Comparisons of Hospital Output in Canada: National and International Perspectives*

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Abstract

The break down of change in total expenditure in health care services into change in price level and change in output level is an important policy tool for analysing total spending over time and for the purpose of international comparison. The current cost-based approach in measuring health care output does not allow this price and output decomposition. In this paper we discuss various approaches in direct output measurement and propose an episode-based approach with quality adjustment which closely resembles the concept of output in the system of national accounts. This episode-based approach uses courses of treatment for each Case Mix Group and Day Procedure Group as the basis for output. Using data from the Canadian Institute for Health Information, we calculate an episode-based output index of the Canadian hospital sector for the periods 1996–2000 and 2003–2005. The result for the chained Fisher index shows that the quality-unadjusted index increases at an average annual growth rate of 1.6%. We expect that with the quality adjustment the actual rate is higher. We also offer recommendations for the implementation of quality adjustment and the establishment of a health satellite account.
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1 Introduction

Health care expenditures have gained increasing attention by policy makers in Canada and other industrialized countries because of their rising trends, both in dollar values and as percentages of national incomes. Discussions, however, focus mainly on total

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Table 1: Health Care Expenditures in G7 Countries in 2004

Country	% of GDP	% Publicly Funded	Health as % of Government exp.	Expenditure per person (US$)
Canada	9.8	69.8	17.1	3,038
France	10.5	78.4	15.4	3,464
Germany	10.6	76.9	17.3	3,521
Italy	8.7	75.1	13.7	2,580
Japan	7.8	81.3	17.2	2,823
U.K.	8.1	86.3	15.9	2,900
U.S.A.	15.4	44.7	18.9	6,096

Source: WHO (2007)

expenditure of the health care section. Total expenditure is an important statistic simply because in most countries, where a large part of health care services is provided or funded by the public sector, it has the largest share in government budgets. There is some concern that rising costs could put some strain in public finance. Table 1 shows the total health care expenditures as a percentage of national income, percentages of health care spending that was publicly funded, percentage of government budget on health care, and expenditures per person expressed in U.S. dollars for the G7 countries in 2004. A thorough policy analysis, national or international, requires the breakdown of expenditure changes into price changes and output (quantity) changes. An increase in expenditure may arise from a price change, which can be caused by higher compensation for the medical staffs or more expensive drugs and equipment. On the other hand, it can be caused by increased demand for health care services due to technological or demographic changes. The distinction between these two components of expenditure changes can be the key information in the process of finding policy solutions (Gerdtham and Jönsson, 2000).

Economic statisticians, however, face serious challenges in price and output measurement in the health care sector. First, for the majority of citizens in industrialized countries, health care services are not direct out-of-pocket expenses but are covered by private or public insurance. Market prices are therefore not directly observable. Second, as in other products in the service sector, quantities of health care output are not well-defined. As a consequence direct measurement of output is not a straightforward exercise. Third, due to rapid technological changes, new treatment methods and new diagnoses frequently introduce new goods and services. Biases result if the scope and product mix of the services are not updated fast enough. Finally, for the same diseases methods of treatment improve over time. These create biases in the price or the output index if the quality changes are not reflected in the indices.

Due to its unique market structure among industrialized countries, research in the U.S. has focused mainly on the price measurement of health care services. Its statistical agencies publish periodically a consumer price index (CPI) and a producer price index (PPI) for the health care sector. In Canada and other industrialized countries, a large proportion of health care expenditure is publicly financed. Therefore direct measurement of output seems to be more appropriate. There is an important difference between price measurement and direct output measurement. A price index can be calculated by taking samples of prices for the same good or service. Direct output measurement, however, has to be exhaustive, and therefore more data intensive. Some countries such as the U.K. have implemented direct output measurement in a number of government services, including the health care sector.

In this paper we examine the theoretical and practical aspects of health care output measurement in Canada. Currently only total expenditure is reported in the Canadian system of national accounts (SNA). Since total input costs are taken as total output, it is not possible to calculate the total factor productivity of the sector. It is our hope that this research project contributes to the debate in health care output measurement in Canada and eventually leads to a practical solution.

2 Basic Problems

We start with the basic index number problem in price and quantity aggregations. Consider a total of N goods and services with prices p_i^t and quantities q_i^t in period t, $i = 1, \ldots, N$. A bilateral price index P is a ratio of the general price levels between a comparison period ($t = 1$) and a base period ($t = 0$), and similarly a bilateral quantity index Q is a ratio of output levels between the two periods. The product of P and Q, by definition, is equal to the ratio of the total expenditures between the two periods:

$$PQ = \frac{\sum_{i=1}^N p_i^1 q_i^1}{\sum_{i=1}^N p_i^0 q_i^0}. \tag{1}$$

For marketed goods and services with observable prices and quantity, price data are collected by an appropriate sampling method for each good and services. A price index is calculated using a selected index formula. For example, the Laspeyres price index is defined as

$$P_L = \sum_{i=1}^N s_i^0 \frac{p_i^1}{p_i^0}, \tag{2}$$

where $s_i^0 = p_i^0 q_i^0 / \sum_{i=1}^N p_i^0 q_i^0$ is the expenditure share of good i in period 0. Once P is calculated, Q is implicitly implied by the identity in (1). In the U.S. for example, efforts are focused on getting the price index in health care. The real output is then obtained by deflating the nominal output (expenditure) with P. In Canada this procedure also is used to calculate real outputs in out-of-pocket expenses such as prescription drugs and services of optometrists and dentists. In services provided or funded by the government where market price data are unavailable or do not exist, it is necessary to measure Q directly. As mentioned above there are a number of technical challenges facing statisticians. In the health care sector the units of measurement that define quantities of services are ambiguous. We shall examine this problem in detail below. If new treatment methods are available in period 1 but not in period 0, then a structural break occurs in the index formula. In price measurement this will create an upward bias in the price index if the basket of goods and services is not updated frequently. In direct output measurement, however, it is not clear how the problem can be resolved in a satisfactory manner. The biggest challenge is how to incorporate quality change into the quantity index. In price measurement, statisticians have employed subjective adjustment, matched model, and hedonic analysis to allow for quality changes. The last method uses regression analysis to control for changes in characteristics or attributes of a product.[1] Failure to incorporate quality improvement will result in a downward bias of the quantity index.

3 Measuring Quantities

The production of goods and services can be roughly divided into four stages, namely, inputs, activities, products, and outcomes. The followings are examples in the health care sector:

1. Inputs — nurses, doctors, technicians, administration staffs, drugs, medical tools and equipment, clinics and hospitals, catering, etc.

2. Activities — clinic and hospital visits, physical examinations, diagnostic tests, surgeries performed, sessions of therapy, etc.

3. Products — courses (episodes) of treatment, number of cases adjusted for severity, lengths of treatment, quality of care, etc.

4. Outcomes — health status of patients adjusted for environmental and socio-economic factors.

3.1 Measuring Costs

Most countries, including Canada, traditionally measure the total costs of inputs as total expenditures in publicly provided services such as hospital care. Since price information is unavailable, changes in total expenditure are treated as pure price changes. In other words, Q is assumed to be 1 in every period, forcing the price index P equal to the expenditure ratio. Sharpe *et al.* (2007) report that the average annual real output growth of the hospital sector in Canada is 1.02 percent from 1984 to 2003. From the theoretical standpoint, the cost-based approach can be justified by considering the government as a provider of health care services with cost function $C(w, q)$ where w is the input price vector. Assuming zero economic profit, the output prices are the elements of the vector of marginal costs, $p = \nabla_q C(w, q)$. If we further assume that technology exhibits constant return to scale, then $q \cdot \nabla_q C(w, q) =$

[1] See Triplett (1987).

$C(w, q)$ and so cost will be the "correct" value for government outputs (Yu, 2008). Marginal costs, however, are not easily observable. Additional difficulties arise in the definitions of quantity.

3.2 Measuring Activities

Starting from 1998, the U.K. has switched from an input-based measurement to an activity-based one. In the health care sector there are 16 activity series such as inpatient and day cases, outpatient and community health treatments, general practitioner services, dental services, etc.[2] In any series, activities such as surgeries performed or number of consultations are aggregated using a Laspeyres quantity index:

$$Q_L = \frac{\sum_{i=1}^{N} p_i^0 a_i^1}{\sum_{i=1}^{N} p_i^0 a_i^0},$$

where a_i^t is the number of activities i in period t and p_i^0 is its average cost in period 0. These "cost-weight activity indices" was implemented until 2004, when the series were expanded and the definitions of activities were more refined.

From the patients' perspectives, the number or level of activities such as number of diagnostic tests conducted, surgeries performed, or length of hospital stay is not the main concern. It is, instead, whether or not an acute disease or injury can be cured as quick as possible, or a chronic illness can be under control with minimum impacts on their quality of life. Therefore, if a cancerous tumour can be removed with less amount of hospital stay and fewer number of intrusive surgical procedures or chemotherapy treatments, it should be considered as a quality improvement. Although there is a decrease in activities, output measures should be adjusted upward. Therefore activities can be an inappropriate measure as a proxy for output.

3.3 Measuring Cases

There are an increasing number of economists suggesting that health care measurement, particularly for hospital services, should move towards an episode based approach.[3] The idea is close to the concept of a product in a market economy, which is the object of measurement in the system of national accounts. Hospital services, for example, can be classified according to a well-defined system of taxonomy such as the International Classification of Diseases (ICD) published by the World Health Organization (WHO).[4] In the latest version, ICD-10, each type of disease is coded by an alphabet with a two digit number. For example, J60 represents anthracosilicosis, a lung disease suffered mostly by coal mine workers. The Canadian version is called ICD-10-CA. The number of cases in each type of disease can be compared and an elementary quantity index calculated. These indices can in principle be adjusted for

[2] See Pritchard (2003), Mai (2004), and HMSO (2005).

[3] See Triplett (1999), Bernt *et al.* (2000), National Academy of Science (2002), Mai (2004).

[4] Details are available at http://www.who.int/classifications/icd/en/.

severity and quality of care. Aggregation can be achieved by weighing the elementary indices with their relative costs.

3.4 Measuring Strictly Outcomes

There has been a large volume of research on cost effectiveness in health care services.[5] One of the objectives of these analyses is to study the technical efficiency of two or more treatment methods for a particular disease. For example, the cost-effectiveness ratio between two treatment methods A and B for the same disease is defined as

$$CE_{AB} = \frac{p_A - p_B}{e_A - e_B}, \tag{3}$$

where p_A, p_B, e_A, and e_B are respectively their costs and measures of effectiveness. In comparing two treatments, the ratio is compared with a bench mark number. A relatively low ratio means that treatment A is more cost-effective than B. Note that the costs of the treatments should include both direct cost and indirect costs, which may be time of treatments, income loss, etc. The effectiveness measure can be simple mortality rates, success rate of curing an appropriate physiologic measure such as blood pressure, hormone level, etc., or a combination of several desirable characteristics.

Cost-effectiveness ratios can also be used to study allocative efficiency across diseases. The effectiveness e in this case must be a general outcome measure of the well-being of the patients. Commonly used measures are money metric evaluations of the patients' utility values on the treatment. For example, the *quality-adjusted life years* (QALY) of a patient can be defined as the present value of the weighted sum of all future life years. For a patient with age A,

$$\text{QALY}_A = \sum_{i=A} \delta^{i-A} w_i \pi_i, \tag{4}$$

where w_i is a weight between 0 and 1, π_i is the probability of the patient being alive at age i, and δ is a time discount factor. The weight factor w_i is equal to 1 when the patient is in perfect health and 0 if dead.[6] The interpretation of δ is ambiguous. It incorporates both the intertemporal time preference structure of the patient and his/her attitude towards risk and uncertainty. This ambiguity, however, is common in cost-benefit analysis. Conceptually QALY can be viewed as a quality-adjusted life expectancy. That is, if we assume $\delta = w_i = 1$ for all i, the result is life expectancy of the patient at age A. For this reason QALY is sometimes called *health-adjusted life expectancy.* If QALY is multiplied by the dollar value of a statistical life year, the cost-effectiveness ratio in (3) becomes dimensionless, which is useful in cross-disease analysis and international comparison of the same treatments.

[5] For reviews see Brazier *et al.* (1999) and Garber (2000). For the theoretical foundation see Grossman (1972).

[6] Some analysts allow w_i to have negative values, meaning the suffering from an illness is worse than being dead from the patient's perspective.

Another utility-based outcome measure directly models the patients' preferences on health status under risk. Suppose a patient has a von Neumann-Morgenstein utility function $U(Q,t)$ on health status Q and life year t. Then the *health-year equivalent*, H is implicitly defined as

$$U(Q_H, H) = U(Q_T, T).$$

Here Q_H is a perfect health status or profile for H year and Q_T is the patient's actual health profile for T years. That is, the patient is indifferent between living H years under perfect health and T years under the condition Q_T. Conceptually health-year equivalent is similar to the certainty equivalent in expected utility theory. The conversion of any health profile is converted to a standard measure so that health years can be aggregated across patients and diseases.

Cost-effectively analysis is a powerful tool in studying technical and allocative efficiencies. But can it be used as an outcome measure for the purpose of national accounts? In principle, the change in health status of all citizens due to medical intervention can be used as a proxy for the real output of the health care sector.[7] The question raises several theoretical and practical issues.

First, cost-effectiveness analysis is mainly used as a tool to compare different treatments at a particular time. Analysts are more concerned with the ranking of the CE ratios than the values *per se*. In output measurement for the purpose of national account, however, the accuracy of the numbers is important (Triplett, 1999).

Second, health outcomes are determined by the health care services and other factors such as genetic inherence, knowledge and lifestyle of the patients and the public health environments.[8] In cost-effectiveness analysis patients under different treatments are assumed to have the same average background. For national account purposes, however, these factors have to be adjusted for. The analytical tools are not yet available.

Third, the Canadian SNA publishes national income or Gross Domestic Product (GDP) on a quarterly basis. Measuring the life expectancy of our citizens is already a large undertaking. Life tables are available on a yearly basis from Statistics Canada. Measuring the health-adjusted life expectancy of the whole country every three months is a formidable task with the existing information technology and resources.

Fourth, the overall effects of some treatments, particularly those due to newly developed technology, may not be observable after a long time. Technically speaking the QALY defined in (4) are expected values instead of actual values. Therefore the GDP will be subject to future revisions, which is not a desirable feature for users.

Finally, the purpose of the national accounts is to measure values of economic transactions, not the effects or outcomes of consumption. For example, satellite

[7]This seems to be the position taken by Wolfson and Lievesley (2007).

[8]For example, see Lleras-Muney (2005) for the effect of education on mortality rates. For other problems in using QALY as output measurement see Pauly (1999).

TV service companies often offer packages that include hundreds of channels. How many channels the consumers actually watch and how much they enjoy the programs is not the target of measurement from the SNA perspective. Moreover, it is well-known that smoking reduces health outcomes. Therefore in principle in the outcome approach consumption of tobacco should have a negative entry in the health account.

For the above reasons the quality-adjusted episode-based approach is conceptually closer to the real output of marketed product than the approach based only on outcomes.

4 Quality Change

Traditionally, economic statisticians adjust prices of marketed goods with replacement, subjective price adjustment, and matched technique. For example, if a car model in the comparison period includes an air conditioner as a standard feature, the price should be adjusted downward using the extra cost of adding the air conditioner in the base period. For multivariate quality changes, statisticians use hedonic analysis to untangle the price changes. The technique requires large amount of price and quantity data together with their characteristics for each product variety. Nevertheless, the overall price changes can be inferred from a manageable data set. In direct quantity measurement, however, quality data must be collected for every product variety. Also, due to the absence of price information, other techniques have to be used to adjust the quantity data for quality changes.

A widely used tool in cost-benefit analysis is the use of contingent valuation method (CVM) for non-marketed goods such as environmental amenity. The procedure involves interviews, questionnaires, or experimental techniques to ask the respondents directly about their willingness-to-pay (WTP) for the goods, or infer the values indirectly from the experiments. CVM has become acceptable after some studies show that the results yield WTP similar to results using other direct approaches such as the hedonic method and the travelling cost method. CVM can in principle be used for evaluating quality changes in direct output measurement. In the case of health care services provided by private insurance coverage, Pauly (1999) suggests that the price of a quality change of a particular treatment is the difference in premiums charged by the insurance company for including the new treatment in the package. This price difference provides a lower bound estimate for the consumers' WTP for the quality change. For publicly funded system with universal coverage, however, he recommends using a general effectiveness measure such as QALY since inclusion of more costly new treatment methods is a collective choice which involves altruistic externalities.

5 A Quantity Index for Canada

The Canadian health care system is publicly funded by general tax revenue and supplementary health premiums charged by some provinces or territories to households. The premiums, if charged, are far below their market values and are independent of the citizens' health status or age. Since coverage is universal, the system avoids the high transaction costs of adverse selection and statistical discrimination. Woolhandler *et al.* (2003) report that the overall administration cost of the health care system in the U.S. is 31.0% of the total health expenditure, compared with 16.7% in Canada.[9] Due to the funding nature of the system, market prices or marginal costs for insurance coverage or for individual services are not available. In this section we develop a preliminary episode-based output index which uses case mix groups (CMG) as a proxy for quantity. The CMG as it is known today was introduced in Canada in 1990 and has undergone several improvements.[10]

5.1 A Proposed Index

A commonly used theoretical quantity index is the Malmquist quantity index for N products (Diewert, 1993):

$$Q_M(q^0, q^1, q) = \frac{D(U(q), q^1)}{D(U(q), q^0)} \tag{5}$$

where

$$D(u, q^t) = \max_k \left\{ k : U(q^t/k) \geq u, k > 0 \right\}, \quad t = 0, 1,$$

is called a distance or deflation function. D measures the maximum value that can deflate the quantity vector q^0 and q^1 such that the resulting utility level is at least as high as u. In (5) q is a reference quantity vector that defines the reference utility level $u = U(q)$. Note that the definition of the Malmquist index does not involve the price vectors for the goods and services in either period. If we assume that the preference structures of the citizens are homothetic, U can be represented by a linearly homogeneous function. Also, Q_M will be independent of the reference quantity q, that is,[11]

$$Q_M(q^0, q^1, q) = U(q^1)/U(q^0).$$

Now suppose that the quantity vectors are augmented by quality vectors e^0 and e^1 in the two periods. The Malmquist index becomes

$$Q_M(q^0, q^1, q) = \frac{U(e_1^1 q_1^1, \ldots, e_N^1 q_N^1)}{U(e_1^0 q_1^0, \ldots, e_N^0 q_N^0)}.$$

[9]In this study, administration costs from different health expenditure categories have been segregated and summed up to report an overall administration costs.

[10]Before 1990 categories called bin groups were assigned to the data.

[11]See Diewert (1993) for a proof.

The homogeneity assumption ensures that if we used a general quality measure such as QALY, then in the special case that a general technological improvement enhances all output by the same proportion α,

$$Q_M(q^0, \alpha q^1, q) = \frac{U(\alpha q^1)}{U(q^0)} = \frac{\alpha U(q^1)}{U(q^0)} = \alpha Q_M(q^0, q^1, q).$$

For example, the Centers for Disease Control and Prevention reports that nearly 2 million patients get an infection while staying in hospital for other treatments, costing an extra \$5 billion each year in the U.S. health care system (CDC, 2000). If new procedures or technology can lower the infection rate at hospitals, it will become a general quality improvement for the whole hospital sector.

With this theoretical background, we propose a Laspeyres-type quantity index as

$$Q_L = \sum_{i=1}^{N} s_i^0 \frac{e_i^1}{e_i^0} \frac{q_i^1}{q_i^0} \tag{6}$$

where

$$\begin{aligned} s_i^0 &= \text{base period cost share of episode } i \\ e_i^t &= \text{outcome measure of episode } i \text{ in period } t \\ q_i^t &= \text{number of episode } i \text{ in period } t \end{aligned}$$

To measure the real output of inpatient and outpatient services provided by hospital, number of episodes for each Major Clinical Category (MCC) or Case Mix Group (CMG) can be used for q. Alternatively, number of episodes for each ICD-10-CA clinical chapter can be used for q. These quantities are available from the Discharge Abstract Database (DAD), the Hospital Morbidity Database (HMDB) and the National Ambulatory Care Reporting System (NACRS). If MCC or CMG are used, resource intensity weights (RIW) developed by the Canadian Institute for Health Information (CIHI) can be used as cost share s_i for each MCC or CMG. If ICD-10-CA clinical chapter is used, average cost per stay can be used as cost share s_i for each chapter. Average costs per stay by clinical chapter and for selected medical conditions are available in 2004–2005 for Canada (CIHI, 2008). They can be estimated by province and for different years.

5.2 Practical Considerations

The index in (6) calculates the overall output of the health care sector. In practice the overall index is likely to be aggregated from second-level subindices, which can be based on the major clinical categories. For example, in ICD-10 Group I, diseases of the circulatory system is further divided into 10 subgroups such as acute rheumatic fever (I02), pulmonary heart disease and diseases of pulmonary circulation (I28), cerebrovascular diseases (I69), etc. At the subgroup levels, each disease can sometimes be treated with several treatment methods. Quality changes often involve improvement of existing methods or invention of new methods. It is at this level that new goods enter and substitutions occur.

The quality enhancing adjustment factors can be applied at two stages: at the product stage and at the outcome stage. At the product stage, adjustment can be made for unsuccessful or iatrogenic cases such as unplanned re-admissions. In this case, q_i^t would be defined as the number of successful episodes i in period t.

At the outcome stage, the adjustment factor e_i^t can be a disease- or treatment-specific outcome measure such as a physiologic measure, a utility-based measure such as health-adjusted life year (HALY), or a combination of both. The measure taken for each category should be based on the expert knowledge in that particular field.[12]

The HALY family includes measures such as QALY and DALY (Disability-Adjusted Life Year). QALY by definition is not disease-specific but DALY is linked to diseases, conditions or disabilities (Gold *et al.*, 2002).[13] QALYs are based on the Health Utility Index (HUI) and were produced by Statistics Canada for the provinces and Canada for 2001 (CANSIM Table 102-0121). They are preferred to DALYs because in the Canadian context, they can be more readily available. In order to compute quality-adjusted output, QALYs need to be available on a periodic basis for all MCC or ICD-10-CA clinical chapters.

The determination of the quality adjustment factors is a large undertaking which involves the collaboration of medical experts, health economists, and economic statisticians in each category of diseases. The process is similar to what Shapiro and Wilcox (1996) call "house-to-house combat" of measuring quality change in price measurement. Moreover, these indicators do not change much in the short-run. For these reasons, it is more practical to consider a satellite account for the health care sector (OECD, 2000).

5.3 An Episode-Based Index

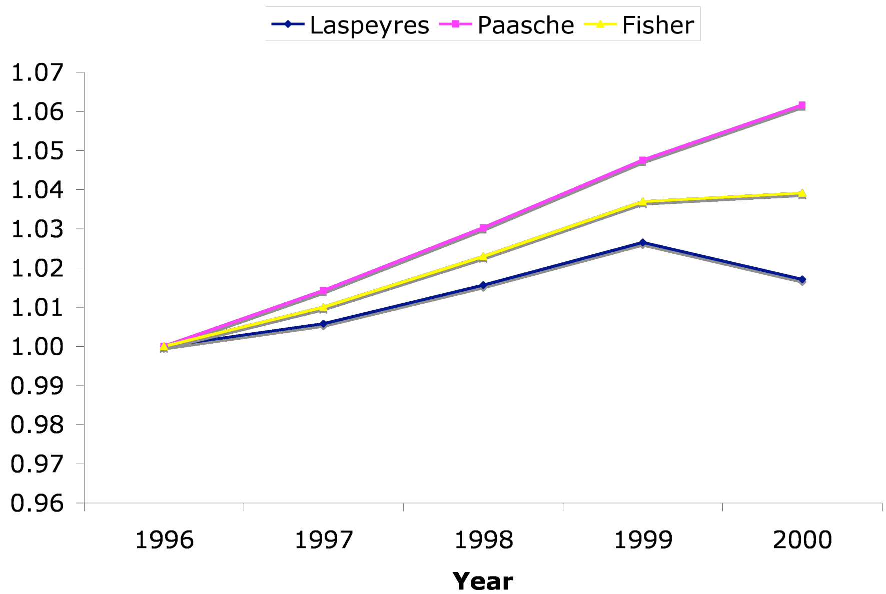
In this section we provide an empirical example using CIHI's data on hospital inpatient and day surgery services in Canada from 1996 to 2005. Between 2001 and 2002, data were submitted to CIHI from ICD-9 to ICD-10-CA. This implementation of ICD-10-CA was staggered across Canada. To avoid the structural break indices for these two years are not calculated. We take the assumption that there are no quality changes in all CMG in consecutive periods. In future work, this assumption will be relaxed to explicitly account for quality changes.[14] With the no-quality

[12]See Berndt *et al.* (2006) on applying this "expert" approach to price indices for mental health care, and Cutler *et al.* (1998) for heart attack treatments. Also, waiting time for diagnoses and treatments can in principle be incorporated into HALY.

[13]Note however that QALY can be computed for specific diseases by subtracting the condition-deleted mortality rates from the overall mortality rates in the life table and by removing people with specific conditions from the survey used to generate the quality weights (Manuel *et al.*, 2003).

[14]Currently, DALY measures are available for 1996 (Statistics Canada, 2002) and QALY measures are available for 2001. However, the same measure should be used at the base period and the end period because DALY and QALY are not based on the same health-related quality of life.

Figure 1: Output Indices for Hospitals in Canada (excluding Quebec and Alberta), Inpatients and Day Surgeries, 1996–2000



Note: Quebec is excluded because their inpatient and day surgery data are not reported to CIHI. Alberta is excluded because their day surgery data are not reported to CIHI.

change assumption, the index becomes

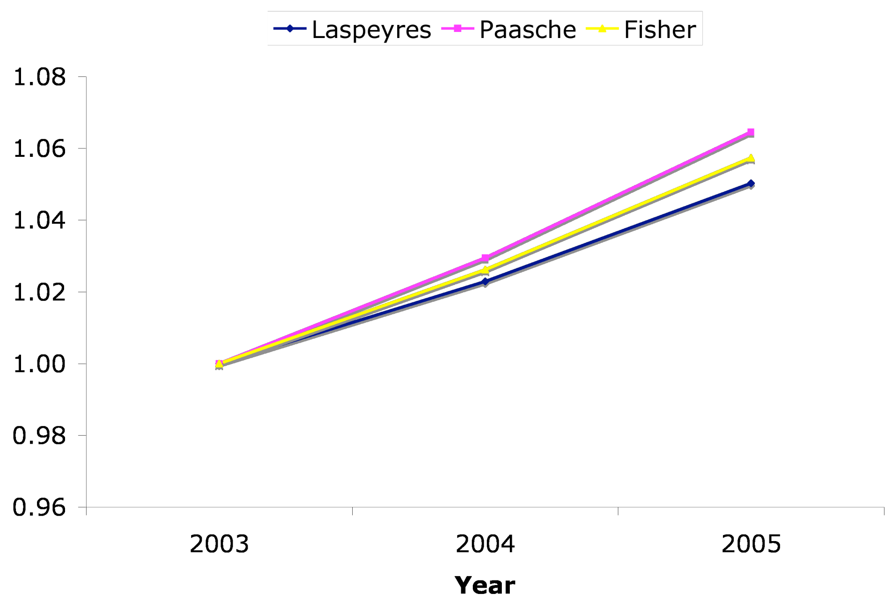
$$Q_L = \sum_{i=1}^{N} s_i^0 \frac{q_i^1}{q_i^0}, \tag{7}$$

which is a commonly used Laspeyres quantity index.

Similarly, the Paasche-type quantity index Q_P can be calculated using the comparison period cost shares s_i^1 in (6) or (7). The Fisher quantity index is simply the geometric mean of Q_L and Q_P, which is currently used by Statistics Canada in the SNA.

Figures 1 and 2 show the three chained quantity indices for the 1996–2000 and 2003–2005 periods respectively. From the trends we observe that the Paasche being the upper bound and the Laspeyres being the lower bound of the theoretical quantity index (Diewert, 1993, 189). The Fisher index is the geometric mean of the two and therefore is a close approximation of the true quantity index. From the numerical results, the Fisher index Q_F between 1996 and 2000 is 1.039 and between 2003 and 2005 $Q_F = 1.057$. Even we assume that there are no changes between 2000 and 2003, the overall quantity index between 1996 and 2005 is 1.099. This translates into an average annual growth rate of 1.6% for the six year period for which the index is calculated. This index provides a lower bound for the hospital output in Canada since it is unadjusted for quality improvement. In other words, from 1996 to 2005,

Figure 2: Output Indices for Hospitals in Canada (excluding Quebec, Manitoba and Alberta), Inpatients and Day Surgeries, 2003–2005



Note: Quebec is excluded because their inpatient and day surgery data are not reported to CIHI. Manitoba is excluded because up to 2003, only Winnipeg facilities submitted data to CIHI. Alberta is excluded because their day surgery data are not reported to CIHI.

Canada's total hospital output on average has increased at least by 1.6% per year. With quality adjustment we expect the growth rates to be higher. This information is a piece of the puzzle in the whole picture that provides insight into the ongoing policy debate on the health care system.

6 Conclusion and Recommendations

In this paper we have reviewed and explored the theoretical and practical problems of measuring the real output of the health care system in Canada. The decomposition of total expenditure change into a price change and a quantity change is important in policy analysis and international comparison of output and productivity. Techniques in cost-effectiveness analysis can be modified in principle to measure quantity via only the outcome of the health care sector. This approach, however, has some conceptual issues that are not compatible with the purpose of the system of national accounts. Moreover, frequent measurement of health outcome for the whole country is impracticable. We recommend an episode-based quality adjusted index to be used in the Canadian SNA. Because this approach requires also measurement of health outcomes, a satellite account is suggested for practical reasons. Data on quantities are available from the Discharge Abstract Database (DAD) or the Hospital Morbidity Database (HMDB) and the National Ambulatory Care Reporting System (NACRS). Data on cost shares are available from CIHI's resource intensity weights or can be made available from special studies in the case of average cost per stay or unit cost. Using the data, we calculate the episode-based quantity index for the periods 1996–2000 and 2003–2005. Our results show that the real output unadjusted for quality change increases at an average annual rate of 1.6%. The index needs to be adjusted for quality changes using measure such as QALY. Details of future quality adjustment for each major clinical category requires the inputs from a team of medical experts, health economists, and economic statisticians. We recommend that policy makers to set up a task force to oversee the implementation of these programs.

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