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Integrating Cost-of-Disease Studies into Purchasing Power Parities (PPP)

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The OECD aging-related diseases (ARD) study contains information on the cost of specific treatments for heart disease, strokes, and breast cancer. I have been asked to review whether such data on cost of disease treatments are appropriate for improving Purchasing Power Parity (PPP) measures for medical care. The short answer is: cost of treatment information is exactly the information that is needed, in principle. However, the information in the ARD studies might need a little refinement. The rest of this paper explains.

I. Health Care Expenditures and Health.

I begin by considering a contention that frequently arises in discussions of the relation between medical expenditures and health. One frequently hears statements such as: U.S. spending on health care, which amounts to around 13% of GDP, must not be productive (says the speaker), because life expectancy in the U.S. is lower than it is in some other countries that spend a smaller amount on health care. What is the relationship between medical care expenditures and health?

There is little disagreement that health is produced by many factors, and not solely by the activities of the medical sector. Diet, lifestyles, environmental factors, genetic endowments, and other influences determine an individual's, or a society's, level of health. It is sometimes asserted that nonmedical influences on health are more important than the medical ones (McKeown, 1976; Mokyr, 1997), and for the major, long-run changes in health, there is much to be said for that position.

Medical and nonmedical influences on the "production" of health can be represented in a very general way as:

(1) health(t) = H(medical(t-n), diet(t-n), lifestyle(t-n), environmental(t-n), genetic, etc.)

[1] An anonymous referee contributed valuable suggestions for improving the exposition of this paper.

"Health" is thus the ultimate output of a "production process" in which medical interventions are one of a number of contributing inputs. Moreover, the present level of health is a consequence, at least in part, of actions in the past—of past expenditures for health care and of past diet, past environmental, and past lifestyle influences. The production of health status is an intertemporal production process, indicated by the (t-n) subscripts in equation (1), where the right-hand side variables are to be understood as vectors that incorporate information for all past periods in the individual's life.[2]

Some of the variables in equation (1) are goods whose consumption makes a positive contribution to present utility, but which have an adverse effect on future health. A rich and fatty diet is an example. Grossman (1972) emphasized that abstaining from consumption of such goods is like an investment, in the sense that current consumption (utility) is reduced in order to have greater utility in the future.

The future periods may be a long way off, so the adverse consequences of current unhealthy behavior will be discounted by a rational consumer. For example, Garber and Phelps (1992) remark that a drastic reduction in fatty diets will only increase the (discounted value) of life expectancy by 4 days for men and 2 days for women. The future health consequences are normally changes in probabilities, rather than deterministic. Discount rates, assessments of probability changes, and--because of genetic factors, for example--the actual risks of adverse effects may differ greatly across individuals. Thus, their willingness to undertake "investments" in future health--to reduce current unhealthy, but utility-generating, consumption activities--may differ greatly.

As incomes rise and as consumers as a group become more wealthy, consumption of rich diets and more sedentary lifestyles may increase because these are luxury goods.[3] Because expensive medical procedures are also more readily available in a more wealthy society, income affects health in two ways. It may encourage less healthy behavior, leading to lower health (Grossman, 1972, presents empirical evidence of this). But income also permits more resources to be devoted to medical care, which increases health.

One might contend that the relation between income and consumption of unhealthy diets is U-shaped: It has long been known that in very poor societies, only the rich are fat, because the poor cannot afford to eat so well. But in wealthier societies, individuals in the lower-income part of the population are more likely to be obese, because with their society's higher income they

[2] This specification is not intended to deny that current levels of health care expenditure and current diet or lifestyle affect current health, but rather to emphasize the time paths of the effects and the fact that individuals' decisions have intertemporal effects.

[3] Smoking apparently has a low income elasticity, but automobile transportation has a high income elasticity almost everywhere, leading to the observation that automobiles kill more people through reduced exercise than they do in accidents.

can afford to eat abundantly (American fast food is cheap, compared with incomes of even the poor), while the rich or the better educated may eat more healthy diets.[4]

Whatever the shape of the relation between income and healthy behaviors, the effects of fatty diets, sedentary behavior, and smoking on heart disease in a society might merely be offset by the development of expensive treatments, such as heart bypass surgery. If so, the overall death rate from heart disease might be the same as the rate in a society with healthier living and a smaller amount of expensive surgery. Cross-country comparisons of heart attack death rates are suggestive in this respect, although (as indicated in the following) not conclusive.

Thus, the incidence of heart disease in two countries tells us nothing about the value of the output of the medical sector. Equation (1) does not imply that a society's *level* of health is determined by its health expenditures or by the level of medical interventions it supports. Neither does it imply that a society with a higher level of health expenditures necessarily has better health than another society with lower health expenditures. Some aggregate-level studies have regressed variables such as countries' levels of pharmaceutical consumption or other measures of medical expenditures on some measure of their health status. Equation (1) suggests how many behavioral and environmental variables must be held constant for such studies to be meaningful. Standard econometric "omitted variable" problems contaminate almost any conceivable cross-country regression specification of equation (1)—there is little way of determining whether it is the level of health expenditures, or some other collinear but omitted variable that determines cross-country differences in health.

In Triplett (2001) I suggested measuring the contribution of the health care sector to the production of health by the incremental contribution to health caused by medical interventions. That is, using equation (1):

(2) effectiveness of the health sector (= N) = ∗ (health) / ∗ (medical), other influences constant,

where ∗(health) is the change in health that is attributable to ∗(medical), the incremental resources put into medical care interventions.

Equation (2) describes a relation between medical procedures and health, *all other influences on health constant*. In principle, since N is derived from equation (1), on could estimate N from a well-specified form of equation (1). However, as noted earlier, it is unlikely that any aggregate regression exercise can ever hold other influences on health constant. For this reason, we need an alternative estimate of N that does hold other influences constant. Scientific evidence on the effectiveness of medical treatments is designed to do just that, with a clinical trial.

Scientific studies of effectiveness are invariably tied to particular interventions. Interventions are, by their nature, specific, and they relate to specific diseases. Measuring the

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[4] Healthy diets have actually become more expensive: In American grocery stores and inexpensive restaurants, fresh fruits and vegetables no longer provide economical portions of diet. In the analysis of healthy or unhealthy diets, relative prices intrude, as they do in most aspects of consumption behavior.

health implications of medical interventions inevitably implies a strategy of examining these interventions on an intervention-by-intervention basis. Economists need, not aggregative information on health expenditures and health status, but information that can be linked to specific medical conditions.

To do this right, ∗(medical) should include the increments of all the resources required by a medical intervention, which may include direct and indirect costs (unpaid caregiving by the patient's family, for example). And ∗(health) should be a comprehensive measure that incorporates all of the effects on health of a medical intervention, including unwanted side effects, if any. In the cost-effectiveness literature (Gold, et al., 1996), such an impact is called a "health outcome." Gold et al (1996, page 83) define a health outcome as the end result of a medical intervention, the change in health status associated with the intervention over some evaluation period, or over the patient's lifetime. Equation (2) implies that the *health outcomes associated with medical interventions define the output of the health care sector*.

For measuring prices or costs of medical care, or for estimating medical care services in national accounts, or the productivity of the medical care industry, or for making international comparisons of health care systems, none of this would matter very much if the treatments did not change. Each treatment, z, is associated with one value of N, say, N_z, so we can just count treatments and aggregate them in some way. But treatments do change and they also differ across countries. When change occurs, it is necessary to evaluate the changes in treatment—to use the usual price and output measurement language, one needs to "quality adjust" medical expenditure data for changes in the treatments. It is at this "quality adjustment" point that effectiveness measures are required, because the quality adjustment requires comparing the effectiveness of the new treatment with the old, or the treatment carried out in country A with the one usually used in country B.

Equation (2) thus implies that the information that economists need for measuring health care output is the same as the information needed to determine whether a medical intervention is an effective treatment. This medical data is addressed in cost-effectiveness studies.

It is commonly observed that actual treatments do not always correspond to medical best practice, and that results in practice do not always match the results of clinical trials. In principle, N would be adjusted to take account of these problems (excess surgery, for example). We are a long way from having such adjusted empirical measures, but economic measurement of health expenditures according to the human repair model is just beginning.

II. The Human Repair Model

In Triplett (2001) I considered an approach to measuring the output of medical care that is based on equations (1) and (2). I called it the "human repair model," to make the point that in the human repair model, measuring health care output proceeds in ways that are similar to methods used for nonmedical services (for example, car repair).

In the human repair model, we assemble data on expenditures on treating groups of diseases, such as, for example, expenditures on treating mental conditions, or circulatory diseases, or, if more detailed data are available, on treating heart attacks or treating depression. Such expenditures by disease data are produced in cost-of-disease accounts, including Hodgson and Cohen (1999), Moore, et al. (1997), Mathers, et al. (1998), and United Kingdom Department of Health (1996).[5] Regrettably, time series consistency has not been a past priority in constructing cost-of-disease accounts, which creates a substantial data problem.

If we can construct price indexes by disease, then these disease-specific measures of medical inflation can be used as deflators to obtain measures of the real quantity of medical services by disease. For countries that have publicly-provided health care systems, it is more natural to estimate the quantity side: quantity indexes of numbers of treatments, weighted with costs, give the real changes in the quantities of medical care services, and the price indexes are estimated implicitly (see section IV). The essence of the human repair model is the same in either case: One begins from an accounting for the costs of treating diseases, then the quantity and price information necessary to understand changes or differences in medical care expenditures is constructed on a disease by disease basis.

The human repair model obviously contrasts with the "total health/total medical expenditures" approach that I discussed (and rejected) in the previous section. It also contrasts with the approach to medical care price and output measures that have traditionally been pursued in national accounts and in national health accounts (NHA), almost all of which have measured inputs to health care treatments, not the outputs of the medical care process, which are treatments for disease.[6]

In countries where health care is provided by the public sector, health care output is usually measured as is other government output—by combining the inputs that the sector purchases. Because productivity is the ratio of outputs to inputs, measuring output by inputs explicitly eliminates productivity change in the medical care sector, by setting it to zero.

The U.S. has a predominantly privately-produced health care system. Prices are thus relevant, and price indexes are used to create constant price output measures for medical care. Historically in the U.S., the Consumer Price Index (CPI) component for medical care has been used for deflating medical expenditures in national accounts and national health accounts. This CPI medical care index was until recently constructed from a sample of medical care transactions: a hospital room rate, the price for administering a frequently-prescribed medicine, or the charge for a visit to a doctor's office (see Berndt et al, 2000). Such transactions are effectively medical inputs, but they are sufficiently standardized that the same transaction can be observed repeatedly, which is required for a monthly price index.

The historical U.S. CPI approach also tends to eliminate productivity change, because it sets the unobserved output price equal to the aggregation of the input prices collected for the CPI. Productivity can also be expressed as the ratio of output price to input prices. Actually, for

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[5] This UK Health Department study, which is not the same UK study that was cited in the OECD reports, followed the same methodology as the U.S., Canadian and Australian studies, but is somewhat less refined. The OECD reports also cite a newer study from the Netherlands.
[6] It is true that much medical care expenditure is for prevention and maintenance; for economy of language, I include these expenditures in "treatments," though allocating them among diseases is difficult.

much of the period in which this CPI approach was used in the US, measured health care productivity growth was negative (Triplett, 1999a). Negative measured productivity growth in the medical care sector is also evident in data for Canada (Sharpe, Rao, and Tang, 2002).

As suggested by Berndt et al. (2000) and in Triplett (2001), the input pricing methodology has never been regarded as satisfactory for measuring health care inflation, output, and productivity, and for the national accounts. Recently, the U.S. Bureau of Labor Statistics, in its Producer Price Index (PPI) program, shifted to gathering prices for specified medical treatments. The BLS selects a sample of treatments from within a *Diagnostic-Related Group* (DRG) category;[7] it then follow costs of treating the disease sample through time—see Berndt, et al. (2000). As a direct result, measured medical care productivity growth in the US is no longer negative, it is positive (Triplett and Bosworth, 2002).

A substantial amount of research on improved price indexes by diseases is contained in Cutler and Berndt (2001). These studies go beyond the BLS indexes in explicitly introducing, to the extent possible, medical care outcome measures. Diseases for which price indexes have been constructed by researchers include heart attacks, stroke, breast cancer, premature births, arthritis, cataract surgery, and some others.

Although this research so far does not cover a sufficiently wide set of conditions across the full ICD-9, the human repair/cost-of-disease framework clearly has great promise for improving measures of health care in national accounts. Eurostat (2001) endorses the cost of disease approach for future improvements in national accounts. At this writing, there appears to be substantially less interest in the human repair/cost-of-disease approach among compilers of national health accounts, including those of the U.S.

For international comparisons, a Purchasing Power Parity (PPP) shows “the ratio of the prices in national currencies of the same good or service in different countries” (Schreyer and Koechlin, 2002). PPPs are like price indexes, except that comparisons are made across countries or areas, at the same point in time. Schreyer and Koechlin (2002) present a good introduction to the topic; see also OECD (2002).

Like most medical care price indexes, PPPs for health care are constructed from a list of inputs to the medical care process. Eurostat-OECD (2001-3) includes a list of 462 prescription pharmaceuticals, starting with Almax and ending with Xalatan. A set of medical appliances are also included, such as eyeglasses, and medical supplies, such as bandages. Lab tests and general practitioner and other medical consultations (office visits) are other input measures. Prices are obtained for a small number of medical procedures, such as tooth extraction. Indexes of wage rates or earnings for a list of medical occupations complete the Eurostat-OECD PPP health care calculation. Nearly all of the components are input price measures, not output prices.

Results of the latest round (1999) of PPPs for medical care for a selected list of OECD countries are presented in Table 1. The U.S. has costs that are substantially higher than other

[7] U.S. DRGs are identical to DRGs in Australia and similar to those in other countries. They are based on or can be linked to the international classification of diseases (ICD-9). However, the referee points out that implementations of DRGs differ across countries, creating international noncomparabilities in data derived from DRGs.

OECD countries. The reason usually given is that the U.S. has substantially higher earnings for medical care occupations, and earnings have a large weight in the PPP for medical care.

Because PPP compilations are similar to price indexes, a similar cost-of-disease approach to constructing PPPs is a natural extension of the time series work that is emerging in the national accounts arena. Moreover, one use for PPPs is to compare national accounts aggregates internationally. It is thus reasonable to think about replacing the current PPP procedures, which amount to pricing inputs into the treatment of disease, with explicit measures of the cost of disease treatments across countries. Indeed, OECD (1997) contains a proposal for PPP research along these lines.

Pricing the cost of disease treatments is not a simple matter. The problems are discussed extensively in the various contributions in the volumes edited by Cutler and Berndt (2001) and Triplett (1999b). But the data in the ARD study provide exactly a step in the desired direction.

III. Assessing The ARD Cost-by-Procedure Data

For the ARD study, researchers gathered unit costs from a variety of sources for specific treatments. For example, in the heart disease study, unit costs of an elective angioplasty were obtained from studies in nine countries.

The three ARD reports themselves express these unit costs data as a proportion of each country's per capita GDP. The reasoning behind this presentation decision is unclear. Apparently, the researchers desired to abstract from elements of medical care that reflected income differences among the countries and that presumably did not have anything to do with treatments. An example might be provision of private telephone lines in hospitals: In higher income countries such amenities might come to be prevalent, essentially because there is a lodging element in a hospital stay with standards that go beyond medical necessity. At one place the report even considers dividing the unit cost data by the existing PPP for medical care.[8]

For calculating a PPP, the unit costs themselves are desired, not the unit costs divided by per capita GDP or by some other number. The underlying unit cost data for the ARD heart disease study have been provided by Veronique Defontenay, and are displayed in Table 2.

Data in Table 2 are calculated in national currency units. If the medical procedures in Table 2 are really identical across countries, the data suggest that an elective angioplasty procedure costs about $3000 Canadian in Canada in 1996, ₤3000 in Great Britain, and $21,000, U.S., in the United States (the Great Britain and United States costs actually refer to earlier years, so they must have risen by 1996).

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[8] To the extent that the ARD unit cost data measure output prices, dividing them by the existing PPP input price indexes would actually produce a measure of medical sector productivity. As noted above, existing PPPs for medical care are input cost indexes. One method for calculating multifactor productivity is precisely to divide an output price index by an input price index. See Schreyer's (2001) manual on productivity for the OECD. A qualification is that the PPP does not include all inputs (services of medical capital goods are generally excluded)

A PPP unit expresses the costs or prices of a product or common set of products across countries. Typically, for the OECD the common unit is either the unit of the largest country (the United States) or of the OECD average. A PPP for each of the product categories in Table 2 can be obtained simply by dividing through by a common currency unit. Table 2 is converted into a PPP table using the United States as the numéraire, with the results displayed in Table 3A. To take the entry for "elective PTCA" as an example, the PPP can be interpreted as the exchange rate between the U.S. and Australian dollars that reflects cost differences in elective PTCA, which as the table shows is about 25 to 1. In an actual PPP program, some index number formula would be used to combine the individual PPP entries of Table 3A (and those for the other disease treatments in the study), but I have not done this for present purposes.

The PPP definition calculated in Table 3A is not such an intuitive one. In Table 3B, the PPPs are expressed in units of a common currency, in this case the U.S. dollar.[9] In standard PPP terminology, the numbers in Table 3B are called "comparative price levels."[10]

Taking as an example the entry for elective PTCA for Canada, Table 3B indicates that this procedure costs 10% in Canada of what it costs in the U.S., expressed in U.S. dollars. The procedure costs 19% of the U.S. costs in Australia, and around 24% of U.S. costs in Great Britain. For bypass surgery (CABG), Canadian costs are around 20% of the costs for this surgery in the U.S., Australian, Belgian, Danish and Italian costs are around 40-45%, while in Japan the surgery costs 13% more than in the U.S.

From almost everything that has been written about international comparisons of medical care costs, one expects higher costs in the U.S. For one thing, it is well established that earnings of medical professionals are higher in the U.S. than in most other countries (an old result, see Aaron and Schwartz, 1983). However, the ratios in Table 3B seem too large to be believable. They are substantially greater than the differences recorded in the standard PPP program (see Table 1), which records mainly input prices to medical care. If output price spreads among countries were really greater than the spreads in their input prices, this implies that multifactor productivity differences among countries are inversely proportional to their price levels. That is a startling hypothesis.

The report expresses a number of qualifications about the cost data (see Section 6.3.1, paragraph 19 and paragraph 21). I suppose I am saying that the tabulation in Table 3.B make me more uncomfortable with the data than are the authors.

The ARD cost data were obtained from a variety of studies that were conducted for other purposes. No doubt few of the original researchers were concerned about international comparability. An extension of the ARD work will probably need to collect the prices directly to assure comparability, rather than relying on secondary sources. It is well worth the effort.

IV. Conclusions.

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[9] We used exchange rates for 1997, taken from International Monetary Fund (2002).

[10] Comparative price levels "provide a measure of the differences in price levels between countries…the number of units of a common currency needed to buy the same [commodity or group of commodities] in each country." (OECD 2002, page 12).

Although I have reservations about the data that were collected in the ARD study, these are exactly the kind of data that are required to make international comparisons. It is well known that expenditures on health care differ tremendously across countries. One suspects that variations in the costs of medical procedures, variations in the utilizations of different procedures, and perhaps other factors explain these international differences. Decomposing the changes in medical care expenditures into prices and quantities is the first step in understanding international differences in health care expenditures. However, the cost data will no doubt have to be collected with as careful attention to international comparability as are any other PPP collections.

A supplementary note on direct quantity measures. Most of the cost data in the ARD study appear to be costs, or charges, which are not always the same thing as prices. In many OECD countries, prices for medical procedures do not exist because they are not charged directly, or else the prices that are charged are not realistic prices in the sense that car repair prices express the cost of repairing one's car.

However, one ultimately wants quantity comparisons across countries. How does the real volume of health care services differ internationally? Getting a PPP is only an intermediate step. The same thing is true for national accounts. We want to know changes in, for example, real consumption. Mostly, we measure prices of consumption commodities in order to deflate expenditures data in national accounts—we want quantity measures of consumption (the national accounts term is "volume"), in other words, we want to know about international differences in standards of living. PPPs are only a step toward the ultimate objective.

For non-market commodities, it may make no sense to compute the quantity measures by deflating by a price index because there is no applicable price index. However, a straightforward alternative exists: One can compute a quantity index directly. In the health context, the costs of medical procedures provide the weights for computing a quantity index in national accounts. This is discussed briefly in Triplett (2001).

The same point can be made about PPP comparisons. One wants a PPP in the usual case in order to make comparisons of real consumption levels across countries. In the case of health, one wants a PPP for health services in order to make comparisons of the real consumption of health services across countries. Where health care is not a market commodity, price indexes or PPPs are not really relevant. Instead, one can get at the underlying question—measuring differences in real health services internationally—by computing a quantity index of medical treatments.

For constructing international quantity studies, the costs of medical treatments provide the weights. The PPP (if it is wanted for its own sake) can be computed implicitly. Accordingly, the cost data collected in the ARD study can be used to get at the underlying question, just in a somewhat different form from the usual PPP analysis. Discussion of this point takes us too far afield.

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Table 1
Price Levels for Health Expenditures on GDP at International Prices, 1999

(US=100)

Australia	51.5
Belgium	63.2
Canada	50.7
Denmark	78.7
Finland	74.3
Greece	39.0
Italy	61.0
Japan	75.0
United Kingdom	62.5
United States	100.0

Source: OECD (2002), Table 11, p. 152

Table 2
Costs by procedure in national currency units

	country	AUS	BEL	CAN	DNK	Fin		GRC	ITA	JPN	GBR	USA
	NCU	AUD	BFR	CAD	DKK	FIM		GDR	EUR	Yen	GBP	USD
	year	98-99	98	96	97	99		?	98	*We assume 99*	93	91
1	**Uncomplicated AMI**	4,803	118,844	4,325	44,717	14,650	drg 122	430,000	3,889			
	(a) disch. Dead	5,105										
	(b) disch. Alive											
2	**Complicated AMI, with PTCA, alive**	9,575	329,262	7,240	58,667	23,090		1,121,638				27,653
3	**Complicated AMI, w/o PTCA, alive**	6,684	161,060	5,841	58,667	23,090	drg 121	430,000	4,884			30,226
4	**AMI, deceased**	5,857	83,657		21,785	10,070	drg 121		3,511	2,651,009		
5	**Elective PTCA excl. AMI**	5,419	162,351	3,112	31,211	29,610	drg 112	2,206,391	6,197	1,942,915	3,024	21,113
	(a) No compl (incl AMI)											
	(b) PTCA (IHD & compl.)											
6	**CABG**	17,596	518,520	8,887	95,357	52,190		2,840,000	12,911	4,324,965	5,722	31,600
	(a) w/o cath											
	(b) with cath				150,584	102,860			15,600			

Table 3a

PPP for Medical Procedures, Expressed in National Currency Units, Relative to U.S. Costs

country	AUS	BEL	CAN	DNK	Fin	GRC	ITA	JPN	GBR	USA
NCU	AUD	BFR	CAD	DKK	FIM	GDR	EUR	Yen	GBP	USD
year	98-99	98	96	97	99	?	98	We assume 99	93	91
1 Uncomplicated AMI	Not Calculated									
2 Complicated AMI, with PTCA, alive	34.6	1190.7	26.2	212.2	83.5	4056.1				100
3 Complicated AMI, w/o PTCA, alive	22.1	532.9	19.3	194.1	76.4	1422.6	16.2			100
5 Elective PTCA excl. AMI	25.7	769.0	14.7	147.8	140.2	10450.4	29.4	9202.5	14.3	100
6 CABG	55.7	1640.9	28.1	301.8	165.2	8987.3	40.9	13686.6	18.1	100

Explanatory Note: Unit costs for each country for each line of Table 2, divided by U.S. unit cost for the same line.

Table 3b

Comparative Price Levels
U.S. =100

country	AUS	BEL	CAN	DNK	Fin	GRC	ITA	JPN	GBR	USA
NCU	AUD	BFR	CAD	DKK	FIM	GDR	EUR	Yen	GBP	USD
year	98-99	98	96	97	99	?	98	We assume 99	93	91
1 Uncomplicated AMI	Not Calculated									
2 Complicated AMI, with PTCA, alive	25.6	33.3	19.0	32.1	16.1	14.9				100
3 Complicated AMI, w/o PTCA, alive	16.4	14.9	14.0	29.4	14.7	5.2	17.2			100
5 Elective PTCA excl. AMI	19.0	21.5	10.7	22.4	27.0	38.3	31.2	76.1	23.5	100
6 CABG	41.2	45.9	20.4	45.7	31.8	32.9	43.5	113.1	29.7	100

Explanatory Note: PPPs from Table 3A, divided by each country’s exchange rate (national currency per U.S. dollar) in 1997.