205	0.205	0.999	-
198	0.217	0.230	0.944	drs
199	0.135	0.154	0.879	irs
200	0.328	0.482	0.680	drs
201	0.260	0.261	0.999	-
202	0.770	0.776	0.992	irs
203	0.293	0.297	0.987	drs
204	0.173	0.173	1.000	-
205	0.251	0.273	0.919	drs
206	0.190	0.198	0.959	irs
207	0.323	0.381	0.849	drs
208	0.309	0.365	0.849	drs
209	0.295	0.304	0.968	drs
210	0.287	0.311	0.923	irs
211	0.835	0.875	0.954	drs
212	0.658	0.814	0.808	drs
213	0.310	0.322	0.963	irs
214	0.341	0.350	0.974	drs
215	0.257	0.270	0.948	drs
216	0.435	0.746	0.583	irs
217	0.033	0.036	0.914	drs
218	0.671	0.701	0.957	irs
219	0.253	0.282	0.899	drs
220	0.314	0.440	0.714	drs
221	0.275	0.310	0.888	irs
222	0.332	0.333	0.998	irs
223	0.210	0.211	0.994	drs
224	0.225	0.225	0.999	-
225	0.349	0.349	1.000	-
226	0.236	0.303	0.779	irs
227	0.211	0.211	0.997	drs
228	0.113	0.114	0.989	irs
229	0.610	0.632	0.964	drs
230	0.611	0.611	1.000	-
231	0.329	0.352	0.935	irs
232	0.539	0.782	0.689	irs
233	0.300	0.314	0.957	drs
234	0.162	0.172	0.944	irs
235	0.191	0.202	0.946	irs
236	0.394	0.411	0.958	irs
237	0.307	0.310	0.991	irs
238	0.554	0.598	0.926	drs
239	0.815	0.815	0.999	drs
240	1.000	1.000	1.000	-
241	0.448	0.574	0.780	irs
242	0.234	0.440	0.532	irs
243	0.461	0.632	0.729	drs
244	0.289	0.308	0.937	drs
245	0.423	0.476	0.889	drs
246	0.020	0.030	0.689	irs
247	0.142	0.160	0.887	drs
248	0.169	0.189	0.893	drs
249	0.450	0.462	0.976	irs
250	0.439	0.491	0.895	drs
251	1.000	1.000	1.000	-
252	0.347	0.363	0.956	drs
253	1.000	1.000	1.000	-
254	0.738	0.774	0.953	irs
255	0.365	0.462	0.791	irs
256	0.351	0.351	1.000	-
257	0.570	0.570	0.999	irs
258	0.497	0.507	0.981	irs
259	0.115	0.119	0.971	irs
260	0.122	0.146	0.834	drs
261	0.541	0.544	0.995	irs
262	1.000	1.000	1.000	-
263	0.268	0.276	0.971	irs
264	0.171	0.185	0.927	drs
265	0.339	0.414	0.819	irs
266	0.350	1.000	0.350	irs

267	0.387	0.399	0.969	drs
268	0.378	0.378	1.000	-
269	0.314	0.330	0.952	drs
270	0.209	0.233	0.899	drs
271	0.109	0.121	0.901	drs
272	0.231	0.231	0.999	-
273	0.101	0.119	0.849	drs
274	0.270	0.351	0.769	irs
275	0.288	0.315	0.913	drs
276	0.162	0.182	0.891	drs
277	0.272	0.277	0.982	drs
278	0.894	1.000	0.894	irs
279	0.808	1.000	0.808	irs
280	0.758	0.865	0.876	drs
281	0.259	0.372	0.696	drs
282	0.440	0.567	0.775	irs
283	0.711	1.000	0.711	irs
284	0.976	1.000	0.976	irs
285	0.298	0.306	0.975	irs
286	0.323	0.331	0.978	irs
287	0.453	0.453	1.000	-
288	0.191	0.198	0.967	drs
289	0.300	0.309	0.972	drs
290	0.978	1.000	0.978	irs
291	0.940	1.000	0.940	irs
292	0.375	0.394	0.953	irs
293	0.514	0.517	0.995	irs
294	0.091	0.104	0.873	drs
295	1.000	1.000	1.000	-
296	0.328	0.385	0.852	irs
297	0.217	0.227	0.956	drs
298	1.000	1.000	1.000	-
299	0.047	0.057	0.836	irs
300	0.962	1.000	0.962	drs
301	0.470	0.656	0.717	irs
302	0.444	0.566	0.784	drs
303	0.197	0.264	0.747	drs
304	0.358	0.397	0.900	drs
305	0.385	0.393	0.978	drs
306	0.575	1.000	0.575	irs
307	0.630	1.000	0.630	irs
308	0.389	0.421	0.926	drs
309	0.958	1.000	0.958	irs
310	0.100	0.115	0.870	irs
311	0.336	0.437	0.768	drs
312	0.660	0.661	0.998	drs
313	0.380	0.388	0.979	irs
314	0.656	0.715	0.918	drs
315	0.478	0.478	1.000	-
316	0.584	0.606	0.964	drs
317	0.498	0.519	0.961	drs
318	1.000	1.000	1.000	-
319	0.714	0.737	0.969	drs
320	0.402	0.485	0.827	irs
321	0.437	0.439	0.995	irs
322	0.361	0.480	0.751	drs
323	0.588	1.000	0.588	irs
324	0.537	0.537	0.999	-
325	0.435	0.459	0.948	drs
326	0.237	0.244	0.974	drs
327	1.000	1.000	1.000	-
328	0.449	0.508	0.883	drs
329	0.296	0.305	0.973	drs
330	0.296	0.296	1.000	-
331	0.625	0.625	1.000	-
332	0.472	0.476	0.993	irs
333	0.797	0.812	0.982	irs
334	0.431	0.461	0.936	drs
335	0.157	0.165	0.950	drs
336	0.206	0.208	0.992	drs
337	1.000	1.000	1.000	-
338	0.074	0.080	0.926	drs
339	0.729	0.937	0.778	drs
340	0.286	0.327	0.875	drs
341	0.592	0.670	0.883	drs
342	0.980	0.982	0.998	drs
343	1.000	1.000	1.000	-
344	0.860	1.000	0.860	drs
345	0.434	0.630	0.688	drs
346	0.573	0.623	0.920	drs
347	0.518	0.533	0.972	drs
348	1.000	1.000	1.000	-
349	0.320	0.330	0.970	drs
350	0.641	0.680	0.943	drs
351	0.165	0.185	0.893	irs
352	0.450	0.480	0.937	drs
353	0.813	0.816	0.996	drs
354	0.631	0.655	0.964	drs
355	0.729	0.744	0.980	irs
356	0.437	0.611	0.715	drs
357	1.000	1.000	1.000	-
358	0.315	0.343	0.918	drs
359	0.467	0.561	0.832	drs
360	0.568	0.601	0.944	drs

361	1.000	1.000	1.000	-
362	0.462	0.541	0.855	drs
363	0.567	0.716	0.792	drs
364	0.081	0.084	0.967	drs
365	0.683	0.735	0.929	drs
366	0.620	0.758	0.818	drs
367	0.525	0.558	0.941	drs
368	1.000	1.000	1.000	-
369	0.133	0.174	0.760	drs
370	0.375	0.426	0.879	drs
371	0.495	0.500	0.989	drs
372	1.000	1.000	1.000	-
373	0.302	0.358	0.842	drs
374	0.995	1.000	0.995	drs
375	0.684	0.765	0.894	drs
376	1.000	1.000	1.000	-
377	0.609	0.642	0.948	drs
378	0.293	0.347	0.842	drs
379	1.000	1.000	1.000	-
380	0.768	0.788	0.975	drs
381	0.934	0.937	0.997	irs
382	0.518	0.746	0.695	drs
383	0.345	0.507	0.681	drs
384	0.826	0.874	0.945	drs
385	0.166	0.198	0.842	drs
386	1.000	1.000	1.000	-
387	0.513	0.554	0.925	drs
388	0.442	0.465	0.952	drs
389	0.217	0.219	0.993	drs
390	0.252	0.254	0.991	drs
391	0.538	0.538	1.000	-
392	0.245	0.283	0.866	drs
393	0.451	0.481	0.938	drs
394	0.779	0.784	0.993	irs
395	1.000	1.000	1.000	-
396	0.072	0.089	0.807	drs
397	0.176	0.176	1.000	-
398	0.347	0.359	0.966	drs
399	0.417	0.530	0.787	drs
400	0.249	0.249	0.999	-
401	1.000	1.000	1.000	-
402	0.479	0.499	0.960	drs
403	0.372	0.373	0.996	drs
404	0.260	0.319	0.817	irs
405	0.649	0.733	0.885	irs
406	0.581	0.583	0.998	irs
407	0.899	0.899	1.000	-
408	0.333	0.903	0.369	irs
409	1.000	1.000	1.000	-
410	1.000	1.000	1.000	-
411	0.254	0.254	1.000	-
412	0.704	0.704	1.000	-
413	0.478	0.479	0.997	irs
414	0.914	0.976	0.936	irs
415	1.000	1.000	1.000	-
416	0.368	0.374	0.985	irs
417	0.515	0.543	0.948	irs
418	0.243	0.271	0.899	drs
419	1.000	1.000	1.000	-
420	0.673	0.731	0.921	drs
421	0.441	0.499	0.883	irs
422	0.319	0.328	0.975	irs
423	0.555	0.587	0.946	drs
424	0.775	1.000	0.775	irs
425	0.383	0.393	0.973	drs
426	1.000	1.000	1.000	-
427	0.464	0.513	0.905	drs
428	1.000	1.000	1.000	-
429	1.000	1.000	1.000	-
430	0.190	0.217	0.874	drs
431	0.506	1.000	0.506	irs
432	1.000	1.000	1.000	-
433	0.569	0.581	0.981	irs
434	1.000	1.000	1.000	-
435	0.348	0.376	0.925	irs
436	1.000	1.000	1.000	-
437	0.584	0.587	0.996	irs
438	0.218	0.240	0.910	drs
439	1.000	1.000	1.000	-
440	0.539	0.541	0.995	drs
441	1.000	1.000	1.000	-
442	0.204	0.204	0.998	-
443	0.166	0.171	0.972	drs
444	0.333	0.364	0.914	drs
445	0.330	0.332	0.992	irs
446	0.348	0.355	0.982	drs
447	0.233	0.323	0.722	irs
448	0.505	0.527	0.958	irs
449	0.417	0.626	0.666	irs
450	0.659	0.659	1.000	-
451	0.313	0.323	0.969	drs
452	0.944	1.000	0.944	irs
453	1.000	1.000	1.000	-
454	0.206	0.224	0.920	drs

455	0.180	0.188	0.957	drs
456	0.474	0.474	1.000	-
457	0.506	0.593	0.853	drs
458	0.603	0.672	0.898	drs
459	0.464	0.502	0.924	irs
460	0.128	0.129	0.985	irs
461	1.000	1.000	1.000	-
462	0.449	0.495	0.908	drs
463	0.409	0.440	0.929	drs
464	0.380	0.382	0.996	irs
465	0.429	0.449	0.954	irs
466	0.604	0.629	0.960	drs
467	0.578	0.578	1.000	-
468	0.989	1.000	0.989	irs
469	0.163	0.182	0.894	drs
470	0.196	0.205	0.959	drs
471	0.266	0.298	0.893	irs
472	0.419	0.461	0.908	drs
473	0.362	0.362	1.000	-
474	0.393	0.477	0.824	drs
475	0.542	0.547	0.991	drs
476	1.000	1.000	1.000	-
477	0.699	0.829	0.843	drs
478	0.400	1.000	0.400	irs
479	1.000	1.000	1.000	-
480	0.477	0.510	0.935	drs
481	0.932	1.000	0.932	irs
482	0.543	0.614	0.884	drs
483	0.233	0.254	0.919	drs
484	0.632	0.645	0.980	drs
485	0.658	0.686	0.960	drs
486	0.407	0.407	1.000	-
487	0.979	1.000	0.979	drs
488	0.564	0.671	0.839	drs
489	1.000	1.000	1.000	-
490	0.569	0.570	1.000	-
491	0.306	0.309	0.990	irs
492	1.000	1.000	1.000	-
493	0.469	0.491	0.955	drs
494	0.290	0.372	0.781	irs
495	0.290	0.372	0.781	irs

mean 0.472 0.518 0.914

Note: crste = technical efficiency from CRS DEA
vrste = technical efficiency from VRS DEA
scale = scale efficiency = crste/vrste

Descriptive statistics for constant return to scale technical efficiency scores (LNCRSTE) dependent variable

Province	Mean	Median	Max	Min.	S.D.
Ha Noi	-0.994	-0.814	0.176	-3.152	0.914
Hai Phong	-0.626	-0.786	1.892	-2.512	0.933
Vinh Phuc	-0.008	0.000	2.041	-1.875	0.857
Ha Tay	-0.989	-0.850	0.935	-6.213	1.125
Bac Ninh	-0.428	-0.511	1.750	-2.571	1.032
Hai Duong	-0.688	-0.761	1.621	-3.892	0.975
Hung Yen	-0.361	-0.717	3.794	-2.301	1.445
Ha Nam	-0.170	-0.163	3.231	-3.009	1.174
Nam Dinh	0.135	0.000	5.293	-2.429	1.257
Thai Binh	-0.210	-0.042	2.825	-2.556	0.909
Ninh Binh	0.032	-0.108	4.499	-1.919	1.290
Total	-0.386	-0.339	5.293	-6.213	1.153

Descriptive statistics for variable return to scale technical efficiency scores (LNVRSTE) dependent variable

Province	Mean	Median	Max	Min.	S.D.
Ha Noi	-0.842	-0.745	0.435	-2.987	0.947
Hai Phong	-0.387	-0.619	3.547	-2.351	1.155
Vinh Phuc	0.216	0.056	3.511	-1.875	0.966
Ha Tay	-0.860	-0.715	1.036	-6.213	1.150
Bac Ninh	-0.262	-0.376	2.442	-2.512	1.133
Hai Duong	-0.488	-0.617	1.946	-3.476	1.055
Hung Yen	-0.596	-0.498	1.857	-2.154	0.805
Ha Nam	-0.190	-0.030	2.700	-2.806	0.966
Nam Dinh	0.195	0.000	3.999	-2.389	1.032
Thai Binh	-0.116	0.000	3.705	-2.326	0.927
Ninh Binh	-0.146	0.000	1.579	-1.910	0.667
Total	-0.307	-0.096	3.999	-6.213	1.053

Model I

Heteroskedasticity Test: White

F-statistic	0.727	Prob. F(63,431)	0.941
Obs*R-squared	47.531	Prob. Chi-Square(63)	0.926
Scaled explained SS	134.941	Prob. Chi-Square(63)	0.000

Test Equation:

Dependent Variable: RESID^2

Method: Least Squares

Sample: 1 495

Included observations: 495

White Heteroskedasticity-Consistent Standard Errors and Covariance

Collinear test regressors dropped from specification

	Coefficient	Std. Error	t-Statistic	Prob.
C	1.091	2.773	0.393	0.694
ULT	0.330	3.457	0.095	0.924
ULT*MD_OTHERS	1.310	2.758	0.475	0.635
ULT*NURSE_OTHERS	-1.978	2.736	-0.723	0.470
ULT*AGEDOC	0.048	0.032	1.486	0.138
ULT*PRI	-1.589	1.500	-1.059	0.290
ULT*SAL	0.000	0.000	-0.943	0.346
ULT*FREED	1.923	4.382	0.439	0.661
ULT*HI	-0.008	0.016	-0.541	0.589
ULT*PROV	-0.139	0.975	-0.142	0.887
ULT*POP	0.002	0.001	2.355	0.019
MD_OTHERS	18.293	13.299	1.376	0.170
MD_OTHERS^2	2.682	2.486	1.079	0.281
MD_OTHERS*NURSE_OTHERS	5.950	6.793	0.876	0.382
MD_OTHERS*AGEDOC	-0.183	0.216	-0.849	0.396
MD_OTHERS*PRI	-6.676	4.057	-1.646	0.101
MD_OTHERS*SAL	0.001	0.001	1.107	0.269
MD_OTHERS*FREED	-21.728	10.890	-1.995	0.047
MD_OTHERS*HI	0.070	0.050	1.389	0.166

	Coefficient	Std. Error	t-Statistic	Prob.
MD_OTHERS*PROV	0.125	11.359	0.011	0.991
MD_OTHERS*POP	-0.006	0.003	-1.848	0.065
NURSE_OTHERS	1.311	5.176	0.253	0.800
NURSE_OTHERS^2	4.116	3.197	1.287	0.199
NURSE_OTHERS*AGEDOC	-0.068	0.071	-0.947	0.344
NURSE_OTHERS*PRI	-1.712	1.137	-1.506	0.133
NURSE_OTHERS*SAL	0.000	0.000	0.725	0.469
NURSE_OTHERS*FREED	-4.604	5.975	-0.771	0.441
NURSE_OTHERS*HI	0.028	0.024	1.209	0.227
NURSE_OTHERS*PROV	1.223	3.558	0.344	0.731
NURSE_OTHERS*POP	-0.001	0.002	-0.522	0.602
AGEDOC	-0.171	0.146	-1.178	0.240
AGEDOC^2	0.002	0.002	1.011	0.312
AGEDOC*PRI	0.070	0.048	1.444	0.150
AGEDOC*SAL	0.000	0.000	-1.111	0.267
AGEDOC*FREED	0.105	0.103	1.017	0.310
AGEDOC*HI	-0.001	0.000	-1.131	0.259
AGEDOC*PROV	-0.074	0.072	-1.024	0.307
AGEDOC*POP	0.000	0.000	1.878	0.061
PRI	-0.782	2.103	-0.372	0.710
PRI^2	0.256	0.415	0.617	0.538
PRI*SAL	0.000	0.000	-0.852	0.395
PRI*FREED	-0.899	2.542	-0.354	0.724
PRI*HI	-0.009	0.008	-1.181	0.238
PRI*PROV	-1.391	1.563	-0.890	0.374
PRI*POP	0.000	0.001	0.459	0.647
SAL	0.000	0.000	0.330	0.741
SAL^2	0.000	0.000	-0.195	0.846
SAL*FREED	0.000	0.000	1.010	0.313
SAL*HI	0.000	0.000	-0.482	0.630
SAL*PROV	0.000	0.000	0.196	0.845
SAL*POP	0.000	0.000	0.819	0.413

	Coefficient	Std. Error	t-Statistic	Prob.
FREED	5.237	9.177	0.571	0.569
FREED^2	-5.409	7.087	-0.763	0.446
FREED*HI	-0.002	0.031	-0.075	0.940
FREED*PROV	-9.159	7.879	-1.162	0.246
FREED*POP	-0.003	0.003	-1.098	0.273
HI	0.033	0.030	1.096	0.274
HI^2	0.000	0.000	0.267	0.789
HI*PROV	0.009	0.012	0.710	0.478
HI*POP	0.000	0.000	-0.975	0.330
PROV	7.258	5.834	1.244	0.214
PROV*POP	-0.002	0.001	-2.560	0.011
POP	-0.001	0.001	-0.850	0.396
POP^2	0.000	0.000	0.055	0.957

R-squared	0.096	Mean dependent var	1.199
Adjusted R-squared	-0.036	S.D. dependent var	2.926
S.E. of regression	2.978	Akaike info criterion	5.141
Sum squared resid	3823.595	Schwarz criterion	5.684
Log likelihood	-1208.361	Hannan-Quinn criter.	5.354
F-statistic	0.727	Durbin-Watson stat	1.989
Prob(F-statistic)	0.940		

Model II

Heteroskedasticity Test: White

F-statistic	1.022	Prob. F(63,431)	0.436
Obs*R-squared	64.331	Prob. Chi-Square(63)	0.430
Scaled explained SS	155.817	Prob. Chi-Square(63)	0.000

Test Equation:

Dependent Variable: RESID^2

Method: Least Squares

Sample: 1 495

Included observations: 495

White Heteroskedasticity-Consistent Standard Errors and Covariance

Collinear test regressors dropped from specification

	Coefficient	Std. Error	t-Statistic	Prob.
C	1.805	2.904	0.621	0.535
ULT	-0.500	3.320	-0.151	0.880
ULT*MD_OTHERS	0.214	2.627	0.081	0.935
ULT*NURSE_OTHERS	-1.189	2.688	-0.442	0.659
ULT*AGEDOC	0.059	0.029	2.086	0.038
ULT*PRI	-0.477	1.540	-0.310	0.757
ULT*SAL	0.000	0.000	-0.548	0.584
ULT*FREED	-1.389	4.231	-0.328	0.743
ULT*HI	-0.009	0.014	-0.677	0.499
ULT*PROV	0.008	0.905	0.009	0.993
ULT*POP	0.000	0.001	0.669	0.504
MD_OTHERS	13.304	12.215	1.089	0.277
MD_OTHERS^2	1.341	2.295	0.584	0.559
MD_OTHERS*NURSE_OTHERS	5.092	4.275	1.191	0.234
MD_OTHERS*AGEDOC	-0.087	0.176	-0.495	0.621
MD_OTHERS*PRI	-5.605	4.329	-1.295	0.196
MD_OTHERS*SAL	0.001	0.000	1.258	0.209
MD_OTHERS*FREED	-17.662	8.902	-1.984	0.048

	Coefficient	Std. Error	t-Statistic	Prob.
MD_OTHERS*HI	0.053	0.043	1.238	0.216
MD_OTHERS*PROV	12.026	7.018	1.714	0.087
MD_OTHERS*POP	-0.004	0.003	-1.276	0.203
NURSE_OTHERS	8.055	3.551	2.268	0.024
NURSE_OTHERS^2	-1.777	2.344	-0.758	0.449
NURSE_OTHERS*AGEDOC	-0.061	0.049	-1.251	0.212
NURSE_OTHERS*PRI	-1.611	0.936	-1.722	0.086
NURSE_OTHERS*SAL	0.000	0.000	0.928	0.354
NURSE_OTHERS*FREED	-1.818	4.268	-0.426	0.670
NURSE_OTHERS*HI	0.006	0.019	0.340	0.734
NURSE_OTHERS*PROV	2.812	2.943	0.956	0.340
NURSE_OTHERS*POP	-0.003	0.001	-2.050	0.041
AGEDOC	-0.160	0.132	-1.209	0.227
AGEDOC^2	0.001	0.001	0.838	0.402
AGEDOC*PRI	0.074	0.053	1.393	0.164
AGEDOC*SAL	0.000	0.000	-1.483	0.139
AGEDOC*FREED	0.072	0.084	0.857	0.392
AGEDOC*HI	0.000	0.000	-0.837	0.403
AGEDOC*PROV	-0.119	0.056	-2.134	0.033
AGEDOC*POP	0.000	0.000	1.215	0.225
PRI	-2.251	2.305	-0.976	0.330
PRI^2	0.485	0.448	1.082	0.280
PRI*SAL	0.000	0.000	-0.919	0.358
PRI*FREED	-0.764	2.820	-0.271	0.787
PRI*HI	-0.009	0.008	-1.068	0.286
PRI*PROV	-2.272	1.280	-1.775	0.077
PRI*POP	0.000	0.001	0.482	0.630
SAL	0.000	0.000	1.521	0.129
SAL^2	0.000	0.000	-0.726	0.468
SAL*FREED	0.000	0.000	0.371	0.711
SAL*HI	0.000	0.000	-0.933	0.351

	Coefficient	Std. Error	t-Statistic	Prob.
SAL*PROV	0.000	0.000	1.164	0.245
SAL*POP	0.000	0.000	-0.695	0.488
FREED	6.228	8.798	0.708	0.479
FREED^2	-2.169	5.913	-0.367	0.714
FREED*HI	-0.004	0.027	-0.160	0.873
FREED*PROV	-1.998	4.882	-0.409	0.683
FREED*POP	-0.003	0.003	-1.168	0.243
HI	0.003	0.021	0.152	0.879
HI^2	0.000	0.000	1.046	0.296
HI*PROV	0.005	0.011	0.469	0.639
HI*POP	0.000	0.000	0.414	0.679
PROV	3.812	4.392	0.868	0.386
PROV*POP	-0.001	0.001	-1.754	0.080
POP	0.000	0.001	-0.256	0.798
POP^2	0.000	0.000	0.931	0.353
R-squared	0.130	Mean dependent var		1.000
Adjusted R-squared	0.003	S.D. dependent var		2.254
S.E. of regression	2.251	Akaike info criterion		4.581
Sum squared resid	2184.137	Schwarz criterion		5.125
Log likelihood	-1069.768	Hannan-Quinn criter.		4.794
F-statistic	1.022	Durbin-Watson stat		1.934
Prob(F-statistic)	0.436			

	AGE DOC	FREED	HI	MD_ OTHERS	NURSE_ OTHERS	POP	PRI	PROV	SAL	ULT
AGE DOC	1.00	-0.05	-0.01	0.55	0.01	0.12	-0.13	0.02	0.03	0.08
FREED	-0.05	1.00	0.27	-0.05	0.03	-0.20	-0.06	-0.15	-0.10	-0.15
HI	-0.01	0.27	1.00	0.02	-0.01	-0.14	0.06	0.04	0.14	0.01
MD_ OTHERS	0.55	-0.05	0.02	1.00	-0.03	0.04	0.21	-0.04	0.16	0.15
NURSE_ OTHERS	0.01	0.03	-0.01	-0.03	1.00	0.02	-0.05	0.09	0.05	0.00
POP	0.12	-0.20	-0.14	0.04	0.02	1.00	-0.05	0.27	0.14	0.19
PRI	-0.13	-0.06	0.06	0.21	-0.05	-0.05	1.00	-0.05	0.26	-0.06
PROV	0.02	-0.15	0.04	-0.04	0.09	0.27	-0.05	1.00	0.21	0.45
SAL	0.03	-0.10	0.14	0.16	0.05	0.14	0.26	0.21	1.00	0.11
ULT	0.08	-0.15	0.01	0.15	0.00	0.19	-0.06	0.45	0.11	1.00

BIOGRAPHY

Name	Mrs. Lan Do Thi Phuong
Nationality	Vietnamese
Country	Vietnam
Education	Bachelor of Economics Bachelor of Science
Work	Bureau of Health Statistic Planning and Finance Department Ministry of Health No. 138A Giangvo Street, Badinh District, Hanoi, Vietnam