HEALTH ECONOMICS LETTER

A CONSISTENT DECOMPOSITION OF THE REDISTRIBUTIVE, VERTICAL, AND HORIZONTAL EFFECTS OF HEALTH CARE FINANCE BY FACTOR COMPONENTS

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SUMMARY

In studies on the redistributive, vertical, and horizontal effects of health care financing, the sum of the contributions calculated for each financial instrument does not equal the total effects. As a consequence, the final calculations tend to be overestimated or underestimated. The solution proposed here involves the adaptation of the Shapley value to achieve additive results for all the effects and reveals the relative contributions of different instruments to the change of whole-system equity. An understanding of this change would help policy makers attain equitable health care financing. We test the method with the public finance and private payments of health care systems in Denmark and the Netherlands. Copyright © 2012 John Wiley & Sons, Ltd.

1. INTRODUCTION

In studies on the redistributive, vertical, and horizontal effects of health care financing, the sum of the contributions calculated for each financial instrument does not equal the total effects. Although partial approaches exist (Kakwani, 1977; Zhong, 2009), they fail to produce additive solutions for the total effects. The solution proposed here involves the adaptation of the Shapley value to achieve additive results for all the effects and to prevent deviations in the estimates. Moreover, it reveals the relative contributions of different instruments to the change of whole-system equity. An understanding of this change would thus help policy makers achieve equitable financing. To verify the results, this method is illustrated with applications to the public finance and private payments of health care systems in Denmark and the Netherlands.

2. METHODS

Take X as the initial income and T as the sum of the different payments, T_i, where $N = (1, \ldots, i, \ldots, n)$, $N \in R^+$. We measure the redistributive effect (RE) of each financial instrument, T_i, using the Reynolds–Smolensky index (1977), where the additive inconsistency of the results implies that

$$RE(T) \neq \sum_{i=1}^{n} RE(T_i) \tag{1}$$

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Irrespective of whether *RE* is broken down into the vertical effect, *V*, and re-ranking, *Rk* (Kakwani, 1984), or into the horizontal inequity, *H*, and re-ranking, *R* (Aronson *et al*., 1994), the problem of non-additivity in each of the components of *RE* is still reproduced.

Shorrocks (1999) and Chantreuil and Trannoy (2011) proposed applications of the Shapley value (Shapley, 1953) to the decomposition of inequality by factor components. We adapt this methodology to the decomposition of the change of inequality (*RE*) by factor components, following Sastre and Trannoy (2002).

We calculate *RE* of each T_i that makes up health care financing as follows.

$$RE(T_i)_T^{\text{Sh}} = \sum_{\substack{S \subseteq N \\ i \in S}}^{n} \frac{(n-s)!(s-1)!}{n!}[RE(S) - RE(S - T_i)] \tag{2}$$

Hence,

$$RE(T) = \sum_{i=1}^{n} RE(T_i)_T^{\text{Sh}} \tag{3}$$

Then, we can generalize this expression to determine the contribution of each T_i to *V(T)*, *H(T)*, and *Rk(T)* or *R(T)*.

In Table I, the total system of health care financing (*TS*) is the sum of private payments (*PR*) and public financing (*PU*). Thus, sequence 1 calculates *RE* of *PR* after *PU*, whereas sequence 2 calculates the effect of *PU* after *PR*. The Shapley value (Sh) calculates the weighted average of the marginal effects of each instrument in each sequence. Because the sequential calculations comply with the additive property, their weighted average also complies with it, and therefore, an additive and symmetric solution is found (V + VI = VII). This solution can be applied to *RE*, *V*, *H*, and *R* or *Rk*.

Kakwani (1977, 1984), Aronson *et al*. (1994), and Zhong (2009) calculated the total effect, VII, and effects I and IV. All three effects were estimated as the marginal effects on initial income, and the sum of effects I and IV was not equal to the value obtained in VII. Therefore, the result is not additive, and exact percentages cannot be attributed to the effect that each instrument contributes towards the overall effect.

We accept the idea of simultaneity in the case of health care funding because public financing payments, be they general taxes or social security payments, are made throughout the fiscal year to finance the spending for that year. On the other hand, the payments of private insurance premiums are made in the same year. Out-of-pocket payments are made on the basis of the randomness of the illness. Therefore, it is difficult to establish a sequence in these payments.

3. RESULTS

To verify this method, we use data pertaining to public finance and private payments of health care systems in Denmark from 1987 and in the Netherlands from 1992, from Van Doorslaer *et al*. (1999,VDW), denoted as PU^{VDW} and PR^{VDW}, respectively. They provide data on *RE* and *V*, following Aronson *et al*. (1994). We then can deduce the value of *Rk*, according to the definition by Kakwani (1984). Table II reproduces the figures given by VDW, the deduced *Rk* values, and the results from applying the Shapley value.

Table I. Sequential decomposition of the redistributive effect of health care finance by components

	Sequence 1	Sequence 2	Shapley solution
	(Public–private)	(Private–public)	
Public finance (*PU*)	*RE(PU)* (I)	*RE(TS) − RE(PR)* (III)	$RE(PU)_{TS}^{sh} = 1/2[(RE(TS) - RE(PR)]$ $+ 1/2[(RE(PU)]$ (V)
Private payments (*PR*)	*RE(TS) − RE(PU)* (II)	~~RE(PU)~~ (IV)	$RE(PR)_{TS}^{sh} = 1/2[(RE(TS) - RE(PU)]$ $+ 1/2[(RE(PR)]$ (VI)
Total system (*TS = PU + PR*)	*RE(TS)* (VII)	*RE(TS)* (VII)	*RE(TS)* (VII)

Source: Devised by the authors.

Table II. Decomposition of the redistributive, vertical, and horizontal effects of health care system financing in Denmark and the Netherlands by factor components (VDW decomposition versus Shapley decomposition)

	Total system (TS)	VDW decomposition			Shapley decomposition	
	(1)	Public finance (PU^{VDW}) (2)	Private finance (PR^{VDW}) (3)	$PU^{\text{VDW}} + PR^{\text{VDW}}$ (4)	Public finance (PU^{Sh}) (5)	Private finance (PR^{Sh}) (6)
Denmark						
RE	−0.0005	0.0024	−0.0021	0.0003	0.002	−0.0025
V	−0.0003	0.0025	−0.002	0.0005	0.0021	−0.0024
Rk	−0.0002	−0.0001	−0.0001	−0.0002	−0.0001	−0.0001
The Netherlands						
RE	−0.0086	−0.0096	0.0005	−0.0091	−0.00935	0.00075
V	−0.008	−0.0089	0.0011	−0.0078	−0.009	0.001
Rk	−0.0006	−0.0007	−0.0006	−0.0013	−0.00035	−0.00025

	Deviation of VDW with respect to Sh (%)		Contribution of each instrument according to Sh to the change of whole-system equity (%)		
	$(PU^{\text{VDW}} − PU^{\text{Sh}})/PU^{\text{Sh}}$ (7)	$(PR^{\text{VDW}} − PR^{\text{Sh}})/PR^{\text{Sh}}$ (8)	TS (9)	PU^{Sh} (10)	PR^{Sh} (11)
Denmark					
RE	20.00	−16	100.0	−400.0	500.0
V	19.05	−17	60.0	−420.0	480.0
Rk	0.00	0	40.0	20.0	20.0
The Netherlands					
RE	2.67	−33	100.0	109.0	−9.0
V	−1.11	10	93.0	105.0	−12.0
Rk	100.00	140	7.0	4.0	3.0

Source: Columns (1), (2), and (3) from Van Doorslaer et al. (1999, Tables 1 and 3). Columns (4)–(11) are the author's own elaboration from Van Doorslaer et al. (1999).

Q5

Q6

Q7

The health care systems for both countries are mainly publicly financed. In both cases, the VDW results in column 1 of Table II indicate that this financing is regressive ($RE(TS)$ and $V(TS)$ are negative). The Danish health care system is mainly financed via general taxation (82.96% of health spending), with direct payments and voluntary health insurance accounting for 14.26% and 2.04%, respectively. Its regressivity is explained by the out-of-pocket payments for medicine and dental health, which are independent of the income level (Exter *et al*., 2004). On the other hand, the system in the Netherlands is financed as follows: 66.24% through social security, 9.5% through taxes, 8.76% through direct payments, and 15.41% through private insurance (Schäfer *et al*., 2010). Thus, the negative RE is mainly due to the regressivity of the public financing. [Q1]

If we analyse the data by the financing source, the VDW results are clearly inconsistent, as $Rk(TS)$ is summed up by $Rk(PU)^{\mathrm{VDW}}$ and $Rk(PR)^{\mathrm{VDW}}$ only for Denmark. Furthermore, in Denmark, the problem is even greater for RE and V, whose signs are opposing. Thus, the financing of the Danish health care system gives rise to a progressive redistribution of income if we add the values for PU^{VDW} and PR^{VDW} (column 4). Moreover, the health care financing is shown to be regressive when we calculate $RE(TS)$ and $V(TS)$ (column 1).

This inconsistency and its consequences disappear when we apply our adaptation of the Shapley value $((5) + (6) = (1))$. Furthermore, unlike VDW, we can determine the relative contribution for each instrument to $RE(TS)$, $V(TS)$, and $Rk(TS)$ (columns 9, 10, and 11).

4. DISCUSSION

The adaptation of the Shapley value achieves a consistent decomposition of the redistributive effects of health care finance by factor components and reveals the relative contributions of each instrument to the change of whole-system equity. Thus, we find a complete solution to a problem that was only partially solved (Kakwani, 1977, 1984; Zhong, 2009).

This methodological improvement has consequences in the design and implementation of health care financing policies. For instance, in the case of Denmark, $RE(TS)$ is negative. However, adding $RE(PU)^{\mathrm{VDW}}$ and $RE(PR)^{\mathrm{VDW}}$ provides a positive result. This discrepancy allows policy makers to consider either value as a reference. So, if the policy makers are defenders of private health care financing, then they can use both the $RE(PU)^{\mathrm{VDW}}$ value and the $RE(PR)^{\mathrm{VDW}}$ value to assert that public finance more than compensates the redistribution produced by private payments and that there is a margin to reduce it. If, on the other hand, the policy makers are firmly in favour of public financing, then they can use the $RE(TS)$ data to assert that public finance does not correct the negative regressivity of private payments. Thus, such a discrepancy in the data allows their discretional use or, what is worse, their manipulation to 'scientifically' justify what are likely to be biased judgments.

Similarly, an inaccurate VDW calculation hinders the setting of appropriate objectives in a quantitative manner. So, if we wished to eliminate the horizontal inequality in health care finance in the Netherlands, then we would need to reduce the value of $Rk(PU)^{\mathrm{VDW}}$ by 0.0007. However, according to the appropriate calculation that takes into account the interactions between the different resources, that is, $Rk(PU)^{\mathrm{Sh}}$, the value of horizontal inequality would actually be 0.00035. Namely, the inexactitude in the calculation of the indices gives rise to an incorrect or incomplete picture on the ground, which in turn does not allow policy makers to derive appropriate objectives for health care financing policies. As a consequence, the results deviate from the stated objectives.

However, it is worth noting that the Shapley value too has a limitation, because the results may vary with the level of disaggregation of the financing structure (Sastre and Trannoy, 2002). Anyway, this limitation does not invalidate the improvements obtained by applying the Shapley method instead of the traditional method. The obtained values always comply with the additive property and are always more accurate because they consider the interaction between the financing instruments.

CONFLICT OF INTEREST

None

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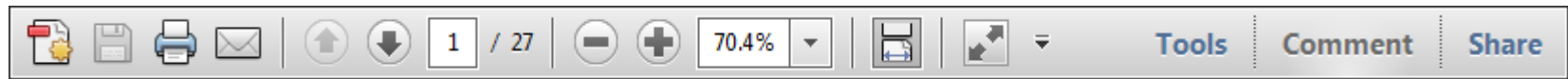
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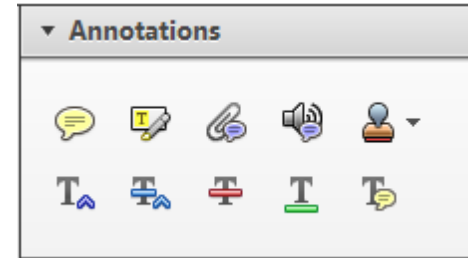
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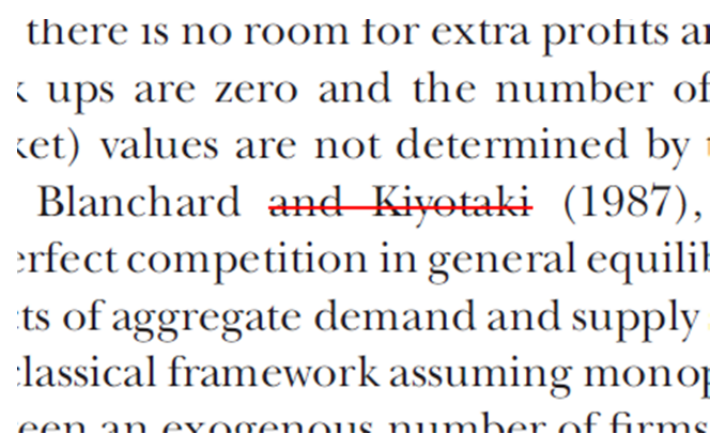- Type the replacement text into the blue box that appears.

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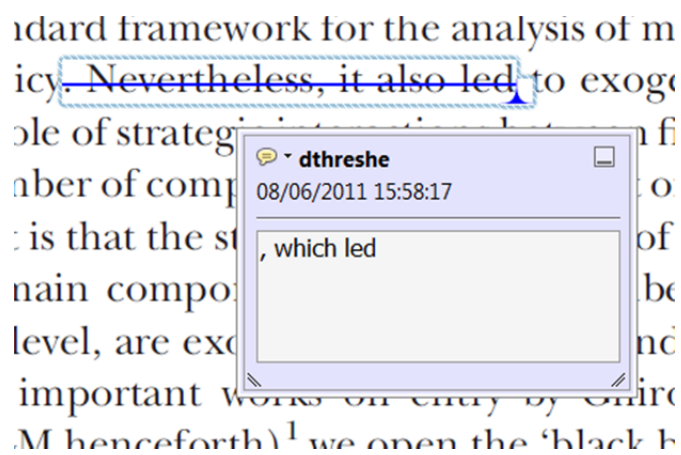
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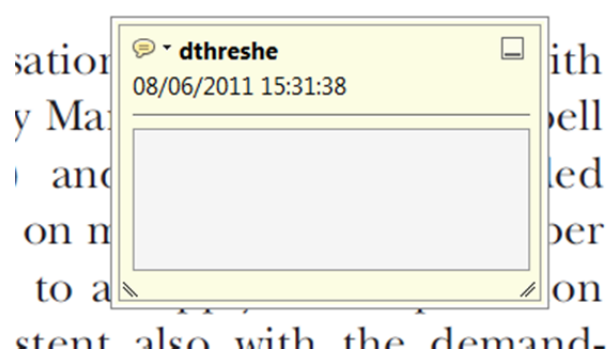
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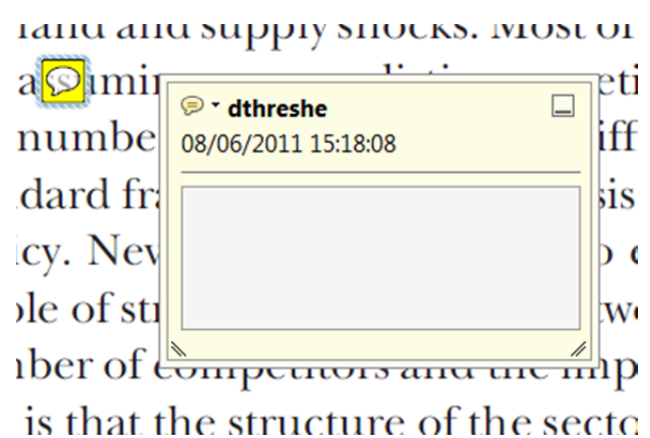

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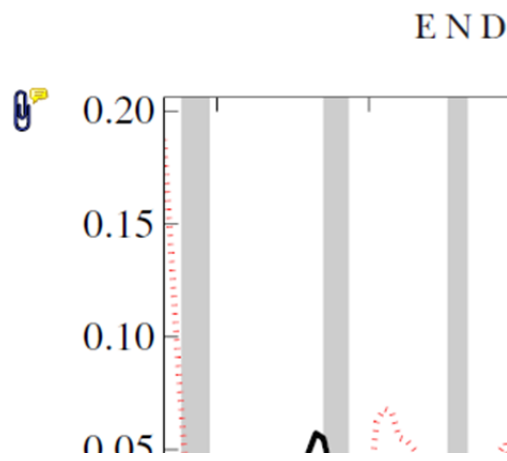
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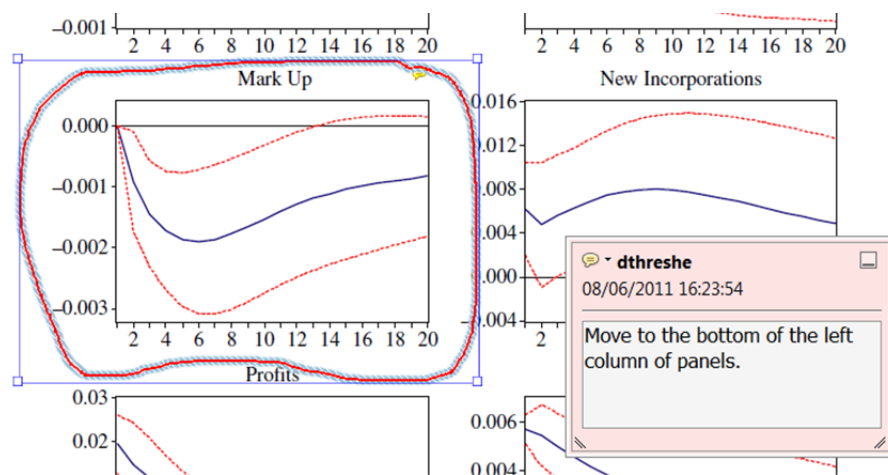
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