HEALTH POLICY AND PLANNING; **15**(2): 230–234

How to do (or not to do) . . .

The real and the nominal? Making inflationary adjustments to cost and other economic data

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Given the scarcity of cost data for health interventions, there has been substantial use of a relatively small number of existing studies to underpin policy development formulation. Intervention-specific cost and cost-effectiveness data have been used to plan overall budgets, to assess the relative efficiency of different interventions and to consider the resource requirements for programme implementation at both the local and national levels. Cost and cost-effectiveness comparisons have been made between these studies and general sources such as the World Bank's *World Development Report 1993*. At the same time, information on key health sector variables, such as annual health expenditures, has been systematically compiled for more than two decades. The question of possible inflationary effects is becoming increasingly important as the original data on which these numbers are based ages. For example, cost figures from the mid-1980s require a 60% inflationary adjustment simply to maintain their real value in current dollars. This paper looks at methods to adjust cost data to account for inflation and discusses the difference between real or constant and nominal or current values. These methods are also used to make inflationary adjustments to other types of economic data such as income.

Introduction

'Prices go up, costs increase'. This somewhat obvious statement is a crucial aspect of the circumstances under which we live, plan our programmes, implement policy and spend money.[1] As pressure on scarce resources increases, there has been a greater focus on the use of cost and cost-effectiveness information to guide policy formulation. In a less than ideal world, information on the cost of programmes is scarce and expensive to acquire. Thus decision-makers tend to rely on existing cost information, which may be taken from different sources and different years. The publication of the World Bank's *World Development Report 1993: Investing In Health* and related-background work (Jamison et al. 1993) has served as a baseline marker for the relative cost of different health interventions, and is consistently used as the basis of comparison for newer studies on the costs and cost-effectiveness of public-health interventions (Gilson et al. 1997; Alonso Gonzalez et al. 2000).

What is inflation?

Money, or more precisely, the value of money, is the standard by which resource use is measured. The term *inflation* is used to describe the process whereby the general price level is rising and money is losing value (Parkin et al. 1997). This means that more money has to be paid to buy or provide the same quantity of goods and services (Phillips et al. 1993). Inflation becomes important when one compares prices and costs, measured in money units, through time. This is because the unit in which the value of resources is being measured (money) is also changing its value. So it is difficult to tell whether an increase in costs represents an increase in the real resources used or simply a decline in the value of the money those costs are measured in.

As general price levels increase, there is a need to adjust price or cost information when comparing data from different years. Otherwise, it is unclear whether differences in costs and prices reflect actual changes in purchasing power or just a change in the value of the money in which these prices are measured. Adjustments are also needed if one is looking at how values of variables, such as health expenditures, change over time. Thus we need to make adjustments when comparing cost information from one intervention for more than one year or when comparing costs and cost-effectiveness information from analyses done in different years. Finally, we also need to make inflationary adjustments when predicting future costs, such as in budgeting processes.[2] This paper looks at the need to make adjustments on cost data to account for the passage of time, the vocabulary associated with the interpretation of these numbers, and the way that the methods used to make these adjustments influence the results. The paper provides correction factors that can be used to adjust cost data for a 30-year period.

Adjusting for inflation

How does inflation make a difference to what a particular basket of goods will cost in different years? If the price of drugs was $140 last year and $150 this year, does this reflect an increase in the real resources used? The answer depends on what the rate of inflation has been. For example, if the rate of inflation between the two years was 5%, then drug prices are rising faster than other prices, but not if inflation was 10%.

We can see this by comparing the percent increase in price relative to the inflation rate:

Percent change in price = (150 – 140 × 100) ÷ = 7.1%

In this example, the change in the drug price was about 7%. Thus if inflation were only 5%, the drug price has increased by 2% more than inflation, while if inflation were 10%, there would have been a 3% reduction in the price of the drugs relative to inflation over the two years. This also means that if one had used the figure of $140 for this year's budget, then this year's actual purchasing power would have been reduced by 5% or 10%, depending on the rate of inflation.

It is essential to ensure that when making comparisons across years or projecting monetary values for future years, allowances are made for inflation. Money values that are unadjusted for inflation are often referred to as *nominal* or *current* dollar amounts. So, referring to an increase in drug prices from $140 to $150 between 1998 and 1999 is expressing the values in nominal terms. The figure of $140 is expressed in 1998 dollars or money units, while $150 is expressed in 1999 dollars or money units. However, due to inflation, $1 in 1999 is worth less than $1 in 1998. In order to do a realistic comparison between the two values, we need to express them in the same values (either 1998 dollars or 1999 dollars). Converting the values to one year's values, means that you are expressing the values in *constant* or *real* terms (i.e. the same monetary units).

In this example, we can select the base year as either 1998 or 1999. If we use 1998 as our base year, then we need to *deflate* $150 to 1998 values. If we choose 1999 as the base year, then we need to *inflate* $140 to 1999 values. If inflation is 5%, then drug prices in constant terms can be calculated as:

1998 base year:

- 1998 drug costs = $140
- 1999 drug costs in 1998 values = 150/(1 + 0.05) = 150/1.05 = $142.86 1999 as the base year:
- 1998 drug costs in 1999 values = 140 × (1 + 0.05) = 140 × 1.05 = $147
- 1999 drug costs = $150

A comparison of the two ways of calculating the constant values, shows that the difference in cost between the two years ($2.86 in the first example and $3 in the second) depends on the choice of base year. In practice, the most recent year for which reliable data is available is generally used as the base year. In order to correct for inflation, we have either inflated or deflated the current year's value by an *inflation adjustment factor*. This inflation adjustment factor reflects the proportionate change in prices (or rate of inflation) between the two years. In this example, we expressed the 5% rate of inflation as 0.05 and added it to 1. This reflects the fact that $1 in 1998 is actually worth 5% more than $1 in 1999, or that you would need $1.05 1999 dollars to have the same purchasing power as $1 in 1998.

Where do we find information on inflation in order to construct these estimates? Generally, inflation is measured by trying to capture the change in the average price of goods in a country. Most commonly, the price of a particular set of goods and services (e.g. a typical 'basket' bought by consumers) is monitored through time. Changes in the price of this basket are used to calculate the overall inflation rate in a country. These measures are usually referred to as consumer or retail price indices (CPI or RPI) and may be routinely published in Central Bank statistics. Another measure of inflation is the GDP implicit deflator that reflects price changes for all goods and services produced in a country, and so is the broadest-based measure of inflation (World Bank 1999). A good source of cross-country information is the IMF's *International Financial Statistics*, which provides statistics for each country, and attempts to provide quarterly and annual statistics on both national statistics, such as the CPI, as well as the GDP implicit deflator. The World Bank's annual *World Development Report* also provides average annual GDP implicit deflators for most countries expressed in US dollars. Countries with more detailed data collection may also produce health-sector specific indices of inflation, which are based on a basket of typical 'health' goods and services such as the salaries of nurses in the health sector. Ideally, a health-sector specific index would be the most desirable measure of inflation to consider, since trends in the health sector may not be similar to the 'typical' basket of goods in a country. However, in practice this index is not widely available for many low and middle-income countries.

Typically, when a measure of inflation is reported it is presented in terms of an index. This index selects a base year, set at 100. Changes in price levels will then be reported relative to this base year. So, if 1990 is the base year, the CPI for that year would be given as 100.0. Then, depending on inflation, the value in 1998 might be given as 214.0 and 1999 as 224.70.[3] To convert to 1999 dollars, from 1998 prices, we use the following approach:

$140 × 224.7/214.0 = $147

The base year is updated every 5–10 years to avoid inflation rates of several hundred or thousand percent. Thus when using inflation figures that have been calculated over long periods of time, it is important to check whether or not the figures are always relative to the same base year. When presenting data in constant figures economists will indicate the base year in which the values are presented (i.e. the year of the monetary unit). By convention if 1998 US dollars were used as the base, then this would be described as US$ (1998) and we would talk about the values as being measured in 1998 constant dollars. Similarly, if 1999 dollars were used then

'US$ (1999)' would be used to indicate this. If figures are presented in nominal or current values, we would usually only see a note of the currency used (e.g. $).

Inflation over time: compounding

The measure of inflation can be thought of as a compound or cumulative measure. If the price is $100 in year one and inflation is constant at 5% each year, then we would expect the price to be $105 next year. However, in two years' time the price would not be $110 but rather $110.25. This is because inflation in year two is applied to the price at the beginning of that year, $105, rather than to the original price of $100. So the price level in two year's time would then be $105 × 1.05 = $110.25.

Given this compounding, if inflation is not accounted for over time, the use of cost data from previous time years may substantially under-estimate the level of resources that are currently needed. For example, if we look at the relative costs and benefits of public health interventions taken from the *1993 World Development Report* in Table 1, we see that the costs are given in 1990 dollars.

If we now express these costs in terms of the purchasing power in the year 2000, we see that there is between a 37% and 63% difference in the costs, depending on the choice of inflation rate. [The 3.2% rate is the average annual inflation rate between 1985–1997 as measured by the US GDP implicit deflator (World Bank 1999)]. This highlights the need to express cost data in real terms when making comparisons between studies done in different years or when making projections about future costs, even with relatively low rates of inflation.

Table 2 presents correction factors that can be used to convert cost data over a 30-year period. These factors could be used to convert to any base year, although we have used the year 2000 as an example. The use of these correction factors is a 'short-cut' to adjust for inflation and reflects adjustment for the average value of inflation over a period. In reality, inflation rates changes from year to year. If one were interested in the specific changes between each year, then each year's values would have to be corrected by the corresponding annual inflation rate (as measured by a CPI or GDP deflator).

Depending on the inflation rate that is being used, the correction factors will be different. There are five inflation rates shown in Table 2. So if one is converting cost data expressed in US dollars into year 2000 US dollars, the first column may be used. Examples of correction factors for India and South Africa are also shown. Correction factors using rates of 5% and 10% inflation may be particularly useful in projecting future expenditure in terms of year 2000 dollars. Somewhat higher rates of inflation may be used when projecting into the future to provide a margin of error, given that future rates of inflation are uncertain.

In order to use Table 2, one needs to consider the year in which data is taken, the base year into which the data will be converted, and the rate of inflation that should be used. For example, if a study gives the total cost of a project as $US 10 000 in 1993, and the base year is 2000, the selection of the correction factor will depend on the rate of inflation chosen.

Table 1. 1993 WDR estimated costs and health benefits of selected public health and clinical services corrected for inflation

Country group and package	Annual cost US$ (1990) Taken from Table 5.3, 1993 WDR Cost per DALY	Annual cost US$ (2000) Using 3.2% inflation rate Cost per DALY	Annual cost US$ (2000) Using 5% inflation rate Cost per DALY
Low Income			
Public Health Package			
Minimum essential package of clinical services			
• Short-course chemotherapy for tuberculosis	3–5	4–7	5–8
• Management of the sick child	30–50	41–68	49–81
• Prenatal and delivery care	30–50	41–68	49–81
• Family planning	20–30	27–41	33–41
• Treatment of STDS	1–3	1–4	2–
• Limited Care	200–350	274–480	326–570
Middle Income			
Public Health Package			
Minimum essential package of clinical services			
• Short-course chemotherapy for tuberculosis	5–7	7–10	8–11
• Management of the sick child	50–100	68–137	81–163
• Prenatal and delivery care	60–110	82–151	98–180
• Family planning	100–150	137–205	163–244
• Treatment of STDS	10–15	14–21	16–24
• Limited Care	400–600	548–822	652–977

Source: The US$ 1990 are taken from World Bank (1993), US$ 2000 columns are authors calculations.
Note: Cost per DALY is rounded to the nearest dollar. WDR = *World Development Report*.

Table 2. Inflation correction factors for a 30-year period

Year (For example, relative to base year of 2000)	3.2% ICF (Average annual rate for United States, 1985–97)	8.3% ICF (Average annual rate for India, 1985–97)	12.8% ICF (Average annual rate for South Africa, 1985–97)	5% ICF	10% ICF
Correct from 1985	1.604	3.307	6.090	2.079	4.177
Correct from 1986	1.554	3.059	5.399	1.980	3.797
Correct from 1987	1.506	2.819	4.786	1.886	3.452
Correct from 1988	1.459	2.603	4.243	1.796	3.138
Correct from 1989	1.414	2.404	3.762	1.710	2.853
Correct from 1990	1.370	2.220	3.335	1.629	2.594
Correct from 1991	1.328	2.049	2.956	1.551	2.358
Correct from 1992	1.286	1.892	2.621	1.477	2.143
Correct from 1993	1.247	1.747	2.323	1.407	1.949
Correct from 1994	1.208	1.613	2.060	1.340	1.771
Correct from 1995	1.170	1.490	1.826	1.276	1.610
Correct from 1996	1.134	1.376	1.619	1.215	1.464
Correct from 1997	1.099	1.270	1.435	1.158	1.331
Correct from 1998	1.065	1.173	1.272	1.102	1.210
Correct from 1999	1.032	1.083	1.128	1.050	1.100
Base year 2000	1.000	1.000	1.000	1.000	1.000
To project to 2001	1.032	1.083	1.128	1.050	1.100
To project to 2002	1.065	1.173	1.272	1.102	1.210
To project to 2003	1.099	1.270	1.435	1.158	1.331
To project to 2004	1.134	1.376	1.619	1.215	1.464
To project to 2005	1.170	1.490	1.826	1.276	1.610
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To project to 2010	1.370	2.220	3.335	1.629	2.594
To project to 2011	1.414	2.404	3.762	1.710	2.853
To project to 2012	1.459	2.603	4.243	1.796	3.138
To project to 2013	1.506	2.819	4.786	1.886	3.452
To project to 2014	1.554	3.059	5.399	1.980	3.797
To project to 2015	1.604	3.307	6.090	2.079	4.177

Correction factors have been calculated by compounding the given inflation rate for a given number of years. Inflation data have been derived from World Bank (1999). ICF = inflation correction factor.

Since this data is in US dollars, the selected correction factor is based on 3.2% inflation, which reflects the average inflation rate in the US over this period. Then the correction factor is 1.247 and is multiplied by the total cost ($10 000). The total cost of the project in year 2000 dollars is then obtained ($12 470). If we were using expenditure in rupees or rand, then the correction factors corresponding to India and South Africa would be appropriate, as they reflect average inflation in these countries over this period.

We can also use the correction factors to consider future inflation. For example, if you are planning a five-year budget (2001–2005) and know that you are likely to spend $US10 000 in recurrent costs in 2000 and would like to maintain the same purchasing power over the five years, then the correction factors can be used to adjust for this. Let us assume that we expect 5% inflation per year on average, our 2001 budget for recurrent costs would then be:

$10 000 × 1.050 = $10 500

By 2005, the recurrent cost budget would then be $10 000 × 1.276 = $12 760 in order to maintain the same purchasing power as in the year 2000.

The use of these correction factors (using average rates of inflation) is appropriate when inflation is relatively low (e.g. below 15%) and stable over a long period.

A final note: inflation, interest and exchange rates

Inflation, particularly prolonged periods of high inflation will also affect other variables that are used in measuring costs. First, inflation may affect the interest rate. Interest rates are used to value the opportunity cost of using capital items. A nominal rate of interest reflects the rate at which people are lending money, and will also reflect the rate of inflation, whereas the real rate of interest reflects the real cost of money.[4] In practice, the distinction between real and nominal interest rates becomes more important as inflation gets higher than 5–7%.

Second since inflation varies from country to country, the rate at which different currencies are exchanged will reflect these differential inflation rates. We often do comparisons of costs across different countries and over more than one year. So a key issue is whether to convert to a common currency (usually US$) before correcting for inflation (then using the US inflation rate) or to work in a local currency (using local inflation rates) and then convert to US$. In practice, the numbers you obtain will be substantially different if there are high rates of inflation in a country relative to the US, and so the two methods of adjustment will yield different answers. Unless there is a situation of rapid inflation (e.g. 15–20% or higher), it is generally better to work in local currencies and then convert at the end. However, if there is a relatively high proportion of imported commodities in a cost analysis, then working in US$ will be more appropriate.

Clearly the nature of the adjustment which is made will affect the resulting values. Two people may choose entirely different factors of adjustment for different reasons. However, what is most important is that the process of adjustment is transparent and that all the critical information used, such as the choice of base year and value of exchange rates, is clearly specified. Where feasible, it is good practice to present a sensitivity analysis using a range of adjustment factors. This will allow people to consider how robust their conclusions are relative to their choice of assumptions.

Endnotes

[1] There are also cases where the prices or costs of goods and services go down over time. This is especially true of technology-intensive goods such as computers, and is an example of a real change discussed in section 3.

[2] Issues such as the generalisability and transferability of costs between settings have been discussed elsewhere (Murray et al. 1994; Jefferson et al. 1996).

[3] If the index is over 200, this means that nominal prices have more than doubled since 1990.

[4] To obtain the real interest, a simplification that can be used is to subtract the inflation rate from the nominal interest rate. However, as inflation rises above 10–15%, it is more appropriate to use the formula: real interest rate = (1+nominal rate)/(1+inflation rate) – 1. But, as inflation becomes higher, there is a tendency to use currencies such as US dollars, which have low and stable exchange rates to measure resources, even in local transactions.

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Acknowledgements

Lilani Kumaranayake is a member of the Health Economics and Financing Programme, which is supported by funds from the UK Department of International Development (DFID). The author would like to thank Toby Mendel for providing detailed comments on an earlier draft, as well as two anonymous referees.

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