

**MEDICAL CARE DEMAND AND CONSUMPTION:  
A COINTEGRATION ANALYSIS**

**BY  
YONG PAY LAN  
(EGAX 01043)**

**SUBMITTED TO THE  
FACULTY OF ECONOMICS AND ADMINISTRATION  
UNIVERSITY OF MALAYA  
IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE DEGREE OF  
MASTER OF ECONOMICS**

**MAY 2003**

**Perpustakaan Universiti Malaya**



**A511704784**

## **ACKNOWLEDGEMENT**

First and foremost, I wish to express my heartfelt gratitude and appreciation to my supervisor, Dr. Yap Su Fei of the Faculty of Economics and Administration, University of Malaya, for her invaluable advice, patient supervision, unreserved assistance, guidance and encouragement throughout the period of this study, which, made this project paper a reality.

Thanks are also due to the staff of Faculty of Economics and Administration, the librarians of the University of Malaya, librarians from the Ministry of Health, staff from the Department of Statistics and also librarians from the National Library of Malaysia for their guidance and services rendered to me in completing my project paper.

I also wish to express my gratitude to my cousin, Bee Lian, who helped me to obtain valuable data from Singapore from the library of the National University of Singapore. Besides, I would also like to thank my friends, Ai Loon, Guat Cheng, Beng Yee and Hooy Yuen, because they shared invaluable experience and advised me throughout the period of this study. Last but not least, I would like to dedicate this project paper to my dearest parents and brothers for their love, support, encouragement and concern for me during this study period.

Finally, I would like to say a special word of thanks to all my course mates and wish them all the best in their future undertakings.

## **ABSTRACT**

There is a need to acquire a better understanding of medical care demand and consumption in Malaysia and Singapore. This study attempts to examine the medical care demand function using a simplified generalized version of Grossman's Health Capital Model. The model is used to derive a cointegration restriction between the demand for medical care, net consumption expenditure and the relative price of medical care. The results are consistent with the prediction of the model. Overall, this cointegration relationship (considered as a basis for the medical care demand equation) suggests that net consumption expenditure and relative price of medical care are the key determinants of the macroeconomic demand for medical care in the long run. By quantifying elasticities, the study highlights the measure of weightage accorded to prices and consumption. The paper also provides support for the work of Lee and Kong (1999) in justifying the use of medical care demand functions in a time series context. Furthermore, the model draws attention to the microeconomic foundations of a macroeconomic relationship.

# TABLE OF CONTENTS

ACKNOWLEDGEMENT	i
ABSTRACT	ii
TABLE OF CONTENTS	iii
GLOSSARY OF MATHEMATICAL TERMS	viii
LIST OF TABLES	x

## CHAPTER 1 INTRODUCTION

1.0	OVERVIEW	1
1.1	GENERAL INFORMATION ON MEDICAL CARE IN SINGAPORE	2
1.2	GENERAL INFORMATION ON MEDICAL CARE IN MALAYSIA	6
1.3	OBJECTIVES	10
1.4	OUTLINE OF STUDY	11

## **CHAPTER 2 LITERATURE REVIEW**

2.0	INTRODUCTION	12
2.1	HEALTH MODELS	13
2.2	DEMAND FOR MEDICAL CARE, HEALTH CARE EXPENDITURE AND ELASTICITIES	16
2.3	EFFECTS OF UNCERTAINTY IN HEALTH MODELS	21
2.4	CONCLUSION	23
2.5	SUMMARY OF THE LITERATURE REVIEW	24

## **CHAPTER 3 THEORY**

3.0	INTRODUCTION	25
3.1	CONSUMPTION MODEL	26
3.2	THE BASIC HEALTH CARE DEMAND MODEL	29
3.3	A GENERAL DISCUSSION OF GROSSMAN'S MODEL	31
3.3.1	GROSSMAN HEALTH CAPITAL MODEL (IN MATHEMATICAL FORM)	33
3.4	GENERALIZED GROSSMAN-TYPE HEALTH INVESTMENT MODEL	39
3.5	OUTLINE OF THE MODEL	43
3.6	CONCLUSION	48

## **CHAPTER 4    METHODOLOGY**

4.0	INTRODUCTION	49
4.1	DATA	50
4.2	FRAMEWORK OF ANALYSIS	51
4.2.1	UNIT ROOT TEST	51
4.2.1a	AUGMENTED DICKFY-FULLER TEST	53
4.2.1b	PHILLIPS-PERRON TEST	54
4.2.1c	UNIT ROOT TEST APPLICATION	55
4.2.2	COINTEGRATION TEST	56
4.2.2a	ENGLE AND GRANGER COINTEGRATION TEST	57
4.2.2b	JOHANSEN COINTEGRATION TEST	58
4.2.3	COINTEGRATING REGRESSION	62
4.2.3a	NORMALIZED COINTEGRATING REGRESSION	62
4.2.4	GRANGER CAUSALITY (GC) TEST	63
4.2.5	SERIES VOLATILITY	64
4.3	STATISTICAL TEST	65
4.4	LAG DETERMINATION	71
4.5	CONCLUSION	74

## **CHAPTER 5    RESULTS AND DISCUSSION**

5.0	INTRODUCTION	75
5.1	PART I SINGAPORE ANALYSIS	76
5.1.1	UNIT ROOT TEST RESULTS: FOR SINGAPORE CASE	76
5.1.2	RESULTS OF THE JOHANSEN COINTEGRATION TEST IN THE SINGAPORE CASE	84
5.1.3	RESULTS OF THE NORMALIZED COINTEGRATING REGRESSION FOR ONE COINTEGRATING VECTOR EQUATION IN THE SINGAPORE CASE	85
5.1.4	RESULTS OF THE GRANGER CAUSALITY TEST IN THE SINGAPORE CASE	88
5.1.5	SERIES VOLATILITY IN THE SINGAPORE CASE	91
5.2	PART II MALAYSIAN ANALYSIS	93
5.2.1	UNIT ROOT TEST RESULTS: FOR MALAYSIAN CASE	93
5.2.2	RESULTS OF THE JOHANSEN COINTEGRATION TEST IN THE MALAYSIAN CASE	100
5.2.3	RESULTS OF THE NORMALIZED COINTEGRATING REGRESSION FOR ONE COINTEGRATING VECTOR EQUATION IN THE MALAYSIAN CASE	102
5.2.4	RESULTS OF THE GRANGER CAUSALITY TEST IN THE MALAYSIAN CASE	105
5.2.5	SERIES VOLATILITY IN THE MALAYSIAN CASE	108

5.3	CONCLUSION	110
-----	------------	-----

## CHAPTER 6 CONCLUSION

6.0	INTRODUCTION	114
6.1	KEY FINDINGS	115
6.2	LIMITATIONS	117
6.3	SUGGESTIONS FOR FUTURE RESEARCH	117
6.4	CONCLUSION	118
	BIBLIOGRAPHY	119
	APPENDIX	142



## Glossary of Mathematical Terms<sup>1</sup>

$n$	Total length of life
$t$	Age
$H_0$	Inherited stock of health
$H_t$	Stock of health in period $t$
$H_{\text{max}}$	Death stock
$\phi_t$	Service flow per unit stock or number of healthy days per unit stock
$h_t$	Total number of healthy days in period $t$
$Z_t$	Consumption of an aggregate commodity in period $t$
$I_t$	Gross investment in health
$\delta_t$	Rate of depreciation
$M_t$	Medical care
$TH_t$	Time input in gross investment function
$X_t$	Goods input in the production of $Z_t$
$L_t$	Time input in the production of $Z_t$
$E_t$	Stock of human capital
$g = \partial I_t / \partial M$	Marginal product of medical care in the gross investment production function
$g$	Marginal product of time
$P_t$	Price of medical care
$P_t^X$	Price of $X_t$
$W_t$	Wage rate
$A_0$	Initial assets
$r$	Rate of interest

<sup>1</sup> Reference from Appendix B of Michael Grossman (1972) "On the Concept of Health Capital and the Demand for Health," *Journal of Political Economy*, 80, pp. 283-294.

$TW_i$	=	Hours of work
$TL_i$	=	Sick time
$\Omega$	=	Constant length of the period
$R$	=	Full wealth
$G_i$	=	Marginal product of health capital
$U/h_i$	=	Marginal utility of healthy days
$\lambda$	=	Marginal utility of wealth
$\pi_i$	=	Marginal cost of gross investment in health
$\dot{\pi}_i$	=	Percentage rate of change of marginal cost
$\gamma_i$	=	Monetary rate of return on an investment in health or marginal efficiency of health capital
$\alpha_i$	=	Psychic rate of return on an investment in health
$\dot{\phantom{x}}$	=	A tilde over a variable denotes a percentage time derivative
$S_i$	=	Share of depreciation in the cost of health capital
$\varepsilon$	=	Elasticity of the $MC$ schedule
$K$	=	Fraction of the total cost of gross investment accounted for by time
$\sigma_p$	=	Elasticity of substitution between medical care and own time in the production of gross investment
$\ell_{H,W}$	=	Elasticity of $H$ with regard to $W$
$\ell_{M,W}$	=	Elasticity of $M$ with regard to $W$
$\hat{\phantom{x}}$	=	A circumflex over a variable denotes a percentage change per unit change in $E$
$r_H$	=	Percentage change in gross investment for a one unit change in $E$
$C_i$	=	Total cost of gross investment in health in period $i$
$C_H$	=	Total cost of $Z_i$
$m_i$	=	Weight attached to total utility in period $i$
$q_i$	=	Marginal cost of $Z_i$

## LIST OF TABLES

TABLE 1	Results of the Augmented Dickey-Fuller and Phillips-Perron Unit Root Test: Singapore's Case	79
TABLE 2	Results of the Johansen Cointegration Test: Singapore's Case	85
TABLE 3	Results of the Normalized Cointegrating Regression – 1 Cointegrating Vector Equation/Long-Run Elasticities: Singapore's Case	87
TABLE 4	Results of the Granger Causality Test: Singapore's Case	89
TABLE 5	Volatility of the Studied Series: Singapore's Case	92
TABLE 6	Results of the Augmented Dickey-Fuller and Phillips-Perron Unit Root Test: Malaysia's Case	96
TABLE 7	Results of the Johansen Cointegration Test: Malaysia's Case	101
TABLE 8	Results of the Normalized Cointegrating Regression – 1 Cointegrating Vector Equation/Long-Run Elasticities: Malaysia's Case	104
TABLE 9	Results of the Granger Causality Test: Malaysia's Case	106
TABLE 10	Volatility of the Studied Series: Malaysia's Case	109