Int J Health Care Finance Econ (2006) 6: 3–23
DOI 10.1007/s10754-006-6863-8

# Is the United States an outlier in health care and health outcomes? A preliminary analysis*

**William S. Comanor · H. E. Frech III · Richard D. Miller, Jr.**



**Abstract** U.S. health care is often seen as an outlier, with high costs and only middling outcomes. This view implies a household production function for health, with both health care and lifestyle serving as inputs. Building on earlier work by Miller and Frech (2004), we make this argument explicit by estimating a production function from augmented OECD data. This allows us to determine whether the U.S. is literally an outlier; which turns on whether the United States is very far off the production surface. We find that the Unites States is somewhat less productive than the average OECD country, but that a substantial part of the observed difference results from poor lifestyle choices, particularly obesity.

**Keywords** Obesity · Health production · U.S. health care · Comparative health care systems

**JEL Classification** I12 · I18

*Earlier versions of this paper were presented at UCLA on May 29, 2003 and at a Conference on Health and Economic Policy in Munich, Germany on June 27, 2003. Thanks are due to the participants of those sessions for helpful comments, and especially to Tom Rice at UCLA. We also appreciate the excellent research assistance of Andrea Lehman.

W. S. Comanor (✉)
Department of Economics, University of California, Santa Barbara, CA 93106 and Department of Health Services, School of Public Health, University of California, Los Angeles, CA 90024
e-mail: comanor@ucla.edu

H. E. Frech III
Department of Economics, University of California, Santa Barbara, CA 93106
e-mail: frech@econ.UCSB.edu

R. D. Miller, Jr.
LNU-MSU College of International Business, Missouri State University, Dalian 116029, China
e-mail: RichardMiller@missouristate.edu

## Introduction

In recent years, many have argued that the U.S. health care system is both more expensive and less effective than those found elsewhere. David Cutler, for example, points out that in 1991 the U.S. spent $752 billion on health care, which represented 13.2 percent of its gross domestic product. By comparison, only two other developed countries spent more than 9 percent of GDP on health care, and the average value was 7.9 percent (Cutler, 1994, pp. 13–14).

Other writers have reached similar conclusions. Some observe that "the U.S.A spends more on health care services than most industrial countries in dollars and percent of GDP while having the least access of care of any of the other 29 countries," (O'Rourke and Iammarino, 2002). Despite its higher spending levels for health care, they observe that the U.S. has not achieved better outcomes or improved health status. As compared with other developed countries, the U.S. appears to produce only middling results (Poterba, 1994).

Implicit in this discussion is the existence of a health production function that links health inputs and outputs. These arguments suggest that the United States is an outlier in that outputs are lower than would be projected by the level of inputs.

In this paper, following Miller and Frech (2004), we estimate a health production function which links inputs and outputs across OECD countries. From these estimates, we can determine whether the United States really is an outlier when comparing its health system with those found elsewhere. Another way to pose this question is to ask whether the U.S. health care system is less productive as compared with those in other developed countries.

An important characteristic of these arguments is that they focus on differences in health care systems rather than in the underlying populations. Health outcomes of course depend on both population characteristics and the health care system in use. The reason is that a health care system interacts with the population to determine health outcomes; and it may be that beneficial outcomes are more difficult to reach because of particular features of the population. Of course, it is not simply a matter of determining the overall healthiness of the population, but rather whether individual countries have particular attributes that make it difficult to achieve desirable health outcomes.

In some countries, health habits and conditions support good health outcomes so that relatively few health inputs may be required. On the other hand, there are countries where population habits or conditions may be relatively unhealthful, so that substantial health inputs are needed merely to achieve average results. In that case, one needs to correct for these factors before estimating the relationship between inputs and outputs. This issue may be particularly important for the U.S. since certain health predicates are different from those found elsewhere.

There are three population factors that are considered in this analysis. The first factor is cigarette smoking, which is generally considered to have a negative impact on health outcomes. Where smoking rates are high, a health care system may need to spend considerable resources to deal with the problems created by this practice. Poor outcomes are due not so much from the inefficiency of the health system as from the poor conditions in which it must operate.

Another relevant factor is alcohol consumption, although here the record is mixed. There is evidence that moderate drinking actually improves health outcomes,[1] although it may still be true that heavy drinking leads to poorer results. This factor may therefore have a complicated functional form in any estimated relationship.

[1] See, e.g., Stamfer et al., 2000.

A third critical factor is the rate of obesity. The significance of this factor is the subject of this paper.[2]

## The importance of obesity

Obesity levels in the U.S. have increased significantly in recent years. Chou and his colleagues (2000) report that the number of obese adults in the U.S. has increased by more than half since the late 1970s. They explain this change by asserting that there has been an "increase in the value of time, particularly of women... [which has led to a] reduction in home time... [and a corresponding] increase in the demand for convenience food." (p. 1) This factor has contributed to the expansion of fast food restaurants that, they suggest, has had a substantial impact on obesity.

Mokdad et al. (1999) report that for 1991, the proportion of obese adults in the U.S., as measured by a Body Mass Index (BMI) that equals or exceeds 30 $kg/m^2$, was 12 percent. By 1998, this percentage had shifted to nearly 18 percent, which is an increase of nearly one-half within a seven-year period. These authors comment that "rarely do chronic conditions such as obesity spread with the speed and dispersion characteristics of a communicable disease epidemic," but that was the case here. They note that "this rapid increase in obesity in all segments of the population and regions of the country implies that there have been sweeping changes in U.S. society that are contributing to weight gain by fostering energy intake imbalance." These results occurred, the authors suggest, not because of changes in individual motivations or health care but because of broader societal changes. Philipson and Posner (1999) also explore these issues through a simple economic model.

Obesity levels are relevant for our purposes because they present a substantial health burden. One indication of this burden is their impact on premature death rates. It has been estimated that this factor alone leads to over 280,000 premature deaths per year in the U.S. (Allison, 1999). For many diseases, obesity provides a much worse prognosis and requires greater interventions. These results are summarized in Chou (2002). Other studies emphasize the increased disease burden resulting from obesity. Must et al. (1999) report that high blood pressure is the most common condition related to obesity. They also find an increased incidence of Type II diabetes, gall bladder disease, and osteoarthritis (p. 1526).

Most dramatically, Sturm (2002) has shown that obesity leads to far worse performance on health status than smoking, problem drinking or simply being overweight. The effects on health care use are dramatic. Obesity leads to 36 percent more total health care consumption and an impressive 77 percent more pharmaceutical consumption. In contrast, smoking—the next most important population factor—increases total health care consumption by 21 percent and pharmaceutical use by 28 percent. Being overweight, with a BMI of between 25 and 30, has a much smaller effect. Using a similar approach and a far larger data set, Finkelstein, Flebolkorn and Wang (2003) have confirmed Sturm's results, and estimated that 9.1 percent of total U.S. medical expenditures is due to obesity and/or being overweight. In related work, Thorpe et al., 2005, p. W5-321) found that, in a sample of privately insured U.S. consumers,

[2] Some, notably Michael Marmot (2005) have argued that income inequality is a major determinant of health outcome across geographic units. But, a recent exhaustive survey indicates that income inequality has little impact (beyond that inherent in nonlinear purely income effects). See Angus Deaton (2003). In our work, we did sensitivity testing with measures of income inequality, but they had essentially no impact on observed health in our data.

**Table 1** Health outcome measures for the United States comparisons among 18 developed countries

| | Life expectancies (1995) | | |
|---|---|---|---|
| | At birth | At age 40 | At age 60 |
| Male: | | | |
| U.S. value | 72.5 | 35.6 | 19.1 |
| U.S. rank | 17 | 14 | 8* |
| Mean value | 74.0 | 36.2 | 18.9 |
| Standard deviation | 1.2 | 1.0 | 0.8 |
| Female: | | | |
| U.S. value | 79.2 | 40.7 | 22.9 |
| U.S. rank | 15 | 14 | 11* |
| Mean value | 80.2 | 41.5 | 23.2 |
| Standard deviation | 1.2 | 1.2 | 1.0 |

*Notes:* The 18 comparison countries are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Ireland, Italy, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, U.K., and U.S.A.
*Indicates a tie with other countries

that obese and overweight adults consumed 56 percent more health care than those of normal weight.

In this analysis, we consider the importance of obesity levels for reported measures of health outcomes. As we found in our earlier work, this factor has a significant impact on health outcomes. It is also one in which the U.S. population is particularly vulnerable. Unfortunately, the United States is the world leader in obesity. Our purpose is to examine how obesity levels affect estimated relationships between health inputs and outputs.[3]

## Health outcome measures

In the analysis below, we estimate a health production function in which we quantify health inputs and outputs. Furthermore, in light of the questions raised above, we distinguish different characteristics of the various populations. For this purpose, we gathered relevant data for eighteen developed countries, and for both genders. We present here the basic data and discuss certain hypotheses.

Because of availability and consistency of measurement, the most commonly used health outcome measures are life expectancies. Our data are defined at three points in the life cycle: at birth, at age 40, and at age 60. These data, divided between the genders, are presented in Table 1. As can be seen, U.S. life expectancies at birth are generally lower than those found elsewhere among developed countries. In this selected group of eighteen countries, the U.S. stands in seventeenth place for males and fifteenth place for females. For males, the U.S. value of 72.5 years is slightly more than one standard deviation below the mean, while for females the U.S. value of 79.2 years is just under one standard deviation below the mean. From these data, U.S. health outcomes are not particularly advantageous.

At the same time, average life expectancies at birth among these countries do not differ very much. A standard deviation of 1.2 years for both men and women indicates that the conventional range of plus or minus two standard deviations is less than five years in life expectancy.

[3] There is an alternative view of obesity as a health care outcome, rather than a lifestyle choice largely unrelated to the health care system. We find this view unpersuasive.

**Table 2** Health outcome measures for the United States comparisons among 18 developed countries

| | Disability adjusted life expectancies (1998) | |
|---|---|---|
| | At birth | At age 60 |
| Male: | | |
| U.S. value | 67.5 | 5.0 |
| U.S. rank | 13* | 13 |
| Mean value | 68.8 | 5.5 |
| Standard deviation | 1.4 | 1.0 |
| Female: | | |
| U.S. value | 72.6 | 8.4 |
| U.S. rank | 15 | 15 |
| Mean value | 74.1 | 9.0 |
| Standard deviation | 1.6 | 1.3 |

*Notes:* The eighteen comparison countries are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Ireland, Italy, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, U.K., and U.S.A.
*Indicates a tie with other countries

Turning now to life expectancies at age 40, we find that the U.S. value is closer to the mean, and its rank is slightly higher than before. Although still in the bottom half of these eighteen countries, U.S. values are now only slightly below average.

In the case of life expectancy at age 60, the U.S. position is more impressive. For men, the U.S. value is higher than the mean for these countries, although the difference is quite small. The United States ranks in a tie for eighth place. The same results apply to females, although here the U.S. value is just below the general mean. Thus, U.S. health outcomes appear to be relatively better at higher ages.

To be sure, there are various problems associated with using life expectancies to measure health outcomes. In particular, these statistics ignore morbidity rates. Lower morbidity is a key health output. Further, considerable health care resources are directed at illnesses that are not directly life threatening. To take account of these issues, albeit imperfectly, we also use disability-adjusted life expectancies to measure health outcomes. The results for life expectancies both at birth and at age 60 for 1998 are reported in Table 2.[4] Using this variable as well, the U.S. value stands in the bottom half of the distribution. As can be seen, its value is in thirteenth place for men and in fifteenth place for women among the eighteen developed countries. In all cases, the U.S. values lie below the mean.

## Measures of health care consumption

The Organization for Economic Cooperation and Development (OECD) routinely collect data on health care expenditures from its member countries. These expenditures are generally broken out by type, such as expenditures for inpatient care and outpatient care and expenditures

[4] These measures were constructed by the World Health Organization as part of its study of the Global Burden of Disease. They are explained and defended in Murray and Acharya (1997).

for pharmaceuticals and other medical non-durables. Following Miller and Frech (2004), we break out medical expenditures into pharmaceutical expenditures and all other health care expenditures. All expenditure measures are reported on a per-capita basis.

Converting a nation's per capita health care expenditures to U.S. dollars for the purpose of cross-national comparisons can be fairly tricky. Using spot market exchange rates or even GDP purchasing power parity (PPP) exchange rates is not likely to be appropriate. This approach is only appropriate if prices for medical care goods and services differ across countries in the same way that prices differ in general. Researchers that have looked at this issue in depth, including Szuba (1986) and Danzon and Percy (1995), have demonstrated that this is far from the truth. Regulation of the medical care industry has remained a national prerogative in many countries and, in the case of pharmaceuticals, trade barriers have traditionally been significant. For more detail on this issue see Frech and Miller (1999).

To facilitate cross-country comparisons of real health care expenditures and use, the OECD calculated a series of health care industry specific PPP exchange rates for most of its member countries for the following years: 1980, 1985, 1990, 1993, and 1996. Frech and Miller (1999) found that the OECD PPP exchange rates for both health care in general and pharmaceuticals in particular were consistent with those calculated by Danzon and Percy (1995) and Szuba (1986). As is illustrated in Table 3, these industry-specific PPF exchange rates tend to be very different from the GDP PPP exchange rates for most of the OECD countries included in our study. U.S. medical care prices are relatively high (Pauly, 1993; Andersen et al., 2003). Therefore, using GDP PPP exchange rates would make the United States appear to be an even bigger outlier in terms of health care utilization.

We generated comparable measures of real health care consumption. Following Miller and Frech (2004), we created a measure of pharmaceutical consumption for each country

**Table 3** Comparing purchasing power parity exchange rates, 1990

| | GDP PPP | Health care PPP | Ratio to GDP PPP | Drug PPP | Ratio to GDP PPP |
|---|---|---|---|---|---|
| Australia | 1.39 | 1.02 | *0.74* | 0.83 | *0.60* |
| Austria | 14.00 | 8.59 | *0.61* | 11.29 | *0.81* |
| Belgium | 39.50 | 21.15 | *0.54* | 25.08 | *0.63* |
| Canada | 1.30 | 0.93 | *0.71* | 1.15 | *0.88* |
| Denmark | 9.39 | 6.94 | *0.74* | 7.94 | *0.85* |
| Finland | 6.38 | 4.50 | *0.71* | 4.07 | *0.64* |
| France | 6.61 | 3.62 | *0.55* | 3.02 | *0.46* |
| Ireland | 0.69 | 0.48 | *0.70* | 0.58 | *0.84* |
| Italy | 1421.00 | 876.80 | *0.62* | 768.00 | *0.54* |
| Netherlands | 2.17 | 1.36 | *0.63* | 2.12 | *0.98* |
| New Zealand | 1.61 | 1.04 | *0.65* | 1.16 | *0.72* |
| Norway | 9.73 | 6.09 | *0.63* | 5.63 | *0.58* |
| Portugal | 104.00 | 66.40 | *0.64* | 64.3 | *0.62* |
| Spain | 110.00 | 65.65 | *0.60* | 55.3 | *0.50* |
| Sweden | 9.00 | 6.06 | *0.67* | 4.95 | *0.55* |
| Switzerland | 2.20 | 1.69 | *0.77* | 1.68 | *0.76* |
| U.K. | 0.60 | 0.34 | *0.56* | 0.43 | *0.72* |
| U.S.A | 1.00 | 1.00 | *1.00* | 1.00 | *1.00* |

Source: OECD (2000)

**Table 4** Health care expenditures and gross domestic product for the United States

| | Comparisons among 18 developed countries in 1990 | | |
|---|---|---|---|
| | Health expenditures per capita | Pharmaceutical expenditures per capita | Gross Domestic product per capita |
| U.S. value | $2,515 | $240 | $22,266 |
| U.S. rank | 1 | 6 | 1 |
| Mean value | $1,741 | $238 | $16,291 |
| Standard deviation | $474 | $132 | $3,189 |

*Notes:* The eighteen comparison countries are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Ireland, Italy, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, U.K., and U.S.A.

by converting 1990 per-capita expenditures on pharmaceuticals to U.S. dollars, using the pharmaceutical PPP exchange rates provided by the OECD and reported in Table 3. We created a measure of other health care consumption in two steps. First, we converted 1990 per-capita expenditures on health care to U.S. dollars using health care PPP exchange rates. We then subtracted our pharmaceutical consumption measure from this figure.

The level of U.S. health care consumption, excluding pharmaceuticals, is reported both in absolute terms and relative to the comparison group of 17 other OECD countries in Table 4. The relative position for U.S. non-pharmaceutical health care consumption is quite different from the health output measures presented earlier. Aggregate consumption in the United States as of 1990 is valued at $2,515 per capita, which is more than 1.5 standard

**Table 5** Health risk factors for the United States comparisons among 18 developed countries in 1990

| | Smoking rates (%) | Alcoholic consumption* (liters per capita) | Obesity rates (%) |
|---|---|---|---|
| Male: | | | |
| U.S. value | 28.4 | 9.5 | 19.9 |
| U.S. rank | 16 | 15 | 1 |
| Mean value | 35.2 | 10.8 | 9.5 |
| Standard deviation | 6.8 | 2.6 | 3.7 |
| Female: | | | |
| U.S. value | 22.8 | 9.5 | 25.1 |
| U.S. rank | 12 | 15 | 1 |
| Mean value | 25.2 | 10.8 | 10.1 |
| Standard deviation | 7.6 | 2.6 | 4.8 |

* These data refer to both genders.
*Notes:* The eighteen comparison countries are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Ireland, Italy, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, U.K., and U.S.A.

**Table 6** Life expectancy regressions with obesity included (standard errors in parentheses)

| Variable | Life exp. at birth | Life exp. at 40 | Life exp. at 60 | DALE at birth | DALE at 60 |
|---|---|---|---|---|---|
| FEMALE | 0.0479 | 0.0867 | 0.1693** | 0.0337 | 0.1943 |
| | (0.0288) | (0.0534) | (0.0688) | (0.0438) | (0.1163) |
| GDPPC | −0.0058 | 0.0455 | 0.1033 | −0.0058 | 0.0322 |
| | (0.0259) | (0.0506) | (0.0705) | (0.0373) | (0.1290) |
| PHPC | 0.0086 | 0.0302** | 0.0607** | 0.0186** | 0.0896** |
| | (0.0068) | (0.0113) | (0.0163) | (0.0079) | (0.0234) |
| HEPC | 0.0228 | −0.0087 | −2.0263 | 0.0250 | 0.0444 |
| | (0.0210) | (0.0347) | (0.0484) | (0.0292) | (0.0937) |
| SMOKE | −0.0040 | −0.0045 | 0.0064 | −0.0071 | 0.0078 |
| | (0.0109) | (0.0173) | (0.0233) | (0.0123) | (0.0344) |
| ALCOHOL | −0.0107 | −0.0194 | −0.0137 | −0.0118 | −0.0102 |
| | (0.0120) | (0.0215) | (0.0268) | (0.0175) | (0.0442) |
| ALCOHOL | 0.0139 | 0.0210 | 0.0171 | 0.0161 | 0.0073 |
| * FEMALE | (0.0135) | (0.0250) | (0.0314) | (0.0197) | (0.0515) |
| OBESITY | −0.0153** | −0.0191* | −0.0176 | −0.0192** | −0.0485** |
| | (0.0055) | (0.0098) | (0.0136) | (0.0065) | (0.0163) |
| CONSTANT | 4.2170** | 3.1540** | 1.8549** | 4.0971** | 1.7176** |
| | (0.1428) | (0.2729) | (0.3819) | (0.1908) | (0.6407) |
| R-SQUARED | 0.928 | 0.922 | 0.938 | 0.872 | 0.883 |

* Coefficient is significant at the 0.10 level
** Coefficient is significant at the 0.05 level

deviations above the mean. The U.S. place is number one. This observation is similar to that reported by others. The United States apparently uses much more health care on a per-capita basis than do other developed countries, even after adjusting for higher prices in the U.S.

The remaining columns in Table 4 describe two other relevant variables. The first concerns pharmaceutical consumption per capita in the United States. As can be seen, the U.S. figure here is approximately the mean value of the distribution, which places it in sixth place among the other selected OECD countries. The second variable is U.S. gross domestic product per capita, which is substantially higher than the average of these comparison countries. It stands in first place, and nearly two standard deviations above the mean.[5]

## Health risk factors

We also describe the health risk factors mentioned above for the U.S., and see how they compare with those found elsewhere. These factors are those associated with smoking, alcoholic beverage consumption and obesity. The relevant data are provided in Table 5.

As can be seen, U.S. smoking rates are lower than those found in most other countries. The percentage of smokers in the U.S. for both men and women is below their mean values.

[5] To compare GDP per capita across countries we used the GDP PPP exchange rates listed in Table 3 to convert the measures to US dollars.

The U.S. stands in sixteenth place for men and twelfth place for women in this sample of eighteen countries. If anything, the U.S. has a favorable posture in regard to smoking rates. There is thus no reason for this risk factor to explain the apparent poor performance of the U.S. health care system.

The statistics on alcoholic beverage consumption are not divided by gender. U.S. consumption levels are not particularly high, and lie below mean values for this sample of countries.

The data on obesity rates, however, reveal a very different picture. For both men and women, the U.S. stands in first place among the eighteen developed countries in the percentage of the population considered obese. The U.S. rate for males is just over twice the mean value of the sample, and the U.S. rate for females is nearly 2.5 times that rate. In all cases, U.S. rates are more than two standard deviations above the mean. The U.S. population is much more obese than found elsewhere in Europe and North America.

These findings suggest an important hypothesis regarding the efficacy of the U.S. health care system. To the extent that obesity is a major risk factor for health outcomes, and has a substantial negative effect, then the U.S. health care system may be more productive than had been thought. One explanation for the relative position of U.S. health care system is that the population that uses its services is more at risk than elsewhere. Indeed, the relatively poor outcomes reported above could be due to this risk factor. A major difficulty with most prior studies is that they omit this variable in their analyses. We hypothesize that including the effects of obesity would lead one to find that the U.S. health care system is reasonably productive after all.

**Table 7** Life expectancy regressions without obesity (standard errors in parentheses)

| Variable | Life exp. at birth | Life exp. at 40 | Life exp. at 60 | DALE at birth | DALE at 60 |
|---|---|---|---|---|---|
| FEMALE | 0.0464 | 0.0849 | 0.1676** | 0.0319 | 0.1897 |
| | (0.0316) | (0.0566) | (0.0720) | (0.0455) | (0.1248) |
| GDPPC | −0.0114 | 0.0385 | 0.0970 | −0.0128 | 0.0147 |
| | (0.0402) | (0.0668) | (0.0830) | (0.0508) | (0.1579) |
| PHPC | 0.0111* | 0.0335** | 0.0637** | 0.0218** | 0.0977** |
| | (0.0062) | (0.0101) | (0.0148) | (0.0073) | (0.0211) |
| HEPC | 0.0260 | −0.0046 | −0.0226 | 0.0291 | 0.0547 |
| | (0.0267) | (0.0411) | (0.0528) | (0.0346) | (0.1052) |
| SMOKE | 0.0014 | 0.0023 | 0.0127 | −0.0003 | 0.0251 |
| | (0.0105) | (0.0164) | (0.0218) | (0.0117) | (0.0325) |
| ALCOHOL | −0.0162 | −0.0262 | −0.0200 | −0.0186 | −0.0275 |
| | (0.0121) | (0.0209) | (0.0267) | (0.0164) | (0.0427) |
| ALCOHOL * FEMALE | 0.0152 | 0.0226 | 0.0186 | 0.0177 | 0.0113 |
| | (0.0144) | (0.0258) | (0.0324) | (0.0201) | (0.0545) |
| CONSTANT | 4.1929** | 3.1238** | 1.8271** | 4.0668** | 1.6409* |
| | (0.2303) | (0.3851) | (0.4748) | (0.2778) | (0.8495) |
| R-SQUARED | 0.912 | 0.913 | 0.934 | 0.845 | 0.863 |

* Coefficient is significant at the 0.10 level

** Coefficient is significant at the 0.05 level

**Table 8** Actual and predicted values of United States health outcomes

| | Actual values | Predicted values without obesity | Predicted values with obesity |
|---|---|---|---|
| Male: | | | |
| Life expectancies | | | |
| At birth | 72.5 | 74.7 | 73.8 |
| At age 40 | 35.6 | 36.8 | 36.3 |
| At age 60 | 19.1 | 19.5 | 19.2 |
| Disabilities adjusted | | | |
| Life expectancies | | | |
| At birth | 67.5 | 69.6 | 68.6 |
| At age 60 | 15.0 | 16.0 | 15.5 |
| Female: | | | |
| Life expectancies | | | |
| At birth | 79.2 | 80.9 | 79.7 |
| At age 40 | 40.7 | 42.1 | 41.3 |
| At age 60 | 22.9 | 23.9 | 23.5 |
| Disabilities adjusted | | | |
| Life expectancies | | | |
| At birth | 72.6 | 74.8 | 73.4 |
| At age 60 | 18.4 | 19.8 | 18.8 |

## Methodology

To test this hypothesis and examine the general influence of obesity levels, we extend our earlier analysis to pay particular attention to this factor. We use the aggregate household production function reported in Miller and Frech (2004), which takes the following form:

$$H_i = \alpha + \beta MC_i + \gamma X_i + \varepsilon_i,$$

where $H_i$ is the measure of average health status of the citizens of country $i$, $MC_i$ is a vector of the average consumption of various types of medical care in country $i$, $X_i$ is a vector of life-style or environmental variables in country $i$, and $\varepsilon_i$ is a random error term. These equations are estimated by ordinary least squares in logs for males and females pooled for the eighteen OECD countries for which complete data are available.[6] We thereby have only 36 observations, which limits our options for estimation and requires

[6] Pooling male and female data can lead to understated standard errors because the errors are related for the male and female data from a particular country. Male and female data constitute a cluster. We account for that problem by using the robust cluster estimator first proposed by Huber (1967) and further developed by White (1980). See Miller and Frech (2004), pp. 32–33.

**Table 9** United States residuals from estimated production functions

| | Without obesity | | With obesity | |
|---|---|---|---|---|
| | Standardized | Studentized | Standardized | Studentized |
| Male: | | | | |
| Life expectancies | | | | |
| At birth | −2.19** | −2.36** | −1.56 | −1.60 |
| At age 40 | −1.47 | −1.50 | −0.93 | −0.93 |
| At age 60 | −0.62 | −0.61 | −0.18 | −0.18 |
| Disabilities adjusted | | | | |
| Life expectancies | | | | |
| At birth | −1.82* | −1.90* | −1.14 | −1.14 |
| At age 60 | −1.40 | −1.42 | −0.71 | −0.70 |
| Female: | | | | |
| Life expectancies | | | | |
| At birth | −1.56 | −1.60 | −0.53 | −0.53 |
| At age 40 | −1.52 | −1.55 | −0.81 | −0.80 |
| At age 60 | −1.46 | −1.49 | −1.01 | −1.01 |
| Disabilities adjusted | | | | |
| Life expectancies | | | | |
| At birth | −1.73 | −1.80 | −0.78 | −0.77 |
| At age 60 | −1.49 | −1.53 | −0.58 | −0.57 |

* Statistical significance at the 10 percent level
**Statistical significance at the 5 percent level

that this analysis be viewed as somewhat preliminary.[7] Outcome data are from 1995 and 1998. See Miller and Frech (2004) for more details on the data used and for a literature review.

In these equations, health care expenditures are divided into two components: those used for pharmaceuticals and those used for all other purposes, including physician services and hospital care. Both of these variables' are expressed in U.S. dollars per capita in 1990, where the relevant exchange rates are based on purchasing power parity for the service (i.e. either other health care or pharmaceuticals).

Various other factors are also included in the equations to describe specific population characteristics that may interact with the health care system. The full list of independent variables includes:

- Gross Domestic Product per capita, 1990, converted to U.S. dollars using Gross Domestic Product purchasing parity exchange rates;
- Drug consumption expenditures per capita, 1990, converted to U.S. dollars using pharmaceutical-specific purchasing power parity exchange rates;

[7] The literature generally takes a similar approach. There are also studies using pooled time series/cross data and pure time series studies. These studies show a larger effect of health care, but they involve a substantial risk of unit roots and spurious regression results. See Miller and Frech (2004), pp. 9–13.

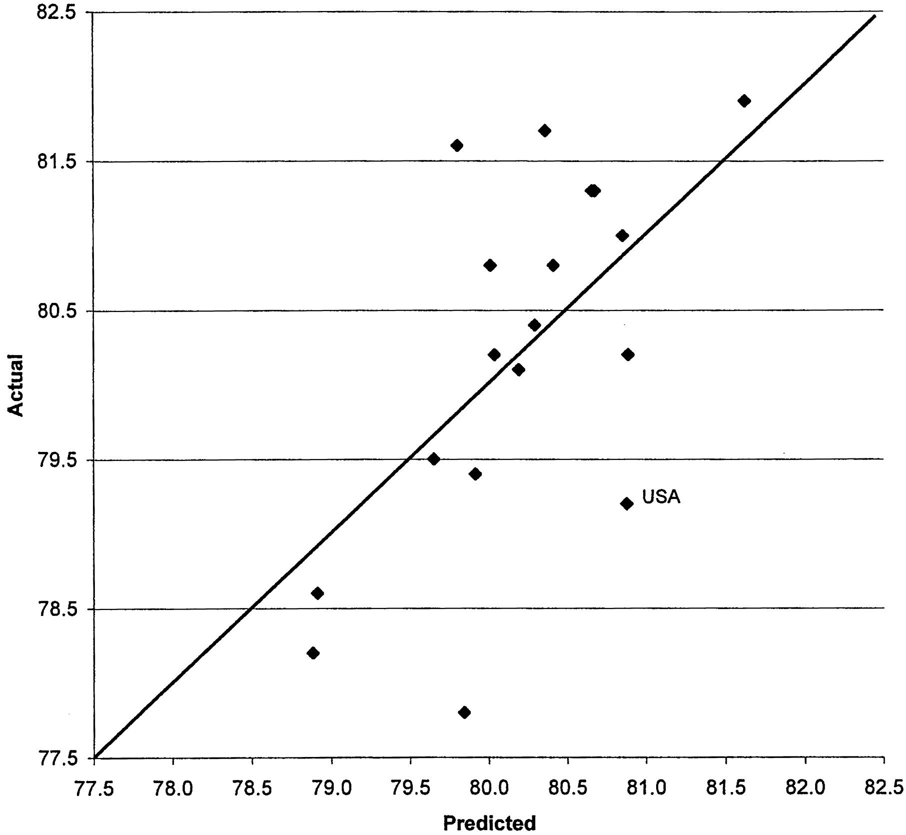


**Fig. 1** Female life expectancy at birth, without obesity

- Other health care expenditures per capita, 1990, converted to U.S. dollars using purchasing power parity exchange rates specific to health care goods and services;
- The percentage of the population over the age of fifteen that smokes, mostly 1990. These data are country and gender specific;
- Alcohol consumption per capita as measured in liters per person, 1990. This variable is only country-specific;
- An interaction term between alcohol consumption per capita and a female dummy variable;
- The percentage of the population that is obese, mostly 1990. These data are country and gender specific.

A more complete discussion of these variables is presented in the earlier work by Miller and Frech (2004). In this study, the same specifications are used as in the earlier one for half of the equations. For the other half, obesity rates are excluded from the model. This allows for a more detailed investigation of the impact of obesity.[8]

[8] We use lags of eight to 10 years. Data limitations prevent the use oflonger lags. Shorter lags of zero to three years gave similar results. See Miller and Frech (2002), p. 57.

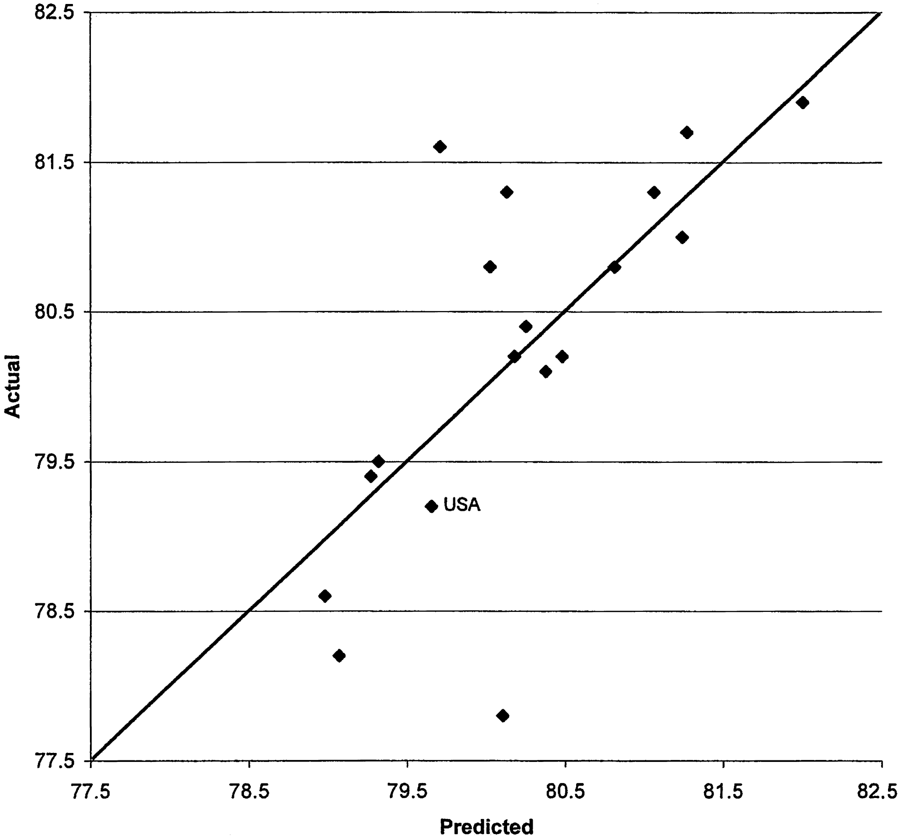


**Fig. 2** Female life expectancy at birth, with obesity

Our basic approach is to compare the projected (predicted) values from health production functions that are estimated both with and without obesity levels. It has been suggested that the U.S. has an inefficient health care system, in that actual health outcomes are lower than would be projected by the level of health inputs. To test this proposition, we compare actual and projected health outcomes for the United States.

In the estimated health production functions, the dependent variables are the logarithmic transformations of the various outcome variables. As a result, we need to return all projections to real values. While it would be simple merely to take the exponentials of the projected values, that method would not be correct because of the nonlinear basis of the logarithmic transformation. However, a nonparametric technique to deal with this problem has been developed by Duan (1983). We use this technique, which is called the Smearing Method.[9]

## Some preliminary results

In Tables 6 and 7 we present results from our models of health care outcomes. The results in Table 6 are from the model in which we include the obesity measure. Thus, the results

9 See Duan, 1983. With these data, the Smearing Method and simple exponentiation give very similar results.

are the same as those reported in Miller and Frech (2004) and are described in greater depth in that paper. The results in Table 7 are from the model from which we omitted the obesity measure. The biggest impact of omitting the obesity measure is on the effect of pharmaceutical consumption on each outcome. In each case, omitting the obesity measure makes it appear that pharmaceutical consumption has an even greater positive impact on each outcome and, in addition, the effect is estimated more precisely (the standard errors are smaller). Some of the other coefficients are affected as well, but none of the qualitative results change. For instance, none of the other coefficients go from being statistically significant to being insignificant or the reverse.

We then compare the predicted values from the estimated health production functions that we estimated both with and without the obesity measure in Table 8. In this table, there are five health outcome measures for each of the two genders. It is striking that the same relative positions are indicated regardless of which health measure is used, and also for both genders. In all cases, the projected health outcome values, without obesity included in the equation, exceed the projected value from the equations that include obesity. When obesity levels are included in the relevant equation, with their expected depressing effects on health outcomes, the U.S. projected values are always lower than where they were without

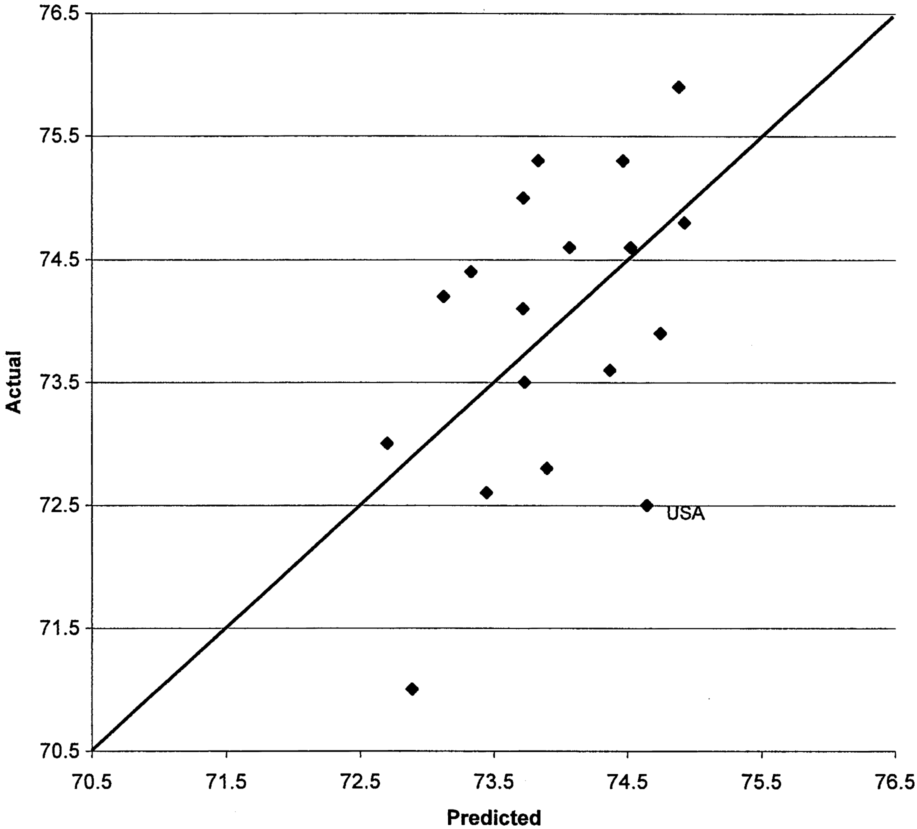


**Fig. 3** Male life expectancy at birth, without obesity

this variable. When the importance of obesity is recognized, the U.S. health care system no longer appears particularly unproductive.

A second implication from this table is that both projected values are always greater than the actual values. Even when obesity levels are included, U.S. health outcomes are still less than projected from current levels of health inputs. This conclusion follows from the fact that the values provided in the first column of Table 8 are always less than the other two columns. However, we see that including obesity in the relevant equations systematically reduces the apparent inefficiency of the U.S. health care system. Accounting for obesity reduces differences between actual and projected health outcome measures by slightly more than half. Thus, the observed inefficiency of the United States health care system appears to be substantially, although not completely, due to the fact that obesity levels are not generally accounted for.

Another approach to this issue is to examine differences between actual values of the various health outcome measures and those predicted from the health production function analysis. The difference between these two values is the residual. These residuals are in logs, as derived from the regression equations.

We use two alternate definitions of residuals. In the first case, we determine the "standardized" residual, which is calculated by dividing each original residual by its estimated

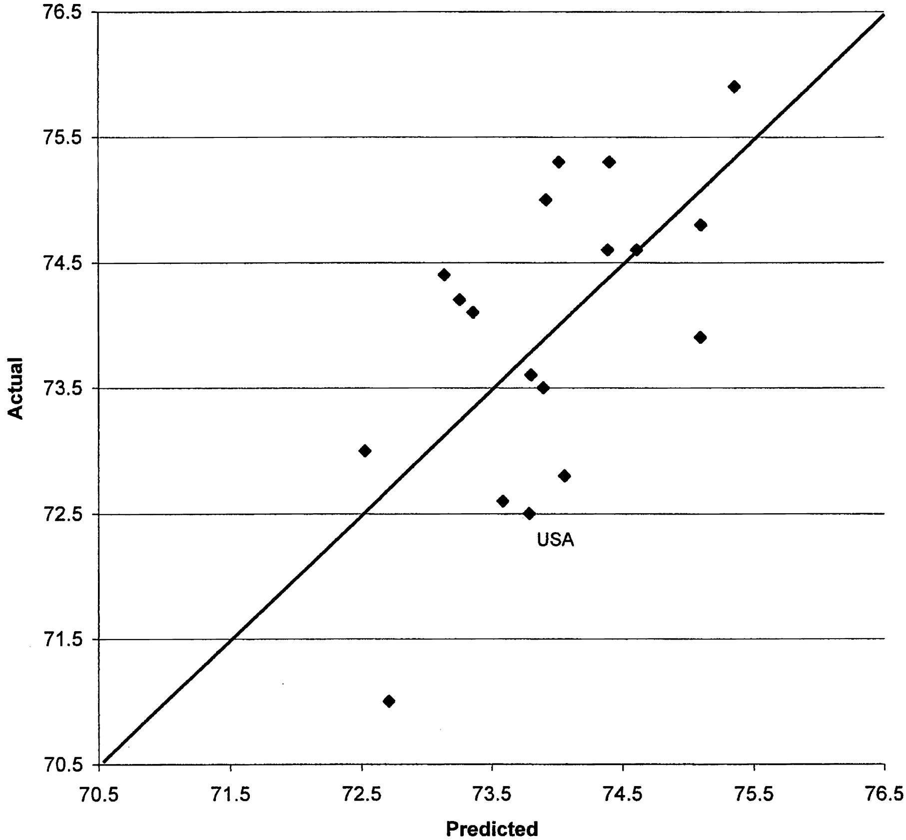


**Fig. 4** Male life expectancy at birth, with obesity

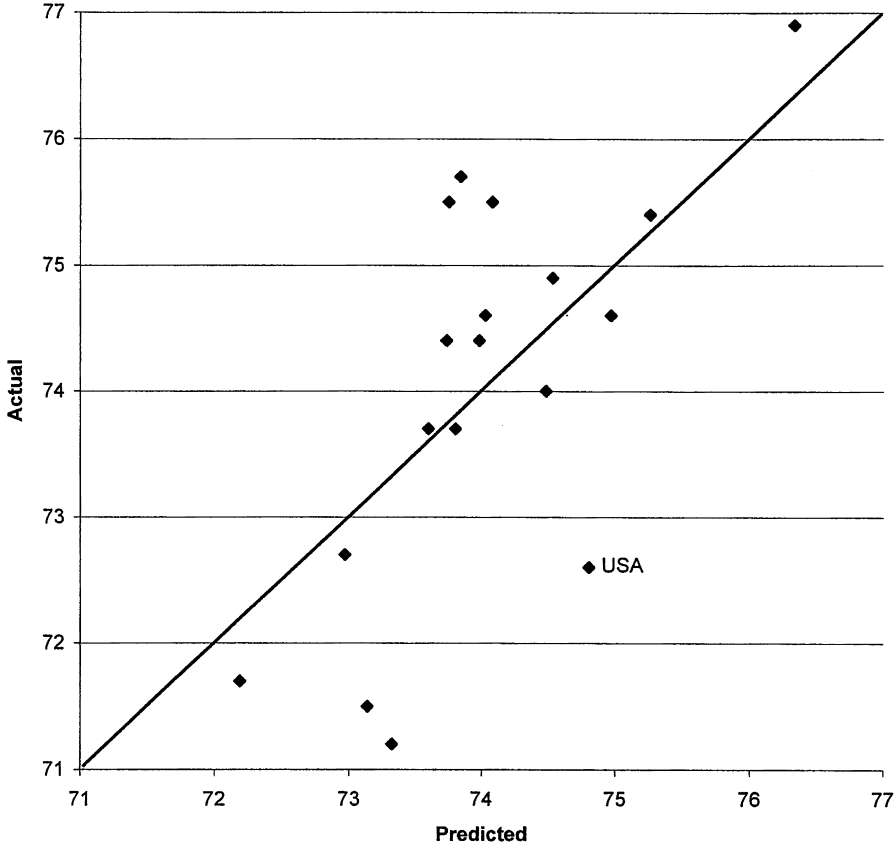


**Fig. 5** Female disability-adjusted life expectancy at birth, without obesity

standard error. And in the second, we calculate a "studentized" residual, which is similar except that it employs the standard error of the regression found by omitting the observation leading to the particular residual. Studentized residuals are generally considered preferable for purposes of identifying outlier values. The standardized residuals can be influenced by the possible outlier itself, since it is included in the regression. In particular, an influential outlier will cause the regression line to be close to it, thereby reducing the measured residual (Belsley, 1980).[10] Both residuals, following standardization achieved by dividing raw values by the relevant standard errors, are directly interpreted as *t* statistics.

In Table 9, residuals are compared in the full model versus the model with obesity excluded. One can see that the U.S. residuals for male life expectancy and disability-adjusted male life expectancy at birth are the only ones that are statistically significant at even the 10 percent level. The interpretation of a 10 percent statistical significance is that residuals this large would occur stochastically in roughly one case out of ten. In this context,

[10] Here, the two residuals are similar because the U.S. observations are not very influential: they have little effect on the location of the estimated surface.

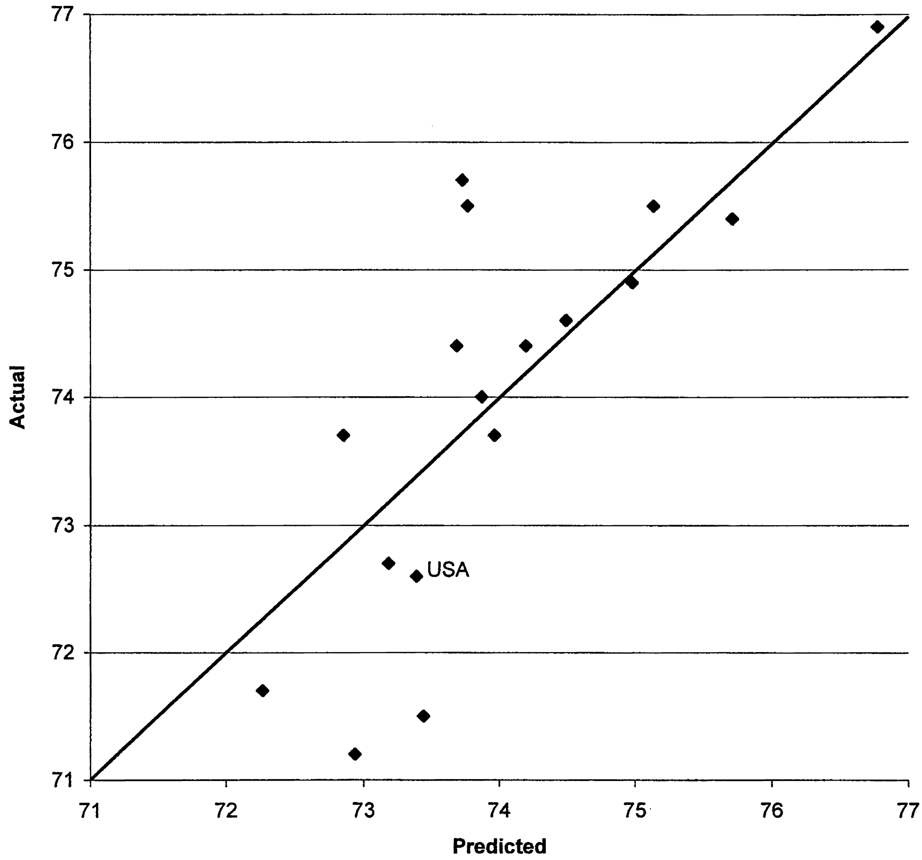


**Fig. 6** Female disability-adjusted life expectancy at birth, with obesity

statistical significance is a descriptive term for how unusual such a residual would be found by chance alone. Especially with a small data set, scientifically important results can be statistical insignificant at conventional levels. Therefore, we do not infer that statistically insignificant residuals are tantamount to zero residuals nor that they should be ignored.

When obesity is included in the equation, however, these outliers become substantially smaller and lose their statistical significance. The effect is stronger for women than for men. In addition, all of the U.S. residuals decline dramatically when this risk factor is included in the equations. It is also interesting that when other countries appear as outliers, controlling for obesity does not generally change their outlier status. The connection between obesity and health outcomes is uniquely present in the United States.

Since the issue here turns on differences between actual and projected values, we can present the information graphically. These differences are portrayed in Figs. 1 through 8. The graphs indicate differences in individual observations from the multivariate production surface by summarizing that surface as a "predicted" value. Those values are portrayed on the horizontal axis, while the corresponding actual values are provided on the vertical axis. An observation that is exactly predicted by the model would lead these two values to be the

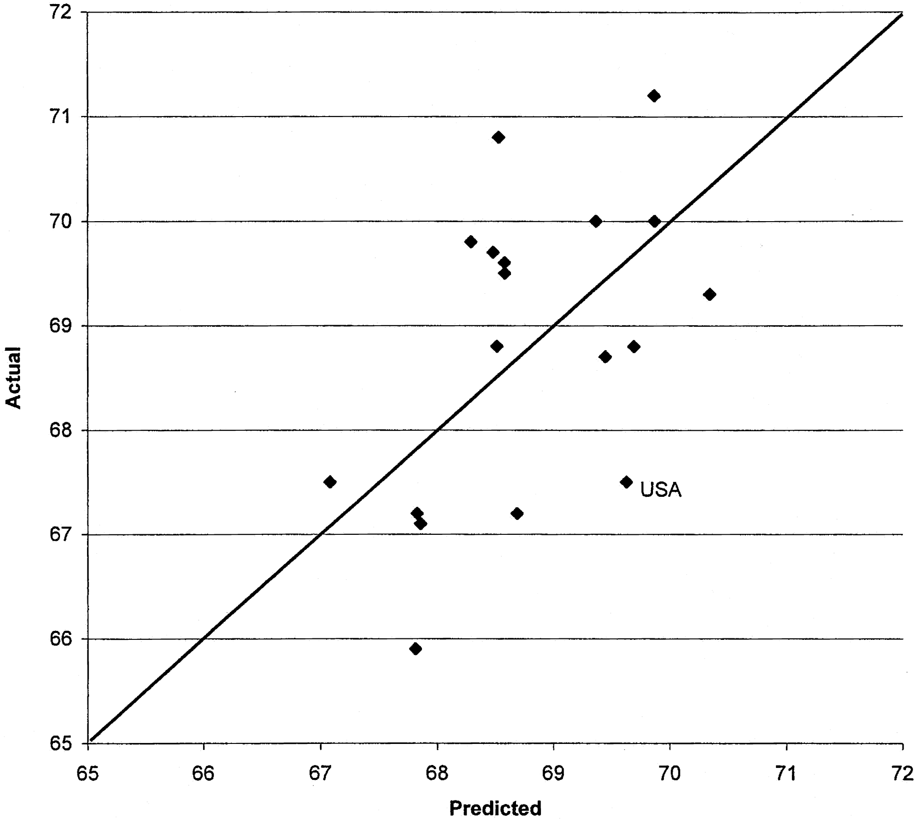


**Fig. 7** Male, disability-adjusted life expectancy at birth, without obesity

same, and thereby rest on the 45-degree line. Where outcomes fall below those predicted by the model, the resulting observation would lie below the 45-degree line.

As can be seen, the U.S. observations always lie below the 45-degree line in that actual values are always less than predicted values. In this sense, the U.S. health care system performs less effectively as compared with the average OECD country. At the same time, these negative residuals are in all cases diminished, and in some cases strongly diminished, when obesity is included in the analysis. In that case, U.S. residuals are comparable to those found for several other developed countries.

## Empirical limitations

Because of the small sample size employed here, a parsimonious model must be used. Thus, there is a possibility of omitted variable bias. For example, health-related lifestyle factors vary in other ways beyond the alcohol, smoking and obesity factors that we measure here. While the data set is too small to enter many variables at once, we performed sensitivity tests on candidate variables, which are reported in Miller and Frech (2004). These variables include education, unemployment, income inequality, air pollution (nitrous oxide emissions), physicians per capita and different lags. None of these factors made much of a difference.

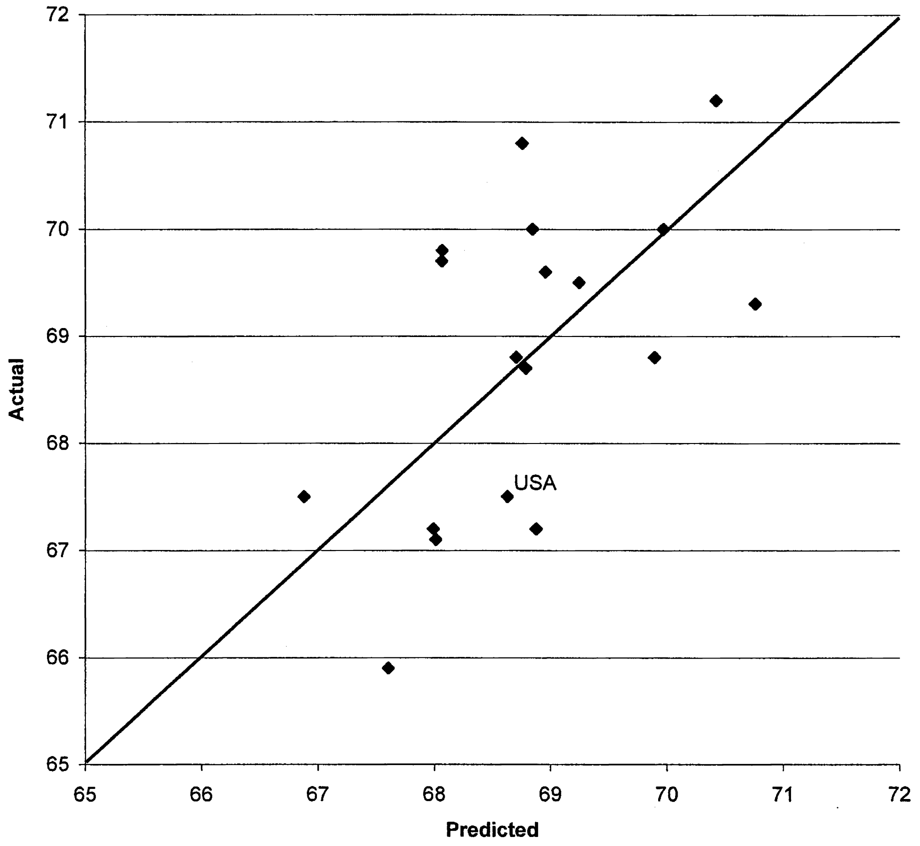


**Fig. 8** Male disability-adjusted life expectancy at birth, with obesity

Of course, this set is hardly definitive because these variables are imperfectly measured and defined, especially across countries.

Another relevant issue is the endogeneity of the independent variables, although lagging the dependent variable by seven to ten years helps with this problem. Of course, health status influences health care expenditures. There are also arguments for the possible endogeneity of obesity. Berndt and Lichtenberg have independently suggested a positive causal relation between health and obesity. Good health reduces risk, which encourages offsetting behavior that raises obesity, such as poor diet and avoiding exercise.[11] In contrast, however, poor health can also prevent exercise and make obesity more likely, which suggests a negative casual relationship between health and obesity. In our judgment, the effects of both behavior patterns are likely to be small.

For most of the other independent variables as well, one can imagine endogeneity issues although they do not strike us as major, particularly for a data set that is limited to OECD countries. In any case, those issues go to the interpretation of the pre-

[11] See Peltzman (1975) for an early discussion of offsetting behavior in the context of improving automobile safety.

liminary findings provided here. Given data limitations, especially on pharmaceutical prices and obesity, it is doubtful that one could effectively apply simultaneous equation methods.

## Some conclusions

While the U.S. health care system has received much criticism for its high costs and modest outcomes, we suggest here that these charges do not have a strong empirical basis. To a large extent, the relatively poor health outcomes reported for the United States result from a particular risk factor prominent in the U.S.: high obesity rates. Once this factor is accounted for, the position of the United States as an outlier among other developed countries is reduced. While no cross-national study can be definitive, the U.S. health care system does not appear particularly unproductive. Further analysis of the relationship between obesity and health care productivity would be welcome.

## References


Allison, D. B. et al. (1999). "Annual Deaths Attributable to Obesity in the United States." *Journal of the American Medical Association* 282(16), 1530–1538.

Andersen, G. F., U. Reinhardt, P.S. Hussey and V. Petrosyan. (2003). "It's the Prices, Stupid: Why the United States is so Different From Other Countries." *Health Affairs* 22(3), 89–105.

Belsley, D.A., E. Kuh, and R.E. Welsch. (1980). *Regression Diagnostics*. New York: John Wiley.

Chou, S.-Y., M. Grossman and H. Saffer. (2002). "An Economic Analysis of Adult Obesity: Results from the Behavioral Risk Factor Surveillance System." National Bureau of Economic Research, Working Paper 9247.

Cutler and D. M. (1994). "A Guide to Health Care Reform." *The Journal of Economic Perspectives* 8, 13–29.

Danzon, P. M. and A. Percy. (1995). "The Effects of Price Regulation on Productivity in Pharmaceuticals." unpublished paper, The Wharton School, University of Pennsylvania.

Deaton A. (2003). "Health, Inequality, and Economic Development." *Journal of Economic Literature* XLI(1), 113–158.

Duan N. (1983). "Smearing Estimate: A Nonparametric Retransformation Method." *Journal of the American Statistical Association* 78, 605–610.

Finkelstein, E. A., I. C. Fiebelkorn and G. Wang. (2003). "National Medical Spending Attributable to Overweight and Obesity: How Much and Who's Paying?" *Health Affairs: Web Exclusive*.

Frech, H. E., III, and R. D. Miller, Jr. (1999). *The Productivity of Health Care and Pharmaceuticals: An International Comparison*. Washington, DC: AEI Press.

Huber, R. J. (1977). "The Behavior of Maximum Likelihood Methods under Nonstandard Conditions." In *Proceedings of Fifth Berkeley Symposium on Mathematical Statistics and Probability*. Berkeley: University of California Press, pp. 221–33.

Marmot M. (2005). *The Status Syndrome: How Social Standing Affects Our Health and Longevity*. New York: Owl Books.

Miller, R. D., and H. E. Frech III. (2004). *Health Care Matters: Pharmaceuticals, Obesity, and Quality of Life*. Washington, DC: AEI Press.

Mokdad, A. H., et al. (1999). "The Spread of the Obesity Epidemic in the United States, 1991–1998." *Journal of the American Medical Association* 282(16), 1519–1522.

Must, A., et al. (1999). "The Disease Burden Associated with Overweight and Obesity." *Journal of the American Medical Association* 282(16), 1523–1529.

O'Rourke and N. Iammarino. (2002). "The Future of Health Care Reform in the United States: Lessons from Abroad," *Review of Pharmacoeconomics and Outcomes Research*.

Organization of Economic Cooperation and Development (2000). *OECD Health Data 2000: A Comparative Analysis of 29 Countries*. Paris: OECD.

Pauly and M. V. (1993). "U.S. Health Care Costs: The Untold Story," *Health Affairs* 12(3), 152–159.

Philipson, T. J. and R. A. Posner. (1999). *The Long-Run Growth of Obesity as a Function of Technological Change*, unpublished paper, University of Chicago, Harris School of Public Policy.

Peltzman S. (1975). ”The Effects of Automobile Safety Regulation.” *Journal of Political Economy* 83(4), 677–726.

Poterba, J. M. (1994). “A Skeptic’s View of Global Budget Caps,” *The Journal of Economic Perspectives* 8, 67–73.

Stampfer, M. J., F. B. Hue, J. E. Manson, E. B. Rimm and W. C. Willet. (2000). “Primary Prevention of Coronary Heart Disease in Women through Diet and Lifestyle.” *New England Journal of Medicine* 343, 16–22.

Sturm R. (2002). “The Effects of Obesity, Smoking and Drinking on Medical Problems and Costs.” *Health Affairs* 21(2), 245–253.

Szuba T. J. (1986). “International Comparison of Drug Consumption: Impact of Prices.” *Social Science and Medicine* 22(10), 1019–1025.

Thorpe, K. E., C.S. Florence, D. H. Howard and P. Joski. (2005). “The Rising Prevalence of Treated Disease: Effects on Private Health Insurance Spending.” *Health Affairs-Web Edition*, W5-317–W5.325.

White, H. (1980). “A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity,” 48, 817–838.