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Multivariate Cointegration Technique Estimation of Health Demand Function: The Case of Croatia

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Abstract

In this paper multivariate Johansen cointegration technique is used in order to estimate health demand function in Croatia. Empirical estimate is based on the theoretical foundation of Grossman's model. According to the estimate, the number of physician visits in Croatia is a function of percentage of urban population, GDP, number of beds per 100 000 people, number of physicians per 100 000 people and total fertility rate. All estimated systems demonstrated strong feedbacks indicating number of endogenous variables greater than one.

Keywords
health demand function, health capital, Grossman's model, Croatian health care system,
Johansen cointegration technique

JEL classification
I11, I18, H51

Introduction

This paper briefly presents and empirically investigates general theoretical framework used in economics of health. The goal is to pin down and empirically test major theoretical determinants of health demand in the case of Croatia during 1980-2005.

In the first part of paper basic elements of Grossman's (1978) model are presented and explained in the framework of the intertemporal utility maximizing individual/household problem. Stock of health is analyzed in the framework of human (health) capital accumulation through various health inducing activities. Within the optimizing problem basic social and macroeconomics variables are analyzed in the context of the health accumulation. Brief analysis of theoretical background describes effects of age, wage rate, education, health inputs (resources), technology, GDP, unemployment, pollution, crime and exercise on the health accumulation process. In the next section, theoretical hypothesis are partly supported with brief survey of empirical evidence in other countries and in the last section the data series which are available throughout entire analyzed period are briefly discussed.

In the second part of the paper methodology and results of performed econometrical test are presented. Augmented Dickey Fuller test was used in order to identify order of integration and Johansen cointegration technique is used to estimate number of cointegrating vectors among the mentioned variables.

The last part of paper offers discussion on the main results of the econometrical test, followed with the analysis of the major drawbacks and limitations of this research and recommendations for the future research.

Theoretical background

In his celebrated paper, Grossman (1972) demonstrated that health can be viewed as a durable capital stock that produces an output of healthy time. Individuals can and do invest in themselves. Such investment can increase the wage rate earned by the individual, however, investing in health capital is different because it allows the investor to increase the total amount of time devoted to the production of monies and commodities. Good health is demanded and supplied as a commodity.

The input of market goods and the individuals own time determine the production of additional health capital. Personal health regimes are defined as any activity undertaken to increase the health capital of an individual by production of the health commodity. A regime can be satisfactorily assumed to involve a market good of some kind, whilst it invariably involves time.

The commodity allows the person to achieve an increase in wages by allowing them to apply less time to sickness. Individuals demand this “good health” before they demand medical care. As a market good, determining the entry and exit into medical treatment could be achieved through standard neoclassical modeling.

The demand for the commodity good health is more complex however. Individuals may be aware of the need and the means of improving health on a long or short-term basis, but may choose not to undertake the changes necessary in an immediate fashion even if they are rational.

Under rationality, this state of affairs is known to cause a higher level of activity needed to induce action. In a standard market for a good, a firm may not produce a good until the profit margin is “high” as opposed to when price is more than floating cost plus fixed costs. The same firm will not abandon the production of a good when the price is less than fixed costs, losses will be far more extensive. For an increase in health capital gained via a personal health regime, such a regime needs to acquire a level of health capital above what is traditionally “profitable”; a very large increase in “good health” is required to instigate the regime, whilst a greater reduction in “good health” is needed before the regime is abandoned. Contemporaneously, the exit level of health capital is defined as the level at which he or she would abandon the personal health regime if the regime could not commence again. (McCarthy, 2006) It is also very important to focus on the variables concerning the model: *age* (pure investment model predicts lower optimal health stock as age increases), *wage rate* (rewards of good health are greater for high wage workers so they demand higher optimal health stock), *education* (education increases marginal product of inputs thus less required to produce given amount of gross investment), *health inputs and technology* (medical infrastructure, benefits).

Grossman's model

In Grossman's theoretical model, individuals are assumed to inherit a stock of health capital H0 . Thereafter their health stock evolves according to the relationship

(1) $H_t - H_{t-1} = I_{t-1} - \delta_{t-1} H_{t-1}$

where Ht is health stock at the beginning of period t, I t-1 is gross investment during the period t – 1 and is the rate of depreciation in operation during the same period (individual's stock of health will develop over the time according ∂Ht /∂t = I t-1 – δtH t).

In Grossman's formulation δ depends only on the individual's age and is hence exogenous. The individual's utility and income are both increasing functions of the stock of health capital, and in selecting the optimal time path of H_t the individual bears these benefits in mind, along with the costs of "holding" health capital. The latter comprise interest costs, depreciation costs and any offsetting capital gains. All are increasing in the cost of new investment. Formally, the equilibrium stock of health capital is defined by the condition

(2) $\tau_t + \alpha_t = (r + \delta_t - \pi'_{t-1})\, \pi_t$

where τt is the financial marginal benefit of health capital, αt is the non-financial marginal benefit, r is the rate of interest, π ist the marginal cost of investment and π't-1 is percentage change. (Wagstaff, 2002)

An expanded view of health production treats net investments in health in a given period (Ht) as depending not only on inputs of purchased medical inputs (Mt) and time to medical care (th), but on choices about time spent in other consumption (tc) and choices about non-medical purchased goods (Xt). Other household consumption activities may have either positive or negative effects on net health stocks. Similarly time spent in the labor market (tw) may have either positive effects on health or negative effects due to occupational injuries.

(3) $H_t = H(t_h, t_c, t_w, X_t, M_t, N, H_{t-1}, E)$

In addition specifying a role for an individual's choices about allocating time and money to health promoting or health reducing activities, Eq. (3) also includes the impact on net health investments of environmental inputs (N) that are beyond an individual's control. This acknowledges that air pollution or high crime levels in an individual's environment will affect the accumulation of health capital. In addition to education, E, Eq. (3) considers that existing health stocks (Ht−1) enter into the production of additions to health capital. Thus, the marginal product of all other inputs is likely to be smaller when there are lower levels of the fixed factor, the existing stock of health. (Leibowitz, 2004)

Empirical proofs

Empirical results from Danish Health Study show, contrary to what is assumed in Grossman's model, individuals do not adjust instantaneously to their desired health stocks. The results suggest that the elderly adjust more slowly to their desired stocks than do the young. Holding the quantity of investment constant, education tends to reduce the demand for health care, as the Grossman model predicts. (Wagstaff, 2002)

Some other studies indicate that the quality of the environment as measured negatively by the level of environmental pollution is an important determinant of individual health. The higher environmental pollution as it operates through the stock of health capital implies a higher consumption of medical services. (Erbsland, Ried, and Ulrich, 2002)

"The demand for health" argued that individuals combine inputs of time and purchased medical care to produce additions to their health stocks. The cost of a given investment can be minimized by equalizing the marginal costs of producing an increment to the health stock by additional spending on medical care and by additional time inputs. In the enhanced formulation, time in health-promoting activities includes both time spent obtaining medical care and time in other consumption that promotes health, such as exercise. Moreover Kobayashi (University of Tsukuba, Ibaraki, Japan) and Myoung-Jae Lee (Sunkyunkwan University, Seoul, South Korea) in "Effects of binary exercise on health care demand" concluded that short-run light exercise increases health care demand by 3-5%, whereas long-run light exercise decreases it by 3-6%. Also, short-run vigorous exercise decreases health care demand by 1-2%, whereas long-run vigorous exercise decreases health care demand by 1-3%. (Lee and Kobayashi, 2002)

It is well known that health insurance coverage induces "moral hazard", reducing an individual's marginal costs of medical care inputs and leading to use of additional medical services that the patient values less than the marginal cost of producing them. The problem of moral hazard is of outmost importance in the case of transition countries. Especially in the case of Croatia that has government owned insurance coverage health system.

Previous analyses of the demand for medical care are characterized by an insurance-like view of health: bad health occurs stochastically and medical services are used to repair the damage if an accident or illness does occur. In contrast, in the Grossman model, individuals weigh the costs and benefits of investments in health to determine how much of a stochastic loss to offset. Grossman's model featured an important role for time. He took the "flow of healthy days" as the desired outcome and allowed for the shadow price of one's own time in producing health as a major input cost. A second major contribution was to treat education as a factor that increased one's efficiency in producing health and reducing the shadow price of investment at any given age. (Leibowitz, 2004)

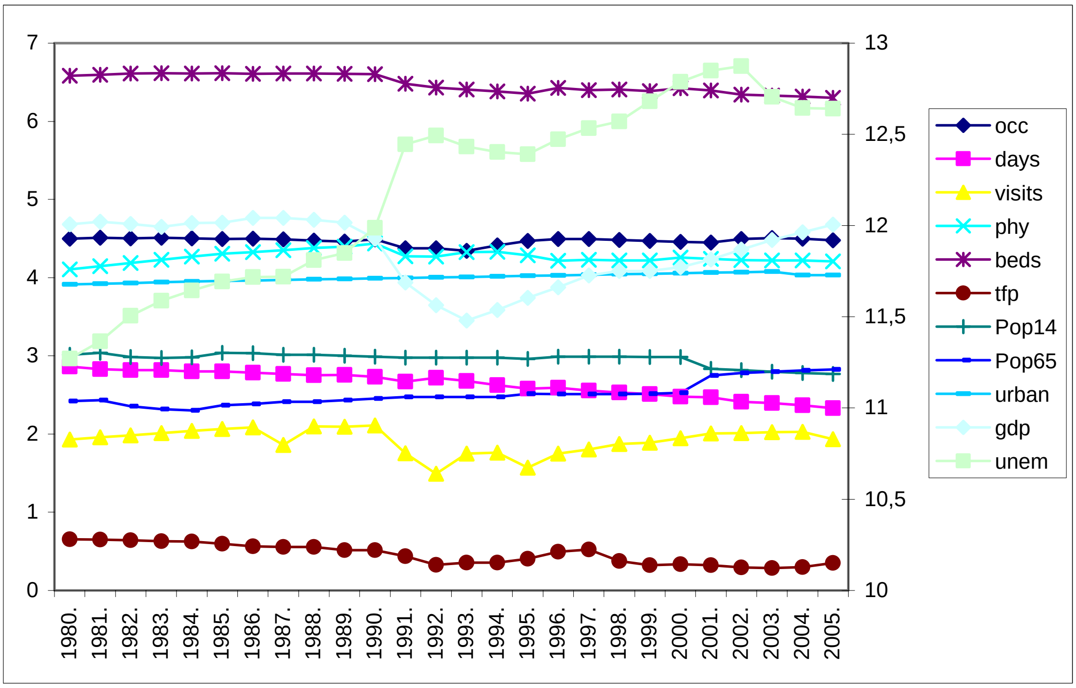
Although it is the time profile of health that the individual selects, the way by which this is achieved is the investment profile. If the individual wishes to increase his health stock from one period to next, or he wishes it to decrease by less than the amount of depreciation, he must undertake some health investment. Since health capital cannot be sold, investment cannot be negative. The model is "neoclassical" in that stocks are assumed to adjust instantaneously to their new equilibrium values. (Wagstaff, 2002)

In order to evaluate and predict the effects of regulations, new technology, changes in social insurance schemes and government, and other programmes, knowledge about the effects on individuals' demand for health and health related behaviour is essential. These effects will not be confined just to the present distribution of health capital direct effects, but they will change the individual's lifetime health profile indirect effects. Hence, present and future total utilisation of health care resources and social insurance are to a large extent the result of aggregate previous, present and future health related behaviour. Therefore, increasing our knowledge of what factors determine observed inequalities in health and the path of lifetime health has important policy implications. (Jacobson, 2000)

Data

In total, ten time series is used in order to perform empirical test of health demand in Croatia. The data set presented in Table 1 is composed from World Development Indicators database (WDI), (World Bank, 2005) European health for all database (HFA-DB), (World Health Organization Regional Office for Europe, 2007), Croatian Bureau of Statistics (CBS), (2007) Croatian Employment Service (CES), (2005), Council of Europe (CEU), (2004).

Figure 1: Main economic and socio-economic data in Croatia



Source: Table 1

The data series for the number of hospital beds per 100 000 people (BEDS) are collected from World Health Organization – European health for all database (HFA-DB). (World Health Organization Regional Office for Europe, 2007) The variable had a constant fall in observed period totaling at 25%.

The data series for the Gross Domestic Product (GDP) between 1990 and 2005 are taken from Croatian Bureau of Statistics (CBS), (2007) and estimate made by Tica (2002) for the period prior to transition. According to data, GDP stagnated through 1980-ties, slumped after 1990, and positive rates of GDP growth emerged after 1994.

Variable PHY denotes the number of physicians per 100 000 people. The data source is World Health Organization - European health for all database (HFA-DB). The variable movement demonstrates notable decrease prior to 1990 and stagnation afterwards at the level of approximately 70 physicians.

Variables POP14 and POP65 represent the number of population younger than 14 years and older than 65 years respectively. The variables are associated with an increased health demand in these two age structures. As in many countries in demographic posttransition it is notable fall in 0-14 years age structure and increasing proportion of population over 65 years. The data for these two variables are obtained from World Health Organization - European health for all database (HFA-DB) and World Development Indicators Database (World Bank, 2005) for population 0-14 in 1980 and 1982-1984.

TFP stands for total fertility rate, number of children that one woman will bear in her fertility period (age 15 to 49). We obtained data for this indicator from the Council of Europe (CEU), (2004) database.

Variable UNEM shows the number of unemployed people and it had an increasing path in observed period. Higher number of unemployed is the result of stagnation in the 1980-ties, transition period in Croatia and large economic devastation in the period of civil war. The data series is collected from the Croatian Employment Service (CES), (2005).

Variable URBAN denotes the urban population of total population of Croatia. The percentage of urban population has an increasing trend but it is still bellow the average of developed countries. The data are obtained from the World Health Organization - European health for all database (HFA-DB) for years 2004 and 2005 and the World Development Indicators Database for the rest of the period.

Variables VISITS, OCC and DAYS are related directly to health care consumption. Therefore, according to the theory and in our empirical test these variables will represent quantity of health consumed, while other data series will be used as explanatory variables.

The variable VISITS stands for the average number of physicians' visits and it is quite stable with the exception of the war period. Variable OCC denotes the occupancy rate for acute care hospitals and variable DAYS the average number of days spent in hospital. The average number of days spent in hospital decreases considerably while the occupancy rate retained stable level of about 90%. The data for the variables are collected from World Health Organization - European health for all database (HFA-DB).

Unfortunately it is not possible to construct data series for CO_2 and SO_2 emission per inhabitant as a measure of pollution and literacy rate, average number of years spent in school or any other variable for educational attainment of population. The data series for CO_2 spans between 1991 and 2003 only and the data series for SO_2 is even shorter, it spans between 1991 and 2000. The literacy rate data for 2003-2005 is missing at this point in time and average number of years spent is school is not available at all at this moment in time.

Table 1: Main economic and socio-economic data in Croatia

Year	Occupancy rate, acute care hospitals	Average number of days spent in hospital	Average number of physicians visits	Physicians (per 100 000 people)	Number of beds per 100 000 inhabitants	Total fertility rate	Population ages 0-14 (% of total)	Population ages 65 and above (% of total)	Urban population (% of total)	GDP mil. Kn (1997 prices)	Number of unempl.
Variable	**occ**	**days**	**visits**	**phy**	**Beds**	**tfp**	**Pop14**	**Pop65**	**urban**	**gdp**	**unem**
1980.	89,99	17,5	6,89	60,75	723,48	1,92	20,33	11,27	50,0610	163773	78.452
1981.	90,93	16,94	7,08	63,23	730,81	1,91	20,90	11,37	50,5072	166166	86.279
1982.	90,25	16,75	7,28	65,81	742,35	1,90	19,82	10,53	50,9534	163989	99.199
1983.	90,79	16,76	7,48	68,49	746,52	1,88	19,57	10,17	51,3996	161462	107.735
1984.	90,26	16,43	7,69	71,28	744,66	1,87	19,71	10,01	51,8458	164903	114.008
1985.	89,59	16,44	7,90	74,19	745,43	1,81	20,88	10,66	52,2920	165136	119.667
1986.	89,88	16,18	8,05	75,67	740,26	1,76	20,78	10,86	52,6416	169707	122.711
1987.	89,13	15,92	6,43	77,53	742,25	1,74	20,35	11,16	52,9912	169541	122.800
1988.	87,47	15,69	8,15	79,8	744,17	1,74	20,34	11,17	53,3408	167962	134.555
1989.	86,53	15,72	8,12	81,2	739,30	1,67	20,10	11,39	53,6904	165385	139.878
1990.	88,9	15,38	8,24	84,32	737,78	1,67	19,86	11,63	54,0400	151257	160.617
1991.	79,42	14,45	5,77	71,62	652,01	1,55	19,59	11,89	54,3876	119075	253.670
1992.	79,3	15,19	4,44	71,35	621,01	1,39	19,59	11,89	54,7352	105151	266.568
1993.	76,88	14,55	5,75	75,73	607,12	1,43	19,59	11,89	55,0828	96742	250.779
1994.	82,33	13,78	5,82	75,97	590,95	1,43	19,59	11,89	55,4304	102449	243.324
1995.	87,4	13,20	4,80	72,53	575,02	1,50	19,29	12,34	55,7780	109466	240.601
1996.	89,59	13,36	5,76	67,76	618,53	1,64	19,89	12,32	56,1670	115971	261.023
1997.	89,32	12,88	6,08	68,45	600,81	1,69	19,89	12,32	56,5560	123811	277.691
1998.	88,22	12,57	6,51	68,12	606,22	1,45	19,89	12,32	56,9450	126936	287.762
1999.	87,12	12,32	6,61	68,03	593,03	1,38	19,77	12,36	57,3340	126843	321.866
2000.	86,3	11,92	7,00	70,53	615,22	1,40	19,81	12,51	57,7230	129438	357.872
2001.	85,5	11,80	7,46	69,3	599,85	1,38	17,01	15,63	58,1460	135189	380.195
2002.	89,6	11,17	7,49	68,42	566,87	1,34	16,72	16,10	58,5690	142730	389.741
2003.	90,68	11,00	7,58	67,97	561,19	1,33	16,42	16,39	58,9920	150351	329.799
2004.	89,9	10,68	7,59	68	552,98	1,35	16,14	16,64	56,3000	156758	309.875
2005.	88,1	10,29	6,92	67,07	545,26	1,42	15,93	16,84	56,3000	163491	308.738

Source:

Methods and results

Unit root test

Augmented Dickey Fuller coefficient (Dickey Fuller 1979) and Fuller's (Enders, 2004) critical values were used for the unit root test. Lags length for the ADF unit root test was selected according to Akaike and Schwarz criteria (Verbeek, 2004). At first, unit root test was tested in the model with constant and trend:

$$\Delta y_t = a_0 + \gamma \mathrm{y}_{\mathrm{t-1}} + a_1 t + \delta_1 \Delta y_{t-1} + \ldots + \delta_{p-1} \Delta y_{t-p+1} + \varepsilon_t \quad (4)$$

In the case that null hypothesis of unit root hasn't been rejected in the model with constant and tend, unit root test was repeated in the model with constant only:

$$\Delta y_t = a_0 + \gamma \mathrm{y}_{\mathrm{t-1}} + \delta_1 \Delta y_{t-1} + \ldots + \delta_{p-1} \Delta y_{t-p+1} + \varepsilon_t \quad (5)$$

At the end, in the case that null hypothesis of unit root has not been rejected in the model with constant only, unit root test was repeated in the model without constant and trend:

$$\Delta y_t = \gamma \mathrm{y}_{\mathrm{t-1}} + \delta_1 \Delta y_{t-1} + \ldots + \delta_{p-1} \Delta y_{t-p+1} + \varepsilon_t \quad (6)$$

The null hypothesis of the model with constant and trend was H0:(a0,γ,a1)=(0,0,0), the null hypothesis for the model with constant only was H0:(a0,γ)=(0,0) and the null hypothesis for the model without constant and trend was H0:(γ)=(0).

Unit root test indicated that there is two stationary I(0) variables and nine I(1) unit root variables. Null hypothesis of unit root was rejected for DAYS in the model without constant and trend, and for OCC it was rejected in the model with constant.

In the case of variables BEDS, GDP, PHY, POP14, POP65, TFP, UNEM, URBAN and VISITS it was not possible to reject null hypothesis of unit root. Therefore, testing was repeated after differencing variables. In 1st differences null hypothesis of unit root was rejected in the model with trend and constant for BEDS, PHY, POP14, POP65, TFP, UNEM, URBAN and VISITS. For the variable GDP, null hypothesis of unit root was rejected in the model without trend or constant.

Null hypothesis of unit root was rejected at 1% significance level for DAYS, POP14, POP65, URBAN and VISITS; at 5% for BEDS, GDP, PHY, TFP; at 10% for UNEM and OCC.

Having in mind that combining I(0) and I(1) variables in the absence of multicointegration, usually results with spurious regression, further modeling was continued with I(1) variables. Stationary variables were completely omitted from the analysis due to the fact that I(1) variables are numerous. Obviously it is much more interesting to estimated data generating process for the system of nine I(1) variables, compared to system of two I(0) variables.

Variables BEDS, GDP, PHY, POP14, POP65, TFP, UNEM, URBAN and VISITS were used to identify system. Since all of the mentioned variables were of the same order of integration it was necessary to test for cointegration in the system before deciding weather to difference series or not.

Table 2: Unit root test

	Unit root test in levels						Unit root test in 1st differences					
	trend+constant		constant		none		trend+constant		constant		none	
Variable name	ADF	AIC lag	ADF	AIC lag	ADF	AIC lag	ADF	AIC lag	ADF	AIC lag	ADF	AIC lag
Beds	-2,1550	0	-0,2686	0	-1,5904	0	**-4,2831**	**0				
Days	-2,7731	0	2,0182	0	**-3,9084**	*0						
Gdp	-1,7729	1	-2,2101	1	-0,2971	1	-2,3615	1	-1,9072	0	**-1,9550**	**0
Phy	-2,4058	0	-2,1872	0	0,2126	0	**-4,1811**	**1				
Occ	-1,8636	0	**-2,7006**	***2								
pop14	-1,4324	0	-0,0498	0	-1,2896	0	**-5,0184**	*0				
pop65	-1,6127	0	0,6349	0	1,7532	0	**-4,5692**	*0				
Tfp	-2,9633	1	-1,4088	0	-1,4992	0	**-3,8854**	**1				
Unem	-3,0792	1	-1,3239	1	0,4536	1	**-3,3503**	***0				
Urban	-1,2435	1	-1,9186	0	1,9147	0	**-4,8900**	*0				
Visits	-2,1939	0	-2,2020	0	-0,2967	0	**-5,0276**	*0				

Note: * denotes significance at 1%, ** denotes significance at 5% and *** denotes significance at 10%

Johanson cointegration technique

Juselius Johansen cointegration technique actually represents nothing more than a multivariate generalization of the Dickey-Fuller test used for unit root test in previous chapter. (Enders, W., 2004) Instead of y representing a single variable, there is an x and ε representing (n*1) vectors, A denotes (n*n) matrix and I is (n*n) identity matrix.

$$\Delta x_t = \pi x_{t-1} + \varepsilon_t \tag{7}$$

$$\pi_t = (A_t - I) \tag{8}$$

The rank of π matrix **r** represents the number of linear combination of variables included in π matrix or number of cointegrating vectors.

Due to the fact that there is only 25 observations for each of the analyzed variables, it was not possible to estimate VAR for lag length estimation. Therefore, beside eliminating two stationary I(0) variables, it was required to omit one more variable in order to estimate lag length and number of cointegrating vectors in the system. First choice was to eliminate population under 14 years of age (POP14) due to the fact that total fertility rate (TFP) is quite analogous indicator.

Lag length of vector autoregression model was selected with likelihood ratio test. Due to small number of observation it was possible to estimate maximum of two lags. Likelihood test resulted with empirical value of 225.21, compared with critical value of 16.919 at 5% significance level (DF=9; number of variables multiplied with number of restriction). In the case when empirical value exceeds critical value, restriction of one lag can be rejected, or in other words VAR model with two lags was selected).

Nevertheless, at the determined lag length of 2 it was not possible to make cointegration test due to the fact that number of observation was too small. Therefore, cointegration test was estimated with lag lengt of 1. Unrestricted cointegration rank test with no intercept or trend in CE or VAR resulted with trace statistics indicating 8 cointegration vectors and maximum eigenvalue statistics also indicating eight cointegration vectors. Both, trace-eigenvalue and max-eigenvalue test indicated that there are eight cointegrating vectors at 1 and 5% significance level (Table 3).

Table 3: The λtrace and λmax tests

Null hypothesis	Alternative hypothesis	λ trace value	5% Critical value	1% Critical value
r=0	r>0	435.9998	141.20	152.32
r≤1	r>1	272.0136	109.99	119.80
r≤2	r>2	185.0752	82.49	90.45
r≤3	r>3	130.6677	59.46	66.52
r≤4	r>4	86.46123	39.89	45.58
r≤5	r>5	51.63746	24.31	29.75
r≤6	r>6	25.78915	12.53	16.31
r≤7	r>7	6.626811	3.84	6.51
Null hypothesis	Alternative hypothesis	λ max value	5% Critical value	1% Critical value
r=0	r=1	163.9862	47.99	53.90
r=1	r=2	86.93841	41.51	47.15
r=2	r=3	54.40748	36.36	41.00
r=3	r=4	44.20647	30.04	35.17
r=4	r=5	34.82376	23.80	28.82
r=5	r=6	25.84832	17.89	22.99
r=6	r=7	19.16234	11.44	15.69
r=7	r=8	6.626811	3.84	6.51

According to the theory in the case of multiple cointegrating vectors it is obvious that matrix row and column operations are going to result in additional cointegrating vectors which are merely combination of original vectors. Therefore it is required to exclude variables within equation or exclude variables across equations or impose conditional restrictions to estimation process. (Enders, 2004)

Exclusion of variables within equation resulted with two quite compatible models. In the first one, likelihood ratio test indicated VAR model for VISITS, URBAN, GDP, BEDS and PHY variables with no intercept and no trend. Trace statistics indicated 3 cointegrating vectors at 5% and 2 cointegrating vectors at 1% significance level, while max-eigenvalue statistics indicated 1 cointegrating vector, both at 1 and 5% significance level (Table 4). (Enders, 2004)[1]

Table 4: The λtrace and λmax tests for LOGVISITS, LOGURBAN, LOGGDP, LOGBEDS and LOGPHY

Null hypothesis	Alternative hypothesis	λ trace value	5% Critical value	1% Critical value
r=0	r>0	91.76396	59.46	66.52
r≤1	r>1	48.41376	39.89	45.58
r≤2	r>2	28.64440	24.31	29.75
r≤3	r>3	11.39498	12.53	16.31
r≤4	r>4	2.402551	3.84	6.51
Null hypothesis	Alternative hypothesis	λ max value	5% Critical value	1% Critical value
r=0	r>0	43.35020	30.04	35.17
r≤1	r>1	19.76936	23.80	28.82
r≤2	r>2	17.24941	17.89	22.99
r≤3	r>3	8.992434	11.44	15.69
r≤4	r>4	2.402551	3.84	6.51

In the second model for VISITS, URBAN, GDP, BEDS and TFP variables, likelihood ratio test indicated model with intercept in cointegrating equation and no intercept in VAR. Trace statistics once more indicated 3 and max eigenvalue statistics indicated 1 cointegrating vectors (Table 5).

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[1] If results of λtrace and λmax conflict, λmax is usually preferred for trying to pin down the number of cointegrating vectors.

Table 5: The λtrace and λmax tests for LOGVISITS, LOGURBAN, LOGGDP, LOGBEDS and LOGTFP

Null hypothesis	Alternative hypothesis	λ trace value	5% Critical value	1% Critical value
r=0	r>0	115.5370	76.07	84.45
r≤1	r>1	65.71497	53.12	60.16
r≤2	r>2	39.97512	34.91	41.07
r≤3	r>3	18.69943	19.96	24.60
r≤4	r>4	4.060595	9.24	12.97
Null hypothesis	Alternative hypothesis	λ max value	5% Critical value	1% Critical value
r=0	r>0	49.82201	34.40	39.79
r≤1	r>1	25.73986	28.14	33.24
r≤2	r>2	21.27569	22.00	26.81
r≤3	r>3	14.63884	15.67	20.20
r≤4	r>4	4.060595	9.24	12.97

Vector error correction models for both models were estimated with two lags (as an initial VAR likelihood ratio test indicated). The first model resulted with cointegrating vector β=(1.00000; 0.82689; -2.21616; 5.12342; -2.55491). Estimated *β* coefficients were significant at conventional levels. Speed of adjustments coefficients were α_{VISITS}=0.3939; α_{URBAN}=0.1394; α_{GDP}=-0.0885; α_{BEDS}=0.0350; α_{PHY}=-0.1494.

The sample values of χ^2 for restriction α_{VISITS}=0, α_{URBAN}=0, α_{GDP}=0, α_{BEDS}=0 and α_{PHY}=0 are 4.37, 6.99, 0.64, 0.11 and 0.66 respectively. Only the speed of adjustment coefficients for VISITS and URBAN have an empirical χ^2 value exceeding theoretical value 3.841. Hence, GDP, BEDS and PHY variables are weakly exogenous, while VISITS and URBAN are not weakly exogenous variables. Having in mind that there is more than one variable in the system which is not weakly exogenous it was not possible to proceed with estimation of autoregressive distributed lag model for demand for health function (Table 6).

According to the first model percentage of urban population, GDP, number of beds per 100 000 inhabitants and number of physicians are significant in explaining movements in average number of physician visits in Croatia. Although, there is feedback in the model and percentage of urban population is not weakly exogenous and can also be explained by others variables in the system. There is a positive relationship between percentage of urban population, number of beds per 100 000 inhabitants and average number of physician visits and negative between GDP, number of physicians and average number of physician visits.

The second model, also estimated with two lags, resulted with cointegrating vector β=(15.643; 1.000; -1.552; -0.524; -0.759; 0.205). Estimated coefficients were significant at conventional levels with exception of TFP variable. Speed of adjustments coefficients were α_{VISITS}=-2.81; α_{URBAN}=-0.017; α_{GDP}=-0.823; α_{BEDS}=-0.880; α_{TFP}=-0.0855.

The sample values of χ^2 for restriction α_{VISITS}=0, α_{URBAN}=0, α_{GDP}=0, α_{BEDS}=0 and α_{TFP}=0 are 4.53, 0.87, 1.78, 4.58 and 0.08 respectively. Only the speed of adjustment coefficients for VISITS and BEDS have an empirical χ^2 value exceeding theoretical value 3.841. Hence, GDP, URBAN and TFP variables are weakly exogenous, while VISITS and BEDS are not weakly exogenous variables. Therefore, in the system with more than one variable which is not weakly exogenous, it is not possible to proceed with ADL, and VAR methodology is necessary (Table 6).

The second model has three variables that are not weakly exogenous and all variables with exception of total fertility rate have negative sign indicating negative relationship. Average number of physicians visits, GDP and number of beds per 100 000 inhabitants are not weakly exogenous, while percentage of urban population and total fertility rate are weakly exogenous indicating strong feedbacks in the system.

Table 6: Cointegrating vector and speed of adjustment parameters for cointegrated systems

Model	Cointegrating Equation						Error correction					
	C	β_{URBAN}	β_{GDP}	β_{BEDS}	β_{PHY}	β_{TFP}	α_{VISITS}	α_{URBAN}	α_{GDP}	α_{BEDS}	α_{PHY}	α_{TFP}
1		0.826891 (0.09832) ⌈	- (0.08608) ⌈-	5.123418 (0.25243) ⌈	- (0.21515) ⌈-		0.393903 (0.42804) ⌈	0.139382 (0.01621) ⌈	- (0.20269) ⌈-	0.034993 (0.13673) ⌈	- (0.19876) ⌈-	
2	15.64281 (2.95716) ⌈	- (0.57936) ⌈-	- (0.09363) ⌈-	- (0.27347) ⌈-		0.205473 (0.20500) ⌈	- (0.79590) ⌈-	- (0.10095) ⌈-	- (0.43755) ⌈-	- (0.18202) ⌈-		- (0.26819) ⌈-

Note: Standard errors in ( ) & t-statistics in [ ].

In the first model Akaike information criterion is -19.30974 and Schwarz criterion is -16.34758, and in the second model Akaike information criterion is -18.05398 and Schwarz criterion is -15.04245. Therefore, it might be assumed that first model describes real data generating process much better, although with strong feedback in the system.

Discussion

According to our estimation average number of physician visits in Croatia is a function of percentage of urban population, GDP, number of beds per 100 000 people, number of physicians per 100 000 people and total fertility rate. Together with the average number of physician visits, the variables percentage of urban population, GDP and number of beds per 100 000 inhabitants also demonstrated significant levels of endogenity in one of the analyzed models.

In the first model, GDP and number of physicians have negative effect on average number of physician visits while variables percentage of urban population and number of beds in hospitals has positive effect. Possible reason for negative effects of GDP and PHY variables should be found in homeland war activities during our data sample. Usually in war GDP and number of physicians decreases while demand increases. Having in mind that our sample is 25 years long and that war lasted almost seven years, it is obvious that our results are strongly affected by the homeland was era.

In the second model, number of physicians is constrained variable and it is replaced by the total fertility rate. Although the model have less representative Akaike and Schwarz model selection criterions, it is interesting with respect to the effect of population aging and its effect on demand for health. Total fertility rate indicated that age structure affects GDP quite significantly together with positive sign.

Unfortunately it was not possible to find meaningful cointegration vector between population percentages for older than 65 and younger than 14 in order to directly estimate effect of demographic aging on health demand. Once again it should be stated that this is a direct consequence of shortness of our sample as a major limitation of this research. A longer sample that span back in time to the years of much different aging structure of Croatia is much more promising in this regard. Unfortunately, most of the population structure changes had occurred prior to the period analyzed in this paper.

Foremost among the economic implications of these purely statistical findings is what they tell us about demand for health in Croatia. Translated to the level of economic (health) policy, these findings reinforce the idea long term horizon optimizing strategies in the Croatian health sector of economy. Increasing our knowledge of factors which determine observed inequalities in health and the path of lifetime health has important policy implications.

At the end, it should be stated that major limitation of this model is shortness of the sample than span 25 years only. In the context of econometric theory and probability theories it should be evident that this is only a kind of the "back of the envelope" estimate of the model that should lead our thinking about long term strategies in managing health care sector in Croatia.

Therefore, a major recommendation for future research should be to invest additional efforts in acquiring longer samples of data. Extending our sample further in past, or increasing the frequency of data to quarterly or even monthly data could result with models that might be used even for forecasting health demand. In that way such techniques might became cornerstones of long term, efficient and above all rational thinking about health care system in Croatia.

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