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THE CONSTRUCTION OF A PRICE INDEX FOR CONTRIBUTIONS TO SOUTH AFRICAN OPEN MEDICAL SCHEMES

By S Ramjee, A Kooverjee and KA Dreyer

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ABSTRACT
An accurate measure of the change in the price of medical-scheme cover over time is necessary to inform health and social-security policy, and would provide consumers, employers and the regulator with a useful benchmark. A medical-scheme contribution index based on gross contributions to open medical schemes is constructed using the Paasche formula and a sample of schemes for the period 2006 to 2010. The results of the index indicate a 17,48% increase in real contributions over the period.

KEYWORDS
South Africa; medical schemes; price index

CONTACT DETAILS
Shivani Ramjee, School of Management Studies, University of Cape Town, Private Bag, Rondebosch, 7701; Tel: +27(0)21 650 2478; E-mail: shivani.ramjee@uct.ac.za

1. INTRODUCTION

1.1 In the 2008–09 fiscal year, health-sector expenditure in South Africa made up 8,9% of gross domestic product.[1] Most (58,4%) of this expenditure occurred in the private sector,[2] where medical schemes act as the primary financing intermediaries by collecting contributions, pooling these contributions and purchasing medical goods and services. As at 31 December 2011 there were approximately 8,4 million beneficiaries covered by medical schemes, representing 16,6% of the population.[3,4]

1.2 Medical schemes are tax-exempt, not-for-profit entities owned by their members. Members of medical schemes pay monthly contributions to the scheme, on their own behalf as well as on behalf of their dependants. Medical schemes are regulated by the Council for Medical Schemes (CMS) under the Medical Schemes Act[5] and are subject to 'community rating' (where contributions are allowed to vary only by family size, family structure, in terms of adult and child dependants, and income and not by risk factors such as age and health status), resulting in relatively simple contribution tables.

1.3 The gross contributions received by medical schemes, which include both risk and savings contributions and are inclusive of loadings for non-healthcare costs such as administration, totalled R107,4 billion in 2011.[6] Medical-scheme contributions form part of the consumer price index published by Statistics South Africa. As of January 2009 they form part of the subcategory 'Miscellaneous Goods and Services/Insurance/Insurance connected with health'.[7] At time of writing, this subcategory has a weight of 3,68% in the headline CPI and is based on the unweighted average contributions of a sample of five medical schemes in South Africa (Kelly, unpublished).

1.4 The affordability of medical-scheme cover has been the focus of long-standing debate. Medical-scheme cover is unaffordable for the vast majority of South Africans[8] and the rising cost of cover has been put forward in numerous forums as part of the motivation for the introduction of national health insurance (NHI).[9]

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1 C Day & A Gray. Health and Related Indicators. *In* Fonn & Padarath (eds.), *South African Health Review 2010*. Durban, Health Systems Trust, 2010
2 ibid.
3 Council for Medical Schemes. Annual Report 2011–12
4 Statistics South Africa. Mid-year population estimates 2011
5 Act no. 131 of 1998
6 Council for Medical Schemes, supra
7 Statistics South Africa. The South African CPI Sources and Methods Manual. Release v.1: Statistics South Africa, 2009
8 Eighty20. Demand-side analysis of medical scheme coverage and access in South Africa. FinMark Trust, 2009
9 D McIntyre. Private sector involvement in funding and providing health services in South Africa: Implications for equity and access to health care. Equinet.

1.5 There is, however, no widely accepted methodology for tracking increases in medical-scheme contributions. This research considered the issues affecting the construction of a price index and the authors propose a method for constructing an index to monitor the changes in the gross price of medical-scheme cover. Application of the method is demonstrated through the construction of a contribution index for a sample of medical schemes based on data for the time period 2006 to 2010.

1.6 Consumers and employers have a direct interest in the changes in the price of medical-scheme cover, and a published price index would be a useful comparative tool. Employers may subsidise the medical-scheme contributions of employees and would have an interest in the trends in remuneration costs, particularly their post-retirement liability. The CMS currently approves annual increases in medical-scheme contributions and would benefit from an accurate and representative benchmark. A major function of the CMS is to protect the interests of members of medical schemes.[10] The CMS could use this index as a high-level tool to monitor the affordability of cover in South Africa, as could labour unions in the wage negotiation process. As medical-scheme contributions are partially tax-deductible, National Treasury and the South African Revenue Service are also likely to be interested in the price of medical-scheme cover over time.

1.7 The adjustment of the contribution index to allow for differences in benefit richness over time is outside of the scope of this paper. South African medical-scheme benefit design is not standardised, which makes objective comparisons difficult.

1.8 South Africa is in the process of moving towards a system of national health insurance and the future of medical schemes in this new paradigm is unclear.[11] The proposed index methodology would need to be revised to reflect the contributions to the funding entity or entities that may replace the current medical-scheme structures. However, the current proposals envisage a 14-year implementation period for NHI, implying the continued existence of medical schemes for some time to come.

1.9 In section 2, the authors outline the relevant literature on index methodology and the current methodology used by Statistics South Africa. In section 3 they outline the data sources they used. In section 4 they describe the methodological choices that they made in defining the price of medical-scheme cover, constructing the basket and choosing an index formula. In section 5 they present their results, compare the results to other relevant price indices and illustrate the sensitivity of the results to the assumptions made. In the final section they discuss the implications of the research and highlight areas for further work.

10 Council for Medical Schemes. Annual Report 2008–9

11 Department of Health. Green Paper: National Health Insurance in South Africa. Pretoria, 2011

2. BACKGROUND

2.1 'Index numbers' are single numbers used to summarise key features of a set of variables. A 'price index' is a measure of changes in prices of a set of goods and services over time, and can be used to separate a change in total expenditure into price changes and quantity changes (ILO et al., 2004).

2.2 The key methodological issues to be considered in the construction of a price index include the determination of the basket of goods and services, the measurement of prices, the aggregation of these prices, the time span the index should cover and the intervals at which it should be calculated. It is desirable that a price index be accurate, simple and intelligible; the accuracy of an index depends on the choice of formula, the sample size, the sampling methodology and the quality of the original data (Fisher, 1927). These issues apply equally to the construction of an index of insurance prices.

2.3 There are practical constraints on index construction, primarily relating to data availability, collection and processing. The construction of an index of contributions to open medical schemes is complicated by the large number of medical-scheme options available and changes in the market: new options are continually being introduced and changes are continually being made to existing options (Boskin et al., 1998). This complexity is offset by infrequent price changes. Although medical-scheme membership changes from month to month, price changes require regulatory approval and thus typically occur only once a year.

2.4 Index numbers are assigned a value of 1 or 100 for a reference period and all price changes are expressed relatively to this reference period which is denoted period 0. A price index can be calculated from the percentage change in the value of an aggregate, holding the quantities constant (ILO et al., op. cit.).

2.5 Alternatively, the change in the price index can be calculated by calculating price changes for each item in the basket of goods, the price changes are then weighted according to the proportion of total expenditure that the relevant item comprises in the basket of goods and services (ILO et al., op. cit.) and a weighted average is calculated. The price movements are referred to as 'price relatives', which are defined as the ratio of the price of a single item at a second date to the price of the same item at an earlier date (ILO et al., op. cit.).

2.6 Either way, a price index is simply a weighted average. The two approaches are mathematically identical if the same assumptions are made. The price-relative approach is particularly useful where various sub-indices are required or where the effect of a change in one constituent needs to be analysed (Crowe, 1965). Further discussion is confined to this approach. The choices of possible formulae thus depend on the method of averaging (for example, geometric averaging) and the possible choices of weights.

Due to the forces of supply and demand (amongst other factors) the pattern of relative quantities of goods and services consumed and hence the weights change over time. The general form of the weights is given in equation (1).

$$s_i^{0b} = \frac{p_i^0 q_i^b}{\sum_{i=1}^{n} p_i^0 q_i^b} \tag{1}$$

where:

p_i^0 is the price of item i, which is assumed to be constant within each time period, in time period 0;
q_i^b is the quantity of item i included in the basket in time period b;
0 is the price reference period; and
b is the weight reference period.

It is likely that the weight reference period will precede price reference period, at least when the index is first published, but weight reference could be any period, including one between the price reference period and the comparison period, if the index is calculated after the comparison period.

2.7 The Lowe formula, denoted here as P_{Lo}, is a standard fixed-basket formula using the general form of the weights. The generic Lowe formula in price-relative form can be seen in equation (2).

$$P_{\text{Lo}} = \sum_{i=1}^{n} \left(\frac{p_i^t}{p_i^0} \right) s_i^{0b} \tag{2}$$

where:

n is the number of items in the basket of goods and services; and
t is the period of comparison.

2.8 There are two special forms of the Lowe formula that are discussed extensively in the literature:

– the Laspeyres formula, denoted here as P_{L} (Laspeyres, 1871, as cited in ILO et al., op. cit.), where the price reference period is the same as the weight reference period (i.e. $b = 0$); and
– the Paasche formula, denoted here as P_{P} (Paasche, 1874, as cited in ILO et al., op.cit.), where both the price and weight reference periods are set to the period of comparison. The Laspeyres formula is given in equation (3); and the Paasche formula in equation (4).

$$P_{\text{L}} = \sum_{i=1}^{n} \left(\frac{p_i^t}{p_i^0} \right) s_i^{00} \tag{3}$$

$$P_P = \left\{ \sum_{i=1}^{n} \left(\frac{p_i^t}{p_i^0} \right)^{-1} s_i^{tt} \right\}^{-1} \quad (4)$$

2.9 The Laspeyres index assumes a "rigid quantitative pattern of consumption" (Marris, 1958, p.244) in that it does not allow for shifts in supply and demand in response to price increases. The Laspeyres index tends to overstate the overall increase in prices because consumers tend to substitute items that have had lower price increases for those that have had higher price increases. This substitution bias is often referred to as the 'Laspeyres bias'. The extent of the bias will depend on the price elasticity of demand and the extent to which substitutes are available. In this situation the Paasche index will understate the overall increase in price as the weights will reflect the shift towards the items that experienced the lowest price increases. It exaggerates the effect of savings that can be generated through substitution.

2.10 The relationship between Paasche and Laspeyres depends on the relationship between price and quantity movements, which are affected by the demand-side effects described above as well as by supply-side effects. Large differences between the Laspeyres and Paasche price-index numbers will arise if the weights in the two time periods are significantly different and if there is a relationship between changes in price and changes in the quantities purchased (Marris, op.cit.). In such a situation there exists a further class of index formulae termed 'superlative formulae'. A commonly used example is the Fisher formula, which is the geometric average of the corresponding Laspeyres and Paasche values (Fisher, op. cit.).

2.11 The common use of the Laspeyres formula is largely driven by a lack of availability of current expenditure data. In addition, the idea of a constant set of weights preserves continuity (Newhouse, unpublished). However, as consumer preferences and conditions change over time the items selected for the basket become less representative and the relative importance of items also changes (Newhouse, op. cit.). This necessitates updating the basket from time to time to ensure that the index does not become irrelevant.

2.12 The large number of goods and services available, together with limitations on data availability, often make it necessary for a price index to be based on a representative sample of goods. The sampling methodology and sample size greatly affect the accuracy of the index and the choices made will influence whether the items in the basket are representative and relevant and whether they reflect the primary purpose of the index (Crowe, op. cit.).

2.13 Because of the time-consuming and data-intensive process involved in the calculation of a price index, purposive sampling is sometimes used. Purposive sampling is more cost-effective, particularly where clusters of data can be collected. For example,

instead of sampling medical-scheme options to estimate expenditure weights, data could be collected from a single medical-scheme administrator that administers multiple medical schemes. Purposive sampling is problematic in that it introduces subjective factors, which means that sampling error cannot be calculated (ILO et al., op. cit.).

2.14 The sampling method will affect the weighting structure of the index, in that weight data will only be available for sampled items. Fisher (op. cit.) refers to the concept of double-weighting (the calculation of weights for individual items and for categories of items) as a means of improving accuracy. If only the individual items are weighted, some categories may be given more weight than other categories if expenditure on the sampled items is a higher proportion of expenditure for those categories. Statistics South Africa[12] and the American Bureau of Labor Statistics (Boskin et al., op. cit.) make use of a hierarchical or pyramidal structure in the construction of their consumer price index where weighting occurs at multiple levels.

2.15 At the lowest level of an index, elementary price indices are estimated, and, because of limitations on data availability, they are most often calculated without the use of explicit expenditure weights (ILO et al., op. cit.). The lack of weighting means that simple averages are used. As with the higher-level formulae, elementary price indices can be in aggregate form or price-relative form. Three options described by ILO et al. (op. cit.) are:
- the Carli index, which uses the simple arithmetic mean of price relatives;
- the Dutot index, which uses the ratio of un-weighted arithmetic mean prices; and
- the Jevons index, which uses the un-weighted geometric mean of price relatives.

2.16 Elementary indices can be calculated either as direct indices or as chain-linked indices. Direct indices compare the current price with the price in the base period, whilst chain-linked indices compare the current price with that in the preceding period. It is computationally easier to deal with missing prices, replacement items and quality changes if chain-linked indices are used (ILO et al., op. cit.).

2.17 For goods and services where the list prices differ from transaction prices, a methodological decision needs to be made as to which to use. However, medical-scheme prices are directly observable. The competitive nature of the market leads to the publishing of prices in advance and prices are typically published online as well as in scheme brochures. There is also no difference between list prices and transaction prices.

2.18 Ideally, when an item included in a price index ceases to exist, a replacement product, responsible for a large proportion of the original item's sales should be sampled and introduced to the index (ILO et al., op. cit.). In the medical-scheme industry the problem of item discontinuation is managed relatively easily since members of the

12 M Haglund. The South African CPI: The reliability of present practices and some potential for improvements. Mission Report RSASTAT:2, 2000. www.csae.ox.ac.uk, 15/08/2013

original option are usually automatically defaulted to a new or existing option (Joseph, unpublished). The quality discrepancies between terminated items and replacement items is managed either subjectively by direct quality adjustments or ignored via the assumption of quality equivalence (Cutler et al., 1998).

2.19 The introduction of new medical-scheme options is relatively infrequent. In other sectors of the market new goods often show atypical price development (Marris, op. cit.) and thus require sensitive treatment. There is no *a priori* reason to expect this in the medical-scheme environment.

2.20 As an alternative approach to those described above, hedonic price analysis can also be implemented at the level of a medical-scheme option. Here the dependent variable would be the price of cover and the explanatory variables would be the attributes of the benefit option. This approach would require that factors such as the profile of people on the option be controlled for, and it requires an understanding of how consumers select benefit plans, including issues of moral hazard, anti-selection and employer decision-making. This approach assumes that consumers make efficient choices. However, inefficiencies may arise in the medical-scheme market because consumers are not fully aware of the goods and services they are purchasing (Berndt et al., 2000).

2.21 Statistics South Africa follows the methodological guidelines in ILO et al. (op. cit.) when compiling the South African CPI which includes insurance prices. At the time of writing, the South African CPI weights were largely based on the 2005–06 income and expenditure survey (IES), which was released in March 2008. The survey ran from September 2005 to August 2006, allowing for a 12-month period in which seasonal expenditure patterns were identified. Statistics South Africa used a sampling method for items to include in the basket based on a combination of expenditure and frequency, the intention being to exclude very high-cost, low-frequency items (luxury goods) and also to exclude very high-frequency, low-cost items.[13]

2.22 Weights represent the proportions of total consumption expenditure of households, and are updated every five years.[14] Prices are updated monthly, quarterly or annually, a Jevons index being used for the elementary aggregates and a Young index being used for higher-level aggregation.[15] The index is published monthly.

3. DATA

3.1 Schemes publish their contributions annually. The majority of options use contribution tables that differentiate contributions between the principal member, adult

13 Statistics South Africa. The South African CPI Sources and Methods Manual, supra
14 ibid.
15 ibid.

dependants and child dependants (so-called 'PAC tables'). There are still some schemes that use contribution tables based on family size ('family size tables').

3.2 Medical-scheme contribution tables are available both from the registered scheme rules and from scheme marketing material available either in hard copy or electronically from the internet. Where the two data sources contradict one another preference is given to the registered scheme rules. Data were collected for the five-year period from 2006 to 2010. In some instances, scheme administrators had to be contacted directly to obtain the necessary marketing material.

3.3 The CMS publishes annual lagged beneficiary data for each option, including the total number of beneficiaries and principal members as at 31 December of each year. The CMS also collects more detailed beneficiary data by beneficiary type and income band. However, these data are not published.

3.4 The construction of an accurate index of contributions to open medical schemes (ICOMS) is impeded by the practical difficulties associated with accessing detailed data on the numbers of principal members, adult dependants and child dependants in each medical-scheme option. Although these data are collected and stored by individual medical schemes via their administrators, they are not made publicly available. The authors obtained these data for 2009 from the regulator.

3.5 The authors were not able to obtain detailed data relating to the income distribution of medical-scheme members per option. In the absence of such data there is no accurate way to allow for variation in income distributions between options and schemes. Instead, data were drawn from the 2009 General Household Survey (GHS) to estimate an industry-wide income distribution. The GHS is an annual survey conducted by Statistics South Africa designed to measure the living conditions of South Africans.

3.6 The definition of income used in the GHS is total salary inclusive of bonuses and overtime, and before tax and any deductions.[16] The CMS definition of income is broadly consistent.[17] From the GHS data it is possible to identify respondents that belong to a medical scheme. It is not possible, however, to identify which respondents are principal members and not dependants. The assumption was made that only the respondents identified as being the 'head of household' were principal members. Based on earlier GHS data it was found that on average the head of household earns the highest income in a household (Moodley, unpublished). It is possible that the principal member is not the head of household, and does not earn the highest income in the household. This assumption may thus result in an overstatement of the incomes of medical-scheme members.

16 Statistics South Africa. The General Household Survey 2009: Metadata (Vol. Statistical Release P0277). Pretoria, 2009

17 P Khanyile. Personal communication, 2010

3.7 Quarterly earnings statistics published by Statistics South Africa were used to adjust the 2009 income distribution estimated from the GHS data for the other years included in the index.

4. METHODOLOGY

4.1 A price index of medical-scheme contributions would reflect the rate of change in the price of medical-scheme cover as acquired by the individual consumer. The total price of cover may not be paid by the consumer alone, but may be subsidised by their employer, government or another third party. This definition of the index is not entirely consistent with the definition of a consumer price index, which measures changes in consumer purchasing power and is thus based only on consumer out-of-pocket expenditure. By definition it excludes all payments by government as well as employer subsidisation of health care (Berndt et al., op. cit.; Newhouse, op. cit.). The approach taken here is supported by Cutler et al. (op. cit.), who argue that the consumer ultimately bears the full cost of health care via out-of-pocket payments, higher individual premiums, lower wages or increased taxes, and in this way changes in the price of health insurance (or medical schemes in the South African context) affect consumer purchasing power.

4.2 There are two types of registered medical schemes in South Africa: schemes that allow public membership (open schemes) and schemes that limit membership to pre-defined groups of people (restricted-membership schemes). The index of contributions to open medical schemes (ICOMS) constructed by the authors is based on the contributions of open schemes as it is only the options offered by these entities that consumers can choose between (i.e. from a consumer perspective, membership of a restricted scheme is not available unless the membership criteria are met).

4.3 Medical-scheme contributions are made up of risk contributions and savings-account contributions. The risk contributions purchase the member (and his or her beneficiaries) insurance cover as part of a risk pool. They include loadings for non-medical expenditure (e.g. administration and broker commission). Savings-account contributions accrue in their entirety to a personal savings account for each member (i.e. there is no risk pooling). Any unused amount in a medical savings account at the end of a year can be rolled over to the following year, unlike risk benefits, which are forfeited if not used.

4.4 A 2005 directive prohibited 'variable day-to-day benefits' where members had a choice of the level of benefits.[18] The same directive also stopped schemes from offering 'variable medical savings accounts' where members had a choice of the level of contribution they wished to make to their medical savings account,[19] thereby reducing the flexibility and consumer appeal of medical savings accounts.

18 Council for Medical Schemes. Annual Report 2005–6
19 ibid.

4.5 The ICOMS is based on gross medical-scheme contributions, inclusive of both risk and savings-account contributions, as savings-account contributions are no longer discretionary. The index is constructed from the perspective of the consumer and therefore needs to reflect the expenditure incurred by the consumer. Consumer affordability and buying decisions are based on the total contribution and not the risk contribution alone.

4.6 There is, however, an argument to be made for basing the index on risk contributions alone on the grounds that savings-account benefits are not pooled and belong to the member. Members' expenditure on savings-account contributions is directly offset by an increase in the value of their savings accounts. Given that the index is driven by changes in contributions from one year to the next, and that savings-account contributions are defined as a percentage of gross contributions, the results of the index would differ only in cases where schemes change the level of savings-account contributions. From Table 1 it is clear that there has been little change in the overall industry split between risk and savings-account contributions over the period.

Table 1. Risk contributions as a percentage of gross contributions[20]

Year	Risk contributions as a percentage of gross contributions
2006	89,3%
2007	90,2%
2008	90,7%
2009	90,9%
2010	90,9%

4.7 The index reference period used to construct the index was 2006. The introduction of the 2005 directive made comparisons between 2005 and 2006 gross contributions difficult as the 2005 contributions had a discretionary component that varied between members. The index was calculated annually because medical-scheme prices typically increase only on 1 January of each year.

4.8 Because of the practical considerations associated with the collection of historical medical-scheme price information it was necessary to work with a sample and not the entire industry. The basket of goods and services for the ICOMS would comprise a number of medical-scheme options, because medical-scheme contributions vary at the option level. Ideally, sampling should thus occur at the medical-scheme-option level. There are, however, a number of reasons to sample schemes instead and include in the basket all the options offered by each scheme in the sample. If data are to be obtained

20 Sources: Council for Medical Schemes. Annual Reports 2006–07, 2007–08, 2008–09, 2009–10

direct from schemes it makes sense to sample at the scheme level in order to facilitate data collection, as this reduces costs and expedites data collection. Sampling at the scheme level also allows for easier substitution of discontinued options, and the introduction of new options into the basket. The disadvantage of sampling at the scheme level is that for the same number of options there will be fewer schemes included in the index.

4.9 The schemes selected for inclusion in the index were not sampled at random, but were sampled purposively based on their proportion of industry beneficiaries. This allowed the sample size to be reduced whilst still covering a large proportion of total beneficiaries. The features of the sample can be seen in Table 2. In 2009 data were collected for 45% of schemes. However these schemes represented 92% of industry beneficiaries. The size of the sample was influenced by the time and resources available for data collection. The list of schemes identified was cross-checked against beneficiary numbers as at 31 December 2009 and schemes that were no longer in existence were excluded from the sample (viz. Munimed and Global Health). Resolution Health was also excluded as the authors had difficulty obtaining historical contribution data. The resultant sample was made up of 15 medical schemes (detailed in Appendix A).

Table 2. Cover of sample

	31 December 2006	31 December 2009
Proportion of registered open medical schemes	37%	45%
Proportion of beneficiaries in open medical schemes	88%	92%
Number of options represented in index	93	85
Number of options with income bands	27	27

4.10 From time to time the schemes included in the basket will need to be updated in order to allow for new schemes, new options, schemes that have been liquidated and shifts in market share over time. It is envisaged that this will be done on a five-year cycle, although in times of industry change and consolidation it may be necessary to do so more often. This would entail updating the base year and chain-linking the indices.

4.11 A Paasche formula was used to construct the ICOMS. This allows for the index to be calculated on a one-year lagged basis (due to the lag in beneficiary data availability). The Paasche index is preferable to the Laspeyres index because it takes account of the large potential shifts in the number of beneficiaries that can occur from year to year. The formula can be derived by defining p^t_{yj} as the price in time period t for income band y on option j. p^t_{yj} is then calculated as:

$$p^t_{yj} = mp^t_{yjk_m} + ap^t_{yjk_a} + cp^t_{yjk_c} \quad (5)$$

where:

m is the proportion of beneficiaries that are principal members;
a is the proportion of beneficiaries that are adult dependants;
c is the proportion of beneficiaries that are child dependants;
$p^t_{yjk_m}$ is the price in time period t for principal members (k_m) in income band y on option j;
$p^t_{yjk_a}$ is the price in time period t for adult dependants (k_a) in income band y on option j; and
$p^t_{yjk_c}$ is the price in time period t for child dependants (k_c) in income band y on option j.

The weights are calculated using equation (6) as

$$s^{tt}_{yj} = \frac{p^t_{yj}\, n^t_{yj}}{\sum_{yj} p^t_{yj}\, n^t_{yj}} \tag{6}$$

where n^t_{yj} is the number of beneficiaries in income band y and option j at time t.

Thus, the price index at time t can be calculated using equation (7).

$$P_{ICOMS} = \left\{ \sum_j \sum_y \left(\frac{p^t_{yj}}{p^0_{yj}} \right)^{-1} s^{tt}_{yj} \right\}^{-1} \tag{7}$$

4.12 The problem of option discontinuation is dealt with relatively easily since members of the original option are usually automatically defaulted to a new or existing option (Joseph, unpublished). In the case where an option was discontinued in one year and then re-introduced in the following year and in the case where contribution data were missing, the contributions for the missing year were imputed. The imputed price was calculated as the midpoint between the prices in adjacent periods.

4.13 In the case where members were not defaulted to an obvious alternative option, the discontinued option was excluded from the sample. This was possible because of the retrospective calculation of the index. If the index is to be calculated on an ongoing basis, discontinued options will all need to be dealt with explicitly.

4.14 Schemes that make use of income bands typically adjust the level of income bands from year to year in order to maintain the real value of the bands. The number of income bands may also be adjusted over time. Both these types of adjustments are individually determined by schemes and thus may vary considerably. The use of the Paasche formulation allows for the matching of price and quantity data per income band in calculating expenditure shares. Both values relate to time period t and thus no adjustments need to be made to ensure correspondence between the values.

4.15 With the exception of 2010, the number of beneficiaries in each year was calculated as the average of the number of beneficiaries as at 31 December of the previous year and the number of beneficiaries as at 31 December in that year. This assumes that changes in beneficiaries are uniform over the year, and allows for changes in beneficiaries that occur at the beginning of the year as well as changes occurring over the course of the year. The beneficiary data for 31 December 2010 were not available at the time of writing. The 2010 weights were thus based on beneficiary numbers as at 31 December 2009.

4.16 The price relative for each option is based on the average contribution per beneficiary on that option. It was therefore necessary to estimate the number of beneficiaries in each combination of beneficiary type and income band in each year. As the authors were able to obtain the detailed beneficiary-type (principal, adult, child) split per option from the CMS only for 2009, they assumed that this split remained constant over the period. The dependant ratio for each option was also assumed to be constant across income bands. The proportion of principal members in each income band was estimated from the income distribution derived from the 2009 GHS data, inflated and deflated appropriately (¶3.6).

4.17 It is important to note that the index is at medical-scheme option level. The distributions of beneficiaries both across beneficiary type and across income band are used in the calculation of elementary price indices and not in the weighting structure of the index. As discussed in ¶2.15 it is common practice not to weight prices in the calculation of elementary price indices. The use of constant weights is an improvement on unweighted elementary indices.

4.18 Family-size and -composition data from the GHS and CMS are not comparable because the GHS is based on physical households whilst medical schemes are concerned with the relationship and dependence between beneficiaries (i.e. beneficiaries need not reside in the same household). GHS data were therefore used only to estimate the income distribution of principal members and not to determine the beneficiary-type split.

4.19 There were two scheme mergers that occurred on 1 January 2010 (Medicover merged with Liberty, and Bestmed merged with Telemed). From scheme marketing material for 2010 the authors were able to ascertain the new option structure available to members post-merger. However, they needed to make assumptions regarding the movement of members from the old option structure to the new option structure. These assumptions were based on communications with the new merged entities.[21] A further scheme merger took place on 1 October 2010 between Oxygen and Medshield. This merger did not affect the ICOMS calculated for this paper but will affect subsequent calculations.

21 Personal communication, telephone, March 2010

5. RESULTS

5.1 The ICOMS is illustrated in Figure 1. Medical-scheme contributions rose by an average 10,84% per annum over the period. The highest annual increase in nominal terms was from 2008 to 2009. However, in real terms the highest annual increase was from 2009 to 2010, when real contributions increased by 6,94%. Real contributions increased by 17,48% over the period.

5.2 The CPI figures illustrated in Figure 1 are for January in each year for consistency with medical scheme contributions, which typically apply for a calendar year. Statistics South Africa does not publish a sub-index that reflects only medical-scheme contributions. From January 2009 medical-scheme contributions were included in the category 'miscellaneous goods and services'. Before this, medical-scheme contributions were included in the category 'medical goods and services', limiting comparability.

5.3 The CMS receives rule-amendment submissions from all registered schemes annually. Before 2010 the CMS required that any proposed increase that exceeded the increase in the CPI plus three per cent be accompanied by a brief motivation.[22] This benchmark forms an upper limit below which the CMS aims to maintain annual contribution increases. A possible outcome of this approach is that schemes treat the benchmark as a target and not merely as a guideline. It can be seen in Figure 1 that the ICOMS tracks this benchmark closely, but exceeds it cumulatively over the period.

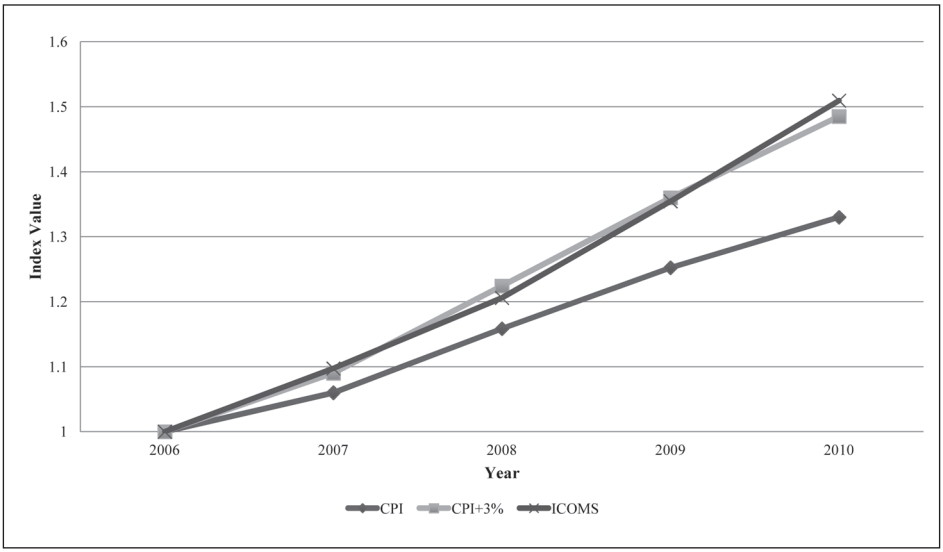

Figure 1. Comparison of ICOMS with CPI and CPI+3%

22 Council for Medical Schemes. Contribution Increases and Benefit Changes, supra

5.4 The ICOMS figures were compared with average increases in gross contributions for open schemes published by the CMS in their annual reports. The CMS do not make use of an index methodology and increases are based on average contributions collected by schemes in each year. The figures were not consistently higher or lower, but did differ in all but one year as shown in Table 3.

Table 3. Comparison of annual increase in ICOMS with figures published by the CMS[23]

	CMS	ICOMS
2006–2007	8,1%	9,7%
2007–2008	9,9%	9,9%
2008–2009	13,3%	12,3%
2009–2010	14,3%	11,4%

5.5 The assumptions underlying the ICOMS were sensitivity-tested. Firstly, the sensitivity to the beneficiary-type split, as defined in ¶4.16, was tested by using an industry split as opposed to the option-specific data obtained from the CMS. The sensitivity to the assumed income distribution was also tested by replacing the income distribution derived from the GHS with an assumption that members were uniformly distributed across income bands. The effect of varying both the beneficiary-type split and income distribution was also tested. The index values were found to be very stable as shown in Table 4.

Table 4. ICOMS using different beneficiary-type splits and income distributions

Year	Base case	Using industry beneficiary-type split and GHS income distribution	Using actual beneficiary-type split and uniform income distribution	Using industry beneficiary-type split and uniform income distribution
2006	1,0000	1,0000	1,0000	1,0000
2007	1,0973	1,0919	1,0966	1,0913
2008	1,2059	1,2050	1,2056	1,2049
2009	1,3546	1,3583	1,3543	1,3581
2010	1,5095	1,5069	1,5092	1,5067

23 Sources: Council for Medical Schemes. Annual Reports, supra

6. DISCUSSION

6.1 The methodology described here does not explicitly account for changes in the extent of the cover provided and thus provides no insight into the value for money provided by medical schemes. The results produced indicate that the real cost of cover has increased over time. Whilst this may be due to an increase in the benefits provided, the effect on affordability of cover remains a concern.

6.2 The accuracy of the index values calculated can be improved by increasing the sample size and by obtaining more accurate beneficiary data direct from schemes. In the absence of accurate member-income data from schemes, the estimates of the income distribution of principal members could be improved by using GHS data from other survey years. However, the index does not appear to be highly sensitive to this assumption. The index constructed here is based on open medical schemes. However, it may be desirable from a regulatory perspective to calculate separate indices for restricted-membership schemes and bargaining councils as well as an index that is representative of the entire medical-scheme industry. It may also be desirable to determine an index based on risk contributions and not on gross contributions.

6.3 Differences arise between the changes in the price of medical-scheme cover, as experienced by the consumer, and the changes in the prices of goods and services experienced by medical schemes. This is because medical-scheme contributions are affected by factors other than the price of the goods and services they purchase, which include changes in the benefits offered, changes in the consumption of medical goods and services, changes in quality of care, changes in beneficiary demographics, and changes in reserve-building objectives (Berndt et al., op. cit.; Da Silva, unpublished). Further work is required to analyse the factors behind increasing contributions. Actuaries are well placed to do such work and should ensure appropriate use of index-construction methodologies when doing so.

6.4 Figures on rising real medical-scheme contributions are typically drawn from the annual reports published by the CMS and mask movement between schemes and between options. Consequently the results obtained here differ from the figures published by the CMS. An accurate index is an important tool for isolating changes in the price of cover.

6.5 The CMS is best placed to collect the necessary data and to publish an accurate ICOMS. This would improve their ability to oversee the annual benefit and price changes submitted by schemes, to engage with underlying price drivers and to inform changes in the health-policy environment.

REFERENCES

Berndt, ER, Cutler, DM, Frank, RG, Griliches, Z, Newhouse, JP, & Triplett, JE (2000). Medical care prices and output. *In* Cuyler & Newhouse (2000: 119–80)

Boskin, MJ, Dulberger, ER, Gordon, RJ, Griliches, Z, & Jorgenson, DW (1998). Consumer prices, the consumer price index, and the cost of living. *Journal of Economic Perspectives* **12**(1), 3–26

Crowe, WR (1965). *Index Numbers*. Macdonald & Evans, London

Cutler, DM, McClellan, M, Newhouse, J, & Remler, D (1998). Are medical prices declining? Evidence from heart attack treatments. *Quarterly Journal of Economics* November, 991–1024

Culyer, AJ & Newhouse, JP (eds.) (2000). *Handbook of Health Economics* Vol. 1A. Elsevier, Amsterdam

Da Silva, R (unpublished). *Indexation of medical costs for South African medical schemes.* IAAHS Colloquium, 2007

Fisher, I (1927). *The making of index numbers: a study of their varieties, tests and reliability*, 3rd ed. Vol. 3. Pollack Foundation of Economic Research, Massachusetts

ILO, IMF, OECD, UNECE, Eurostat, & The World Bank (2004). *Consumer Price Index Manual: Theory and Practice*. International Labour, Geneva

Joseph, J (unpublished). Developing and testing methodologies for calculating an average contribution increase. Unpublished honours research paper, University of Cape Town, 2006

Kelly, P (unpublished). Changes to the consumer price index with a focus on health. Convention, Actuarial Society of South Africa, Johannesburg, 2009

Laspeyres, E (1871) Die Berechnung einer mittleren Warenpreissteigerung. *Jahrbücher für Nationalökonomie und Statistik* **16**, 296–314

Marris, R (1958). *Economic Arithmetic*. Macmillan, London

Moodley, Y (unpublished). The Affordability of South African Medical Scheme Contributions. Unpublished honours research paper, University of Cape Town, 2008

Newhouse, JP (unpublished). Medical Care Price Indices: Problems and Opportunities Vol. W8168, National Bureau of Economic Research, 2001

Paasche, H (1874) Über die Preisentwicklung der letzten Jahre, nach den Hamburger Börsennotierungen. *Jahrbücher für Nationalökonomie und Statistik* **23**, 168–78

APPENDIX A

BENEFICIARIES AND NUMBER OF OPTIONS PER SCHEME IN THE SAMPLE

Table A.1. Average beneficiaries and number of options per scheme per year

	2006	2007	2008	2009	2010
BestMed					
Average beneficiaries	91 673	92 537	92 446	76 850	86 641
Number of options	8	8	8	6	8
Bonitas					
Average beneficiaries	539 656	573 806	587 663	625 188	641 870
Number of options	5	5	5	5	5
Discovery					
Average beneficiaries	1 428 794	1 181 632	1 203 098	1 266 012	1 294 638
Number of options	9	9	9	9	9
FedHealth					
Average beneficiaries	154 659	145 026	151 848	155 417	154 739
Number of options	8	8	8	8	8
Hosmed					
Average beneficiaries	145 522	140 531	100 666	87 884	86 402
Number of options	2	2	2	2	2
Liberty					
Average beneficiaries	77 798	68 271	69 038	66 438	63 407
Number of options	4	4	4	4	6
MediCover					
Average beneficiaries	131 272	138 162	133 952	129 119	101 405
Number of options	3	3	3	3	0
MediHelp					
Average beneficiaries	170 461	174 489	170 681	187 465	200 599
Number of options	6	6	6	6	6
Medshield					
Average beneficiaries	108 635	144 853	194 412	173 200	173 557
Number of options	6	4	4	3	3
Momentum					
Average beneficiaries	128 717	155 703	172 839	163 585	145 198
Number of options	16	16	16	16	16
Oxygen					
Average beneficiaries	207 001	193 438	162 132	109 566	92 126
Number of options	8	7	6	6	6
ProSano					
Average beneficiaries	95 558	84 397	74 082	70 724	69 370
Number of options	4	4	4	4	4
Sizwe					
Average beneficiaries	143 073	151 231	161 652	165 989	163 851
Number of options	5	5	5	5	4
Spectramed					
Average beneficiaries	212 800	189 398	163 305	135 107	124 229
Number of options	5	5	5	4	4
Telemed					
Average beneficiaries	56 833	59 245	64 504	46 853	41 802
Number of options	4	4	4	4	0