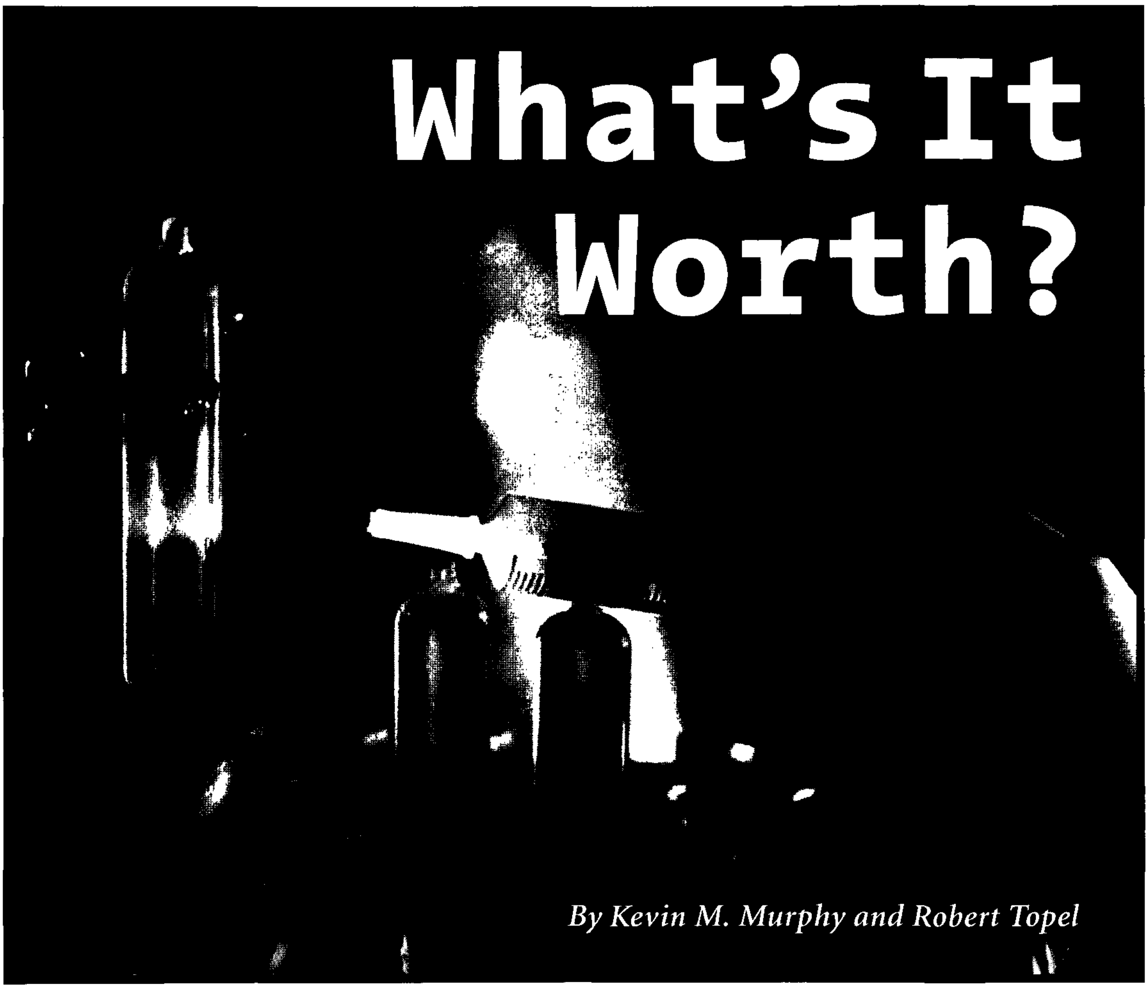
Medical Research What's It Worth?



TED HOROWITZ/STOCKMARKET

By Kevin M. Murphy and Robert Topel

In 1995, the United States invested $35 billion in medical research – a very big number by almost any benchmark. Of this, $13 billion came from the Federal government, which was half again more than a decade earlier and which represented about one-fifth of total Federal outlays on research and development in 1995.

Per person, total annual spending on health care more than doubled between 1980 and 1995, to $2,771. Health-care outlays, which represented 10 percent of personal consumption in 1980, ballooned to 16 percent by the early 1990's, triggering alarms from corporate boardrooms all the way to the Oval Office.

The nation's medical bill, we were frequently informed, was excessive. Yet there was little in the way of rigorous argument to buttress the claim – nor can there be without an estimate of the benefits from improved health and longevity associated with the investment.

Bolstered with a suitable economic framework, we have calculated the economic value of the changes in life expectancy observed over the past several decades. And the results are sure to surprise even the most jaded bean counters.

We estimate that improvements in life expectancy alone (i.e., ignoring the benefits of improved quality of life associated with decreased morbidity) added about $2.8 trillion per year (in 1992 dollars) to national wealth between 1970 and 1990. For purposes of comparison, note that America's gross domestic product in 1980 – the midpoint of the period – was about $4.6 trillion in 1992 dollars.

While some of the improvement in life expectancy was no doubt the result of factors other than better health care, the gains are so large it is hard to believe that the return to health intervention was not enormous. This intuition is bolstered by our finding that about $1.5 trillion of the overall $2.8 trillion annual increase was due to the reduction in mortality from heart disease – an area in which medical advances in both prevention and acute care have been significant.

By the same token, our analysis implies that the potential gain from additional improvements in health care is gigantic. We estimate that eliminating deaths from heart disease would generate about $48 trillion in economic value; from cancer, $47 trillion. While such dramatic improvements in health are not on the immediate horizon, our calculations suggest that the more imaginable result of reducing the death rate from either of these diseases by 20 percent would be worth about $10 trillion – more than one year's national income.

Wait – this story gets even better. A fairly simple (and plausible) model of how better health translates into personal well-being suggests that the returns to improvements in health escalate as the population gets larger, income increases, the average health of the population improves and the population gets closer to the predictable age of the onset of disease. Indeed, we estimate that the growth and aging of the population will by themselves raise the economic return to improvements in the treatment of many diseases by almost 50 percent between 1990 and 2030. Meanwhile, likely increases in real incomes and life expectancy will add at least that much again to the gains.

Our analysis casts new light on some of the key economic issues linked to the value of health research, as well as to the growth in health expenditures. We show, for example, that improvements in health are complementary – that improvements in life expectancy from any source increase the economic reward to further improvements by raising the remaining value of life.

This means that advances against one set of pathologies, for instance, heart disease,

KEVIN M. MURPHY and ROBERT TOPEL teach economics at the University of Chicago Business School. **The Mary Woodward Lasker Charitable Trust supported their research.**

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raise the economic reward to progress on other diseases, such as cancer. This implies that well-documented successes in treating heart disease, where mortality has fallen by roughly 30 percent since 1970, have increased the potential returns to research on cancer and other diseases.

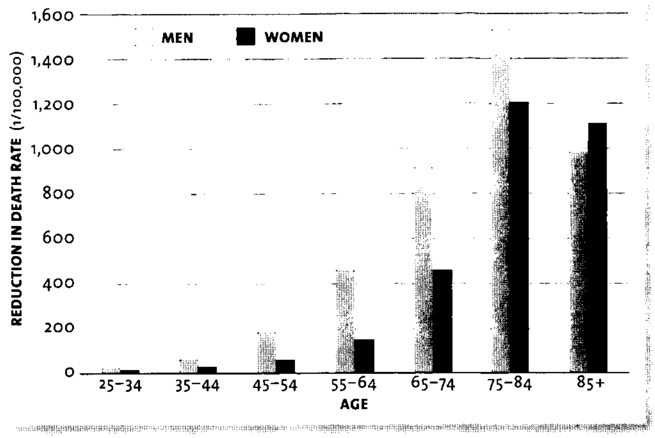
VALUING HEALTH GAINS

Improvements in health affect both the quality of life and the risks of mortality. As economists, we know of no other way to value these benefits than to ask how much people would be willing to pay for these improvements. Rather than attempt such a calculation ourselves, we relied on the voluminous body of economic and psychological research on how people trade off income and risk.

Briefly, the value of life is derived from statistical estimates of the extra wages workers demand in order to bear a small increase in the chance of dying on the job. Let's say moving from a factory job to construction increases the chance of dying by one in 10,000 each year. In other words, in a population of 10,000 workers, this change in risk would raise expected deaths by one per year. Suppose further that workers are paid an extra $500 in annual wages as compensation for bearing the extra risk. To induce workers to play this virtual death lottery, an employer would have to pay an extra $500 in annual wages for each of the 10,000 workers, or $5 million. Thus the value of one statistical life in this example is $5 million.

This example is in the same ballpark as the actual numbers that researchers have found from a variety of indirect estimates – such as measuring how much people will pay to reduce the probability of death by installing smoke alarms in their houses. Kip Viscusi of Harvard University, the uncrowned king of value-of-life calculations, puts the "reasonable range" for the value of life at $3 million to $7 million.

FIGURE 1: REDUCTION IN THE DEATH RATE FROM HEART DISEASE, 1970-1990



ACTUAL AND POTENTIAL HEALTH IMPROVEMENTS

We do not present our mathematical model here. Suffice it to say that standard (and plausible) economic assumptions yield important implications for valuing improvements in life expectancy. To illustrate, we first apply the model to changes in mortality due to heart disease between 1970 and 1990.

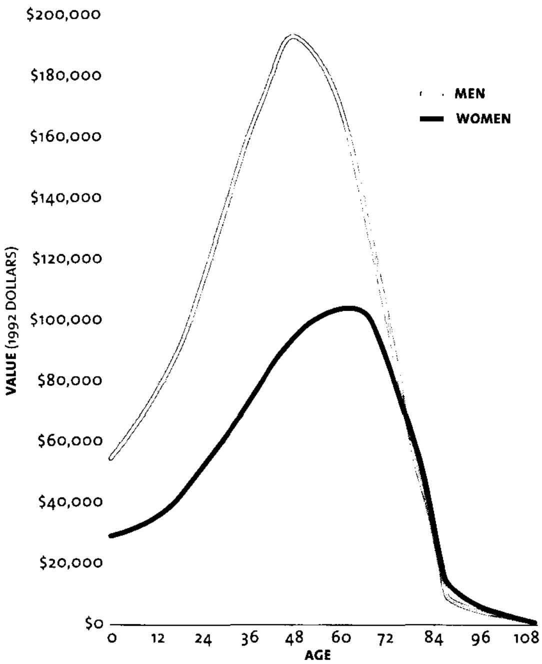
Figure 1 shows the reduction in the death rate from heart disease by age category, as measured by the change in annual deaths per 100,000 individuals. The reduction is concentrated at ages 55+ for men and 65+ for women.

Figure 2 uses our framework to calculate the change in the value of life caused by these reductions in mortality. The value of the decline in heart disease peaks for men at about age 50 and for women at age 65 – in both cases, just prior to the age at which major reductions in deaths have been achieved.

The peak at older ages for both sexes

reflects the fact that heart disease deaths are concentrated at older ages. The difference in timing between men and women reflects the fact that deaths from heart disease typically occurred at somewhat younger ages for men

FIGURE 2: ECONOMIC VALUE OF REDUCTIONS IN HEART DISEASE DEATHS, 1970-1990



than for women. In our model – and as a matter of common sense – progress against heart disease in men is worth more simply because of the greater reduction in death rates from heart disease among men.

At very old ages the expected length of life is so low that marginal increases from dodging the bullet have relatively low value. Compare Figures 1 and 2: the greatest reduction in death rates occurs in the two oldest age groups while the greatest increase in value of life occurs at younger ages.

This result also implies that improvements in life expectancy are complementary – progress against one disease raises life expectancy and therefore increases the value of further improvements in survival rates. For example, the reduction in death rates from heart disease shown in Figure 1 has increased the return to reducing death rates from cancer and other diseases common in old age.

With a parallel calculation, we can estimate the economic value of the increase in life expectancy that occurred between 1970 and 1990, regardless of the source. To make these computations, we used published data on death rates from all causes by age for 1970, 1980 and 1990, discounting the value of future years the same way economists discount the value of future consumption.

We first compared the value of life by age for the 1980 population using 1980 survival rates with what the value of life would have been for this population had survival rates remained at their 1970 values. This difference represents the value, as of 1980, of the cumulative improvements in life expectancy that occurred between 1970 and 1980. The results, shown in Figure 3, make it clear that the gains to individuals were very large.

Improvements in life expectancy had a peak value of about $170,000 for men from the ages of 40 to 55 and about $120,000 for women around age 40. The larger increase in the value of life at birth for both sexes reflects the value of the reduction in infant mortality.

Figure 3 also shows the corresponding increases in values from 1980 to 1990. We do this in an analogous way, comparing the value of life by age for the 1990 population using 1990 survival rates with what the value of life would have been had survival rates remained at their 1980 values. While the gains from 1980 to 1990 are smaller than those from 1970 to 1980, they are still enormous – on the order of $130,000 for 50-year-old men and

$60,000 for 50-year-old women.

Table 1 accumulates the values across individuals of various ages and both genders to estimate the value of these increases in life expectancy. These values are truly enormous: more than $36 trillion for the change from 1970 to 1980 and $21 trillion from 1980 to 1990. The average annual change from 1970 to 1990, shown in the final column, amounts to about $2.8 trillion. This figure for the economic value of the annual improvement in life expectancy is more than half of the gross domestic product in 1980 and nearly equal to total consumption ($3 trillion) in that year. In other words, adding the increased value of life generated by advances in health to conventional measures of national output would increase real output over this period by a staggering 60 percent.

Improvements in health come from many sources, of course, not just medical knowledge. They include improvements in public health measures, changes in lifestyle (that may or may not be informed by medical research) and increased access to health care. So the $2.8 trillion figure exceeds the net gains from improved medical care. By the same token, medical knowledge is just one source of better medical care. To isolate the net social benefit from technological progress in fighting mortality, one would have to subtract both the cost of the research itself and the added outlays for treatment needed to utilize the new technology.

As Table 2 shows, the growth in expenditures that led to increased longevity have been small relative to the increases in the value of life (on the order of 15 percent). Correcting for the increase in health expenditures reduces the net added value from $37 trillion in 1970 to $34 trillion in 1980, and from $21 trillion in 1980 to $16 trillion in 1990. It reduces the average annual increase from $2.8 trillion to $2.4 trillion.

These results imply that life expectancy has increased far above and beyond what would be expected based on the growth in health-care expenditures alone. Thus, in economic terms, the health-production sector must have experienced rapid rates of technological improvement. It remains to be proved that this technical progress is linked to medical research, as opposed to, say, changes in environmental quality. But if even a small fraction of this improvement is due to medical research, the economic return to that

FIGURE 3: INCREASES IN THE VALUE OF LIFE, 1970-1980 and 1980-1990

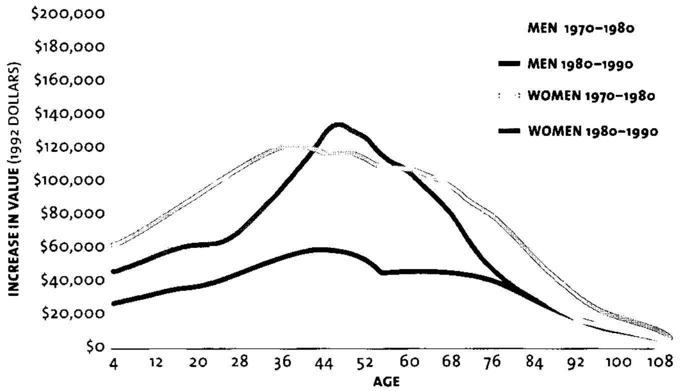


TABLE 1: THE ECONOMIC VALUES OF INCREASES IN LIFE EXPECTANCY

TOTAL VALUES (IN MILLIONS)	1970–1980	1980–1990	1970–1990
Men	$20,547,654	$13,333,130	$1,619,017
Women	$16,042,877	$7,966,696	$1,158,343
TOTAL	**$36,590,530**	**$21,299,826**	**$2,777,360**

research must be substantial.

Indeed, the values in Table 2 seem unbelievably large. Yet these estimates are a direct result of three plausible assumptions:

1. The $5 million value of life drawn from economic research on individuals' willingness to bear risk in return for money.
2. The magnitude of the reduction in death rates over the 1970-1990 period.
3. The sheer size of the United States population, to which increases in the stock of knowledge can be applied.

TABLE 2: THE NET ECONOMIC VALUES OF INCREASES IN LIFE EXPECTANCY

	TOTAL VALUES (IN MILLIONS)		
	1970–1980	1980–1990	1970–1990
Men	$19,441,601	$11,040,528	$1,461,346
Women	$14,781,280	$5,426,623	$ 980,800
TOTAL	**$34,222,882**	**$16,467,151**	**$2,442,146**

The value-of-life estimate implies that changes in health that increase life expectancy by one discounted life-year generate an increase in the value of life of $150,000 to $200,000. With a population of 280 million, this implies a gain of $42 trillion to $56 trillion.

The same sort of calculation allows us to look forward to estimate the value of reducing mortality. Table 3 lists the gains to men, women and the population as a whole that would result from eliminating deaths from various diseases. The numbers reflect the 1995 distribution of individuals across ages and genders. And they correspond to eliminating deaths from specific diseases, holding death rates from others constant.

The $47 trillion and $48 trillion numbers for cancer and heart disease are staggering. They imply that an innovation reducing the death rate from cancer by a mere 1 percent would be worth almost $500 billion. Reducing death rates from a single category of cancer, such as breast or digestive tract cancer, by 10 percent would have a similar value. Reducing the death rate from AIDS by 10 percent would be worth about $750 billion.

By contrast, total Federal support for health-related research in 1995 was about $13 billion, or about one-fortieth of the gain from a 1 percent reduction in the death rate from cancer. The benefits would presumably be offset in part by increases in the cost of applying new technologies. However, if history offers any insight, the potential gains would swamp the costs. Recall, for example, that the increase in medical expenditures from 1970 to 1990 was only about one-eighth of the total increase in the value of life.

INVESTMENTS IN MEDICAL RESEARCH

Table 4 offers estimates of the investments in both medical research and aggregate research and development (R&D) for the nation in 1995, as well as the growth in R&D over the preceding decade. As the table makes clear, the investment in medical R&D is substantial. Moreover, the level of funding for health research grew 80 percent in real terms between 1986 and 1995.

This growth essentially kept pace with the 65 percent growth in health-care spending over the same period, and significantly outpaced the 23 percent growth in GDP. The growth in medical research also outpaced the growth in total R&D (80 percent versus 14 percent). These figures are even more striking when the 46 percent increase in real Federal spending on health care R&D is compared with the 13 percent decline in total Federally funded R&D.

Is spending on health-related R&D too high or too low? While a precise answer can't be inferred from our analysis, it can add perspective on the issue. First, the amount spent on medical research is minute compared with the growth in the value of life. In fact, if we take the net $2.4 trillion increase in the value of life per year for the 1970-1990 period as a starting point, and assume that only 10 percent of this increase is due to increases in medical knowledge, we are left with a return of a still-awesome $240 billion annually.

The estimates for the value of progress against specific diseases in Table 3 tell a similar story. Reducing the death rate from heart disease or cancer by a mere one-tenth of 1 percent would be worth $50 billion – half again more than annual expenditures on health research.

Table 5, listing R&D expenditures as a percentage of net sales, also provides some perspective on the current level of funding for health-related research. The 10.4 percent figure for the drug industry is the highest of any industry. However, the 3.2 percent share for the health-care sector as a whole ranks significantly below the 8 percent shares for office and computing equipment, communications equipment, electronic components and scientific instruments. Indeed, the R&D share for medical care is closer to the R&D share for motor vehicles than to shares in high-technology sectors.

One possible reason for the relatively low ratio of R&D to sales for health care (and the high dependence on government-supported research) is that private enterprise may be unable to capture much of the gain on investments. For service industries such as medical

TABLE 3: THE ECONOMIC VALUES OF REDUCING DEATHS FROM SELECTED CATEGORIES OF DISEASE

	INCREASE IN VALUE OF LIFE (IN MILLIONS)		
DISEASE CATEGORY	MEN	WOMEN	TOTAL
Cancer	$24,325,209	$22,211,974	$46,537,183
Breast	$25,080	$4,617,170	$4,642,251
Digestive Organs	$5,469,042	$4,160,405	$9,629,447
Genital and Urinary	$1,810,372	$2,334,439	$4,144,811
Heart	$28,636,005	$19,711,577	$48,347,582
Stroke	$3,472,990	$4,156,135	$7,629,125
Circulatory Disease	$3,085,051	$2,654,387	$5,739,438
Flu	$1,841,048	$1,591,013	$3,432,061
AIDS	$6,277,524	$1,262,572	$7,540,097

TABLE 4: EXPENDITURES ON R&D – BIOMEDICAL AND AGGREGATE BY FUNDING SOURCE FOR 1995

BIOMEDICAL R&D FUNDING	EXPENDITURE (IN MILLIONS)	% OF TOTAL	% GROWTH 1985-1995
Federal Government	$11,407	45.3%	53.8%
Industry–Drug Industry	$10,202	40.5%	108.9% *
Academic Research–Non-Gov. Funding	$3,593	14.3%	——
TOTAL	**$25,202**	**100.0%**	**75.7%****
Spending on Health Care	$784,200		78.0%
Health R&D as % of Health Expenditures	3.2%		-1.3%
Health R&D as % of GDP	0.3%		38.6%
Health R&D as % of Total R & D	13.8%		50.3%**
AGGREGATE R&D FUNDING			
Federal	$63,147	34.5%	-12.1%
Industry	$110,998	60.7%	220.1%
Other	$8,868	4.8%	68.8%
TOTAL R&D FUNDING	**$183,013**	**100.0%**	**16.9%**
GDP	$7,253,800		26.7%
TOTAL R&D AS % OF GDP	**2.5%**		**-7.8%**

* Based on data for 1986
** Based on data for federal and drug industry only

care, advances often come in the form of procedures that cannot be patented, and so the rewards do not accrue to the investors.

Embodying ideas in physical goods creates an indirect way for innovators to collect on their investments in knowledge. Not surprisingly, the R&D-to-sales ratio is three times higher for drugs – which can be patented – than for health care as a whole. The reliance on Federal funding also mirrors this idea: funding for drug research is almost entirely private, while funding in other areas of medical research depends largely on Washington.

TABLE 5: R&D AS A PERCENTAGE OF SALES, SELECTED INDUSTRIES

Drugs & Medicines	10.4%
Office & Computing Equipment	8.1%
Communications Equipment	8.0%
Electronic Components	8.0%
Optical, Surgical & Photographic Equipment	8.0%
Scientific Instruments	6.6%
Industrial Chemicals	4.7%
Motor Vehicles	3.0%
Non-electrical Machinery	2.4%

The divergence between the "social" return and the private return to investment in medical knowledge is common in R&D. We believe the resulting distortions to private incentives are important to understanding how research is funded today – and why one generally expects it to be underfunded.

Medical care is also subject to other important distortions in incentives. The first and most widely recognized of these is the prevalence of "third party" payers. Insured individuals make most of the decisions about medical spending, though they bear only a small portion of the consequent economic costs. While the growth in managed care has altered this a bit, it seems clear that third-party payment distortions are here to stay. Overall medical spending will surely be higher than it would be in a system in which patients bear the costs of their decisions.

Since the insured tend to overspend, the induced increase in health-care outlays could offset gains from medical knowledge. If, for example, every cancer patient buys an expensive new treatment that has only modest effects, the costs could outweigh the benefits. So to be conservative, we calculated the increased value of improved health net of the increase in medical spending. This eliminates the need to separate the contributions to health of increases in medical knowledge and the associated increases in medical spending.

The effect of third-party payers also skews the pattern of research. Ideally, the search for medical advances would be driven by the potential net gains: the value of increased health and life expectancy, less the true costs of the treatment needed to implement these advances. But with third-party funding, the weight placed on the economic costs of treatments is reduced, skewing innovations toward those that are cost-increasing.

This tendency is aggravated by the reality that cost-increasing innovations often involve new equipment or drugs, which allow the innovators to collect some of the value produced. Those who provide the funds for research should be aware of these distorted incentives, and perhaps lean toward projects that promise cost-reducing innovations.

But it's critical not to lose sight of the main chance. Our analysis suggests that, even after taking account of distorted incentives, the potential gains to medical advancement are enormous. Even the prospect of very limited progress against killer diseases would easily justify current expenditures and most likely expenditures far above current levels.

International Financial Reform
The Morning After

By Albert Fishlow

Muddling through is less painful than clean-slate change

Y2K arrived, and forecasts of apocalypse when the computers decided that William McKinley was still living in the White House proved overwrought. Much the same could be said about global financial reform. For despite a stream of jeremiads in the wake of five years of crises – think Mexico, Thailand, Indonesia, Korea, Malaysia, Russia, Brazil, Ecuador – the powers that be have not been moved to rewrite the rules of international finance. And they aren't about to anytime soon.

SANDRA BAKER/TONY STONE