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Healthcare expenditure with causal recipes☆

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ABSTRACT

Healthcare is turning a big business. A better understanding of the factors affecting healthcare expenditure (HCE) can assist expenditure control. This study uses fuzzy set/Qualitative Comparative Analysis (fsQCA) to explore the sufficient conditions for the outcome, HCE. FsQCA provides causal recipes for each year to show the causal complexities leading to the outcome of that year with high consistencies. The three most recurrent causal recipes are: (1) longevity countries with many doctors and aging population; (2) longevity and rich countries with many doctors; and (3) longevity and rich countries with aging population. The analysis also shows strong predictive validities. The causal recipes of the first few years can successfully forecast the causal recipe(s) of following years.

1. Introduction

Healthcare is a big business, involving significant government regulation, direct program provision, and expenditure (Hall, Viney, Haas, & Louviere, 2004). Total healthcare expenditures (HCEs) comprise health goods and services consumption, and capital investment in healthcare infrastructure (Nahler, 2009). In many developed countries, the HCE may take up to 8% of GDP (Anderson, Hurst, Hussey, & Jee-Hughes, 2000). The factors affecting the HCE are important and can assist the understanding and control of the expenditure.

Many factors may affect the HCE. Huarng and Yu (2014) forecast the quantile relationships for the HCE through factors such as GDP per capita, population of more than 65 years, number of physicians per 1000 population, infant mortality, and life expectancy. Moreover, this study explores and forecasts the relationship between these factors and the HCE.

Complex causality draws growing attention (Schneider & Eggert, 2014). Studies include politics (Redding & Viterna, 1999), social sciences (Cress & Snow, 1996), training (Woodside, 2012), and management (Fiss, 2011; Woodside, 2013; Woodside & Zhang, 2012). Studies with a complex causality perspective distinguish between necessary and sufficient conditions (Fiss, 2007).

The fuzzy set/Qualitative Comparative Analysis (fsQCA) focuses on asymmetric relationships to find conditions that are sufficient to cause an outcome (Woodside, 2013). By consistency and coverage, fsQCA estimates the quality of outcome explanation by alternative configurative models (Woodside, Hsu, & Marshall, 2011). FsQCA differs from conventional statistical methods in the following aspects: Set-theoretic versus correlational connections, calibration versus measurement, conditions configurational versus independent variables, and causal complexity analysis versus net effects analysis (Ragin, 2008).

Hence, this study applies fsQCA to show the causal recipes (combinations of factors or antecedents) for the HCE. Different causal recipes contribute to the high HCE, providing a more exhaustive theory. Further analysis demonstrates predictive validities. Section 2 presents a literature review and poses some propositions. Section 3 introduces fsQCA and antecedents. Section 4 shows annual causal recipes and demonstrates the predictive validities through fsQCA. Section 5 concludes this study.

2. Propositions

Many HCE studies focus on longevity. Omori (2011) studies the relationship between public HCE and longevity. Lichtenberg (2014) studies the relationship between longevity and HCE in France during 2000–2009. Lichtenberg and Pettersson (2012) explore the relationship between longevity and HCE in Sweden from 1997 to 2010. Hence, this study proposes:

Proposition 1. Longevity countries are high HCE countries.

Casado (2001) states that developed countries elderly population is increasing extraordinarily. However, only a small portion of

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expenditures increase results from population aging. Dreger and Reimers (2005) empirically analyze elderly population as an antecedent affecting the HCE. Bech, Christiansen, Khoman, Lauridsen, and Weale (2011) study the EU-15 countries and suggest an aging positive short-run effect on the HCE, but an aging long-run effect close to zero. However, Barros (1998) finds no significant effect of aging population on the HCE. Hence, elderly population is an interesting research factor.

The HCE comprises public and private sources spending on medical services and goods, public health and prevention programs, and administration (Nahler, 2009). Costa-Font and Pons-Novell (2007) find that the number of doctors is a key factor for HCE within Spain. Conversely, Rahman (2008) finds the number of doctors is a statistically insignificant factor. Hence, analyzing the number of doctors' effect on the HCE may be interesting.

Many studies focus on how GDP affects the HCE, including Bac and Le Pen (2002), Hansen and King (1996), Hitiris (1997), Hitiris and Posnett (1992), Liu, Li, and Wang (2011), and Sen (2005). Lago-Peñasa, Cantarero-Prietod, and Blázquez-Fernándezd (2013) examine the relationship between GDP and HCEs; and Mehrara, Musai, and Amiri (2010) analyze the relationship between GDP and HCEs in 31 countries of the Organization for Economic Cooperation and Development. Hence, this study includes GDP as one of the factors.

According to the above literature review, this study states the following propositions:

Proposition 2. Longevity countries with numerous doctors and aging population are high HCE countries.

Proposition 3. Longevity and rich countries with numerous doctors are high HCE countries.

Proposition 4. Longevity and rich countries with aging population are high HCE countries.

3. Research method

3.1. FsQCA

This study applies fsQCA for empirical analyses. FsQCA is an analytic tool using fuzzy set theory and Boolean logic (Ragin, 2008). First, fsQCA calibrates the data from 0.0 to 1.0, where 0.0 means full non-membership and 1.0 means full membership. Woodside and Zhang (2013) gain insight on calibrations performance. After processing calibrated data, fsQCA provides the configurational of antecedents, such as ~X*Y → Z, where X and Y are the antecedents, and Z is the outcome. In addition, * represents logic, and ~represents NOT. The antecedents that * connects are antecedent combinations such as ~X*Y. The above equation means that ~X*Y is a sufficient condition for Z. FsQCA provides different causal recipes without necessarily exhausting all the antecedents.

3.2. Antecedents and outcome

Following Huarng and Yu (2014), this study uses hce (the log of HCEs) to represent the outcome. The antecedents comprise gdp (the log of GDP per capita), old (population of more than 65 years), doc (the number of doctors per 1000 population), im (infant mortality), and le (life expectancy). OECD Health DATA 2009 provides the data of these antecedents and the outcome. After calibration, c_hce stands for the calibrated outcome and c_gdp, c_old, c_doc, c_im, and c_le are for the calibrated antecedents, respectively.

4. Empirical analysis

Table 1 contains fsQCA analysis for the relationships between the HCE and the antecedents of each year from 1992 to 2007. This section provides detail discussions.

4.1. Empirical results by fsQCA

In 1992, for example, three causal recipes exist, each with consistency higher than 0.95. Therefore, these three causal recipes can lead to high c_hce in 1992. For the remaining years, fsQCA provides the causal recipe(s), whose consistencies are all higher than 0.90, indicating that these causal recipe(s) can successfully explain the causal

Table 1
FsQCA analysis results.

	Raw coverage	Unique coverage	Consistency
1992			
(1) **c_le* ~ c_im*c_doc*c_old**	0.676048	0.014384	0.960035
(2) c_le* ~ c_im*c_doc*c_gdp	0.683552	0.021889	0.993636
(3) *c_le* ~ c_im*c_old*c_gdp*	0.829268	0.167605	0.982950
1993			
(1) **c_le* ~ c_im*c_doc*c_old**	0.664384	0.022416	0.949288
(3) *c_le* ~ c_im*c_old*c_gdp*	0.829390	0.187422	0.976540
1994			
(4) c_le* ~ c_im* ~ c_doc*c_gdp	0.495463	0.170599	0.956776
(1) **c_le* ~ c_im*c_doc*c_old**	0.653962	0.329098	0.960889
1995			
(4) c_le* ~ c_im* ~ c_doc*c_gdp	0.489845	0.172640	0.960187
(1) **c_le* ~ c_im*c_doc*c_old**	0.659498	0.342294	0.964192
1996			
(1) **c_le* ~ c_im*c_doc*c_old**	0.643953	0.025783	0.957117
(3) *c_le* ~ c_im*c_old*c_gdp*	0.833026	0.214856	0.973458
1997			
(1) **c_le* ~ c_im*c_doc*c_old**	0.668332	0.024984	0.949423
(3) *c_le* ~ c_im*c_old*c_gdp*	0.850718	0.207370	0.973553
1998			
(1) **c_le* ~ c_im*c_doc*c_old**	0.666879	0.020382	0.939014
(3) *c_le* ~ c_im*c_old*c_gdp*	0.864968	0.218471	0.971388
1999			
(3) *c_le* ~ c_im*c_old*c_gdp*	0.883091	0.883091	0.963256
2000			
(3) *c_le* ~ c_im*c_old*c_gdp*	0.895482	0.895482	0.963715
2001			
(3) *c_le* ~ c_im*c_old*c_gdp*	0.884820	0.884820	0.949286
2002			
(3) *c_le* ~ c_im*c_old*c_gdp*	0.872355	0.872355	0.952347
2003			
(2) c_le* ~ c_im*c_doc*c_gdp	0.633421	0.017173	0.965760
(3) *c_le* ~ c_im*c_old*c_gdp*	0.846103	0.229855	0.958115
2004			
(1) **c_le* ~ c_im*c_doc*c_old**	0.620433	0.004060	0.939549
(2) c_le* ~ c_im*c_doc*c_gdp	0.633288	0.016915	0.970954
(3) *c_le* ~ c_im*c_old*c_gdp*	0.845061	0.228687	0.956355
2005			
(1) **c_le* ~ c_im*c_doc*c_old**	0.621088	0.008163	0.959033
(2) c_le* ~ c_im*c_doc*c_gdp	0.631973	0.019048	0.986200
(3) *c_le* ~ c_im*c_old*c_gdp*	0.844218	0.231292	0.971809
2006			
(1) **c_le* ~ c_im*c_doc*c_old**	0.595890	0.013699	0.963455
(2) c_le* ~ c_im*c_doc*c_gdp	0.597260	0.015069	0.992036
(3) *c_le* ~ c_im*c_old*c_gdp*	0.823288	0.241096	0.976442
2007			
(5) c_le* ~ c_im* ~ c_doc*c_old	0.630420	0.191328	0.967265
(2) c_le* ~ c_im*c_doc*c_gdp	0.553338	0.114246	0.990148