Spending Efficiency in Health Care and Economic Growth

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I. Introduction

A key policy challenge in most OECD countries is to improve outcomes of the health care system while containing its current and future costs. To that end, research at the OECD aims at benchmarking countries and identifying best practices to enhance public spending cost–effectiveness. This could, in principle, proceed at three levels: system wide; by disease; or by sub–sector. The choice is to some extent guided by the present and future availability of data. But it is also dictated by the ends in view. In the case of work at the OECD the purpose of the research extends beyond the desire to identify ways of improving health outcomes *per se*. It embraces the budgetary need to use scarce resources more efficiently and, as an extension, the objective of enhancing economic growth and welfare—within the broader context of the OECD annual *Going for Growth* exercise. For these purposes, the OECD and its Committees have chosen to follow a system rather than disease or sub–sector approach to health efficiency.

Using a system approach, this paper explores the relationship between enhancing spending efficiency in the health care sector and economic growth and welfare[1]. Potential gains from increasing spending efficiency in the health care sector could in general materialise through two mechanisms. *First,* by adopting best international practice, and thus enhancing health care outcomes while keeping the level of health care spending constant, improved health outcomes may affect economic growth and welfare through several channels such as by inducing higher labour supply or raising the incentives to invest in education, or by increasing individual well–being (the latter being a proxy for welfare). *Second,* efficiency gains could be reaped by reducing health care spending, keeping the level of outcomes constant. As concerns the second mechanism, economic growth could be affected through reducing taxes or by allowing a reallocation of resources towards more productive sectors.

This paper investigates the first mechanism. It starts out by exploring the different channels through which rising health outcomes may impinge on economic growth and welfare, based on a review of the existing literature (Section II). The paper then seeks to provide some illustrative estimates of the effect of enhancing health care outcomes on GDP per capita based on the following two–stage process (Section III): (i) the potential for increasing spending efficiency in either direction (i.e., enhancing outcomes or reducing resource use) is computed by means of data envelopment analysis (DEA), based

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1 In this paper, welfare is taken to be a wider measure than GDP.

on measures of health care outcomes, health care spending, and accounting for differences in socioeconomic environment; and (ii) the computed potential for increasing health outcomes (keeping spending constant) is calibrated with estimates reported in the literature on the contribution of health to key growth channels.

The findings in this paper are as follows:

- DEA results need to be interpreted with caution, but those reported here suggest that health care outcomes (i.e., measured by life expectancy at birth) could be enhanced by 3.5% in the OECD on average without having to cut health care spending. Alternatively, health care spending could be cut by 17.9% in OECD countries on average, without reducing life expectancy.
- Based on a review of the literature, there is an apparent strong positive association between enhancing health care outcomes and economic growth and welfare—although the empirical evidence as concerns developed countries is weaker than for developing countries. Calibrating the above DEA results with conventional estimates of the links between health care outcomes and key growth channels the following effects are suggested, in the OECD on average:

— *labour force participation* could be increased by 0.3 percentage points;
— *hours worked* could be increased by about 0.5%;
— *labour productivity* (i.e., measured by wages) could be lifted by about 8%;
— *years of schooling* could be raised by almost a quarter; and
— the *saving rate* could be enhanced by more than 0.8 percentage points.

These results should be taken as illustrative rather than definitive and a number of qualifications are in order. First, despite a flourishing research no consensus appears to have emerged regarding a number of key issues. Notably, controversy relates to the choice of health indicator which best characterises the health status of the population in developed countries, and how to take account of a possible reverse causality between health and economic outcomes. Second, translating these effects into GDP impacts requires further analysis and encounters problems of simultaneity. Insofar as the estimates reported are calculated on the basis of empirical studies which typically have estimated single line equations (and not systems of equations capturing the impact of health on different growth channels simultaneously), the reported figures should be interpreted as separate effects and are not necessarily additive[2]. Finally, while population surveys suggest that health condition is a key dimension of happiness, it is difficult to quantify the contribution of better health to welfare (i.e., going beyond the effect on GDP).

[2] There could, for example, be a degree of double counting of the impact of better health on the economy (e.g., the impact on labour productivity would include an effect operating via the impact on education). It might, however, be expected a *priori* that better health outcomes not only have a positive impact on, say, the number of hours worked but also on other factors important for economic growth (e.g., educational attainment).

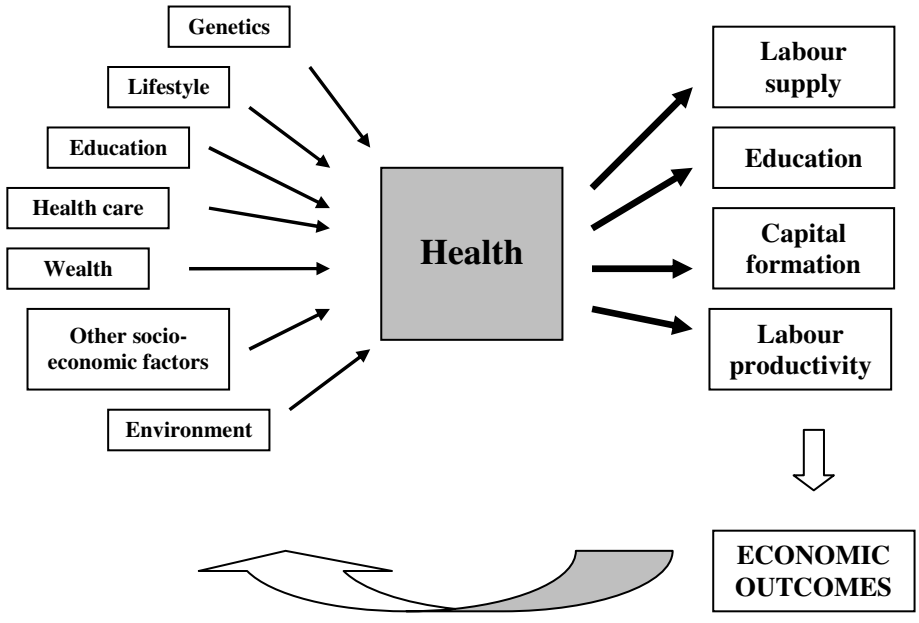
II. Exploring the Links between Health, Economic Growth and Welfare

Channels by which health may affect growth

Improving health care outcomes has in recent years been increasingly recognised as an important factor in the human capital accumulation process—alongside educational attainment—having potentially important spill–over effects on economic growth and welfare. There are several channels through which better health outcomes could affect growth (Figure 1). For example, a healthier workforce may improve the likelihood of being actively employed for those in the working–age population, possibly also providing more hours worked. A further example would be children with good health being able to benefit more from education due to better cognitive abilities.

Various empirical studies on the impact of improved health outcomes on economic outcomes have been carried out in recent years, with the overall finding that health is an apparent robust predictor of subsequent economic growth (Sala–i–Martin et al., 2004)[3]. In a highly influential study focusing on developing countries, the Commission on Macroeconomics and Health (2002) argued that investing in health would generate substantial gains in terms of reducing poverty and stimulating economic growth (Box 1). While most empirical studies have tended to focus on general health indicators (e.g., life

Figure 1. Channels through Which Health May Influence Economic Outcomes



Source: European Commission (2005).

[3] Sala–i–Martin et al. (2004) examines the robustness of 67 explanatory variables used in different cross–country economic growth regressions, and finds that health (i.e., measured by life expectancy) is among the 10 most robust and significant factors explaining variation in long–term growth. The strong positive effect of increasing life expectancy (i.e., longevity) on growth is interpreted as a reflection of growth enhancing factors (in addition to good health itself) such as good work habits and high levels of skills (see Li et al., 2007).

expectancy and adult mortality) or on specific diseases most characteristic of developing countries, others have questioned whether the reported estimates are relevant for developed countries insofar as the latter group of countries typically face other types of disease burdens (European Commission, 2005). In a recent review of the literature, focusing more on developed countries, the European Commission nevertheless finds supportive evidence of a positive relationship between health and economic growth also for high–income countries.

Box 1. The Commission on Macroeconomics and Health

In January 2000, the World Health Organisation (WHO) commissioned an expert group (chaired by Professor Jeffrey Sachs) to assess the impact of health on economic development and to examine ways in which health–related investments could spur economic growth.

The Commission on Macroeconomics and Health (CMH) presented their report in December 2001, arguing that there are significant causal linkages running from health to economic development, notably the following mechanisms:

- *Health and productivity:* Avoidable disease directly reduces the number of years of healthy life expectancy. The economic losses to society of truncated lives—due to the combination of early deaths and chronic disability—are high. Healthier workers are more productive due to higher physical and mental work capacity.
- *Health and demography:* High rates of infant and child mortality are associated with higher rates of fertility, which reduces the ability to invest in human capital. Conversely, when child mortality declines the average age and height of the population rise. (adult height is strongly and positively correlated with earnings). These demographic changes boost overall per capita GDP.
- *Health and investment* A high disease burden creates a high labour turnover and lowers enterprise profitability; it may also lead to lower public investment as health spending squeezes other spending.

To assess the impact of health on economic development, the CMH relied mostly on review and analysis of existing literature, except in the field of HIV/AIDS and on the long–term consequences on economic performance of early childhood nutrition where some new analyses were carried out. The CMH focused its work on poor countries reflecting a paramount need for life–saving health services[1]. The estimates reported by the CMH suggest that a 10% increase of life expectancy at birth would result in raising the economic growth rate by at least 0.3–0.4 percentage points on an annual basis.

The health intervention targets identified by the CMH is related to HIV/AIDS, malaria, tuberculosis, maternal and prenatal conditions, and causes of child mortality, malnutrition, other vaccine–preventable illnesses and tobacco–related diseases—the focus being on relatively simple interventions to achieve these targets. This choice of health intervention targets reflects that communicable diseases are typically more prevalent in poor countries than in high–income countries.

The European Commission (2005) has pointed out that the CMH report proposes no effective interventions that would be directly relevant for rich (or developed) countries. In addition, many of the interventions suggested by the CMH have already been implemented in European countries several decades ago.

The European Commission has reviewed the critiques that have been raised in the aftermath of the CMH report. Part of the criticism was found to be directed towards the absence of an empirical basis for the claims for economic development gains associated with the set of interventions recommended. Others have criticized the encouragement of developing integrated health care systems, arguing that a vertical approach to the eradication of specific diseases would be more appropriate. Some also argue that, rather than assuming a uni–directional relationship going from health to increased affluence, it is important to integrate strategies for improving health and economic opportunities.

1. Hence, one would expect to find a stronger influence on longevity and quality of life of investing in better health compared to raising health outcomes in countries where the population has already reached comparatively high levels of health status.

The rest of this section is organised in the following way. First, the different channels through which better health may affect economic growth are examined, and relevant literature based on microeconomic data is reviewed. This is followed by a discussion of the effect of enhancing health outcomes at the aggregate (macro) level. The section ends by presenting the rather scarce empirical evidence on the links between better health and welfare.

Assessing different growth channels[4]

The literature on the role of health in economic development has focused primarily on four growth channels: (i) health and labour supply, (ii) health and education, (iii) health and saving, and (iv) health and labour productivity. Most of the empirical studies that have been carried out have examined channels (ii) and (iv). Typically, the focus has been on exploring one channel at a time, and the studies are mostly based on individual or household data (therefore being often referred to as microeconomic studies).

Health and labour supply

Enhancing the health status of those in the working–age population could induce higher labour supply through several mechanisms. First, it may reduce the number of sick leave days—consequently increasing the number of days in good health available for either work or leisure[5]. This would also reduce health care spending by lowering the payments to cover sickness benefits, absence of work, etc. Second, enhancing health outcomes could affect individual labour market behaviour through its impact on wages, preferences and longevity. The final effect on labour supply in this case, however, is a *priori* ambiguous. Given that wages reflect individual productivity and healthier workers are more productive, health improvements would allow wages to be increased. This would thus raise the incentives to increase labour supply (*substitution effect*). On the other hand, better health may improve lifetime earnings, which could allow for an earlier withdrawal from the labour market (*income effect*). Third, better health may impinge on individual preferences affecting the trade–off between work and leisure[6]. Fourth, enhancing health care outcomes may—irrespective of the potential effect on wages or preferences—increase longevity. This would raise lifetime consumption needs, which may have to be compensated by increasing labour supply. Finally, illness could affect the labour market behaviour of caregivers, e.g., other members of the household.

Empirical studies tend to confirm that there is a positive association between enhancing health outcomes and labour supply. The empirical evidence concerning developed countries (a large share being based on US data), as reviewed by the European Commission (2005), has focused on the

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[4] This sub–section draws partly on the review carried out by the European Commission (2005).

[5] Empirical evidence casts doubt on the relevance of this effect. International comparisons show that sick–leave is poorly linked to the health status of the population (see Joumard et al., forthcoming, for more details).

[6] To the extent that better health reduces work effort, the individual may choose to work more by reducing time spent on leisure. Conversely, better health may reduce the relative preferences for work—in which case working time could be reduced so as to increase the amount of time available for leisure.

following labour supply effects of health improvements:

- *Labour force participation:* Inferior health outcomes (e.g., measured by self–reported health status, chronic illness or disability) significantly reduce the probability of labour force participation, depending on the health indicator used, gender, the seriousness of illness, etc.
- *Hours worked:* Inferior health outcomes (e.g., measured by self–reported health status) reduce hours worked, depending on gender, ethnicity, etc.
- *Early retirement:* Inferior health outcomes (e.g., measured by perceived health status) cause people to advance their retirement age, depending on the institutional framework in place such as pension rules, availability of disability benefits and occupational insurance arrangements.
- *The labour supply of caregivers:* There appears to be a stronger response among males than females in the event of their spouse's illness (i.e., men reduce their own labour supply by substantial amounts in the event of their wife's illness while women tend to increase their labour supply). This is considered to reflect the unequal distribution of gender roles within the family as well as different labour market status between men and women[7].

More recent empirical studies seem to confirm the above–mentioned findings. Lindeboom et al. (2006) estimate in a study based on British data that the onset of a disability at age 25 reduces the employment probability at age 40 by around 20%. However, no direct effect was found on employment rates from an unanticipated adverse health shock (as measured by unscheduled hospitalisation). In a study based on Australian data, Cai (2007) estimates that the predicted conditional probabilities of labour force participation for those in poor health (as measured by self–assessment) are about 7 to 13 percentage points lower than for those in excellent health.

To the extent that the impact of poor health on labour market behaviour are symmetrical to that of better health[8], the above findings are indicative of a substantial scope for enhancing labour supply. In addition to the pure labour supply effect, better health could also reduce payments to cover sickness benefits, absence of work, etc. Evidence from some countries suggests that this might amount to between 1.3% and 5.5% of GDP[9].

Health and educational attainment

Health may play a potentially important role also through other growth channels such as the impact on educational attainment. The role of health may work through the so–called incentive effect, i.e., healthier individuals with higher life expectancy have stronger incentives to invest in education as the costs can be amortized over a longer time horizon and the associated benefits harvested for a longer

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[7] The sub–labour market response of caregivers may be strongly affected if health insurance is available (European Commission, 2005).

[8] Disney et al. (2003) find some evidence of asymmetry, i.e., the impact of improving health on the transition into economic activity is weaker than the impact of deteriorating health on the transition into inactivity.

[9] See the European Commission (2005). A caveat should be supplied about the interpretation of these figures as they may be influenced by the incentives set by the social security system.

period[10]. Improving health outcomes in childhood may also increase the benefits from education, at all levels of educational attainment. Children with better health are seen to reap larger benefits from education, notably through having greater cognitive ability.

Few empirical studies have so far been carried out examining the links between health and educational attainment in the case of developed countries. For developing countries, most empirical studies tend to support the mechanisms described above. Some recent studies nevertheless indicate that there is a positive association between health outcomes and educational attainment also for developed countries. Finlay (2007) finds supportive evidence of such an incentive effect based on a cross–country panel data analysis covering both developed and developing countries. In a study based on US data on twins, Behrman and Rosenzweig (2004) find that higher birth weight (e.g., due to improving prenatal nutritional intake) has a positive impact on adult schooling attainment. Their within–twin point estimate suggests that a 1 lb. additional birth weight would result in almost a third of a year more of schooling.

In another study based on (Norwegian) twins–data, Black et al. (2007) find evidence of a birth weight effect on educational attainment. Their within–twin estimate indicates that a 10 per cent increase in the birth weight increases the probability of high school completion by almost 1 percentage point. In a study based on British data, Case et al. (2005) find that children experiencing poor health have significantly lower educational attainment (i.e., pass fewer exams)—when controlling for parental income, education and social class. Gan and Gong (2007) find in a study based on US data that previous illness has lasting negative effects on educational attainment. Their estimate suggests that having experienced health limitations before the age of 21 decreases years of schooling by 1.4 years.

Health and saving

Increasing life expectancy (longevity) may increase the propensity to save. Healthier people are likely to have a wider time horizon than those in poor health, and individuals would therefore (in line with the life–cycle hypothesis) be expected to have a higher saving rate when they expect to live longer. However, rising longevity also implies more old people dissaving, which would contribute to a decline in the aggregate saving rate. The overall effect would therefore have to be determined empirically. Improvements in healthy life expectancy may also leave the saving rate unchanged to the extent that it generates increases in the average age of retirement (Bloom et al., 2007)[11].

Health may also impact on the saving rate through other mechanisms than longevity. For example, illness may change people's consumption patterns if deteriorating health reduces utility from

[10] Acquiring education implies being out of the workforce and thus the loss of potential income. In exchange, the individual would expect a return in terms of higher future earnings. For it to be profitable to undertake education, the net present value of future earnings should be at least as high as without undertaking education. Thus, if increasing life expectancy implies increasing the time horizon over which the higher earnings can be collected, the marginal benefit of education would increase.

[11] Increased sickness in old age or adverse retirement incentives in social security systems may however prevent longer working lives.

consumption[12]. In contrast, poor health would result in a decline in the propensity to save to the extent that it reduces current period income (e.g., reflecting lower work capacity), or increases consumption of and out–of–pocket spending on medical services. Furthermore, the saving rate would decline if poor health leads people to increase other consumption so as to compensate for deteriorating health.

The empirical evidence on the links between health and savings, particularly as concerns developed countries, is rather weak. Two recent studies based on a world wide data sample find that improvement in life expectancy is associated with a higher saving rate, although the impact depends on the retirement incentives set in the social security system. Li et al. (2007) find in a panel data study covering 149 countries that health, as measured by life expectancy, has a significant positive effect on the aggregate saving rate (for given levels of fertility and the old–age dependency rate). Their estimate suggests that a 1 year increase in life expectancy would result in a 0.2 percentage point higher saving rate. In another cross–country study based on panel data, Bloom et al. (2007) estimate that a 1 year increase in life expectancy would result in a 0.4 percentage point increase in the (steady state) saving rate in countries having a social security system characterised by universal coverage, mandatory retirement and full funding. They also find that the positive impact of health on the propensity to save disappears in countries with pay–as–you–go systems and high–replacement rates[13].

Health and labour productivity

The labour productivity hypothesis asserts that healthier people have higher returns to labour input. Individuals in good health may be able to produce more per hour worked (and thereby generate increasing per capita incomes) through at least three mechanisms. *First,* greater labour productivity of those with better health outcomes could reflect greater physical (strength and endurance) or mental (cognitive functioning and reasoning ability) capacities[14]. *Second,* more physically and mentally active workers could make a better and more efficient use of technology, machinery and equipment. *Third,* a healthier labour force could be expected to be more flexible and adaptable to changes (e.g., changes in job tasks and in the organisation of labour).

The influence of health on labour productivity is extensively analysed in the literature[15]. Empirical studies have typically proxied an individual's labour productivity by the wage rate (or earnings)—as under perfect competition the wage rate equals marginal productivity. The review carried out by the European Commission (2005) is supportive of the labour productivity hypothesis. Empirical studies

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[12] If the marginal utility of consumption is a function of health status, i.e., the utility of consuming one additional unit increases with the health status, then individuals will seek to consume more when they are healthy than when in ill health. If so, savings will rise when the prospect of poor health increases.

[13] The estimates for pay–as–you–go social security systems, however, are not significant.

[14] The effect of enhanced physical capacities may be more important in typical physical work, while the effect of improved reasoning ability might be more important in non–manual work.

[15] A concern could be raised about the extent to which empirical studies are able to disentangle the positive effect of health on labour productivity from other factors (e.g., working experience, education, talents, etc.). Although this might be overcome by controlling for the other factors in regression analysis, there would still be a risk of "double counting" insofar as better health would also be reflected, say to educational attainment).

focusing on developed countries, and where health is measured by self–reported health status variables, indicate that poor health reduces the wage rate by about 9% on average (or reduce earnings by 18%). In other studies where health is measured by physiological markers such as height or the body mass index, a wage premium of about 0.4–0.9% (or an earnings premium of 1–1.3%) is found per additional centimetre of height.

More recent studies show firm evidence of a positive link between health in childhood and adult labour market outcomes. These studies have to a larger extent been able to control for initial differences in genetic endowments compared to previous studies, as they are based on twins–data. Using birth weight as a marker for health, Behrman and Rosenzweig (2004) and Black et al. (2007) find strong evidence that health affects labour market outcomes. Behrman and Rosenzweig (2004) estimate that augmenting a child's birth weight by 1 lb. increases his or her hourly wage by more than 7%, while Black et al. (2007) estimate that a 10% increase in birth weight would result in more than a 1% increase in the earnings of full–time workers.

What is the effect at the macro level?

The exploration of the four channels above illuminates different mechanisms through which health may impact on economic growth. Overall, empirical studies tend to confirm that there is a positive association between health outcomes and the different growth channels—in studies based on individual or household data. A key issue is therefore to what extent the evidence found in these microeconomic studies is relevant also at the aggregate (macro) level, i.e., how do the health effects found at the microeconomic level add up to affect GDP?

A flourishing literature has aimed at assessing the extent to which contemporary cross–country differences in economic outcomes at the macro level are attributable to better health. Empirical studies have used two methods to scrutinise this issue: (i) economic growth regressions and (ii) the aggregate production function approach[16]. Most empirical studies have relied on a world wide data sample, covering both developed and developing countries. Furthermore, a large share of these studies have focused on health as an integral part of human capital, i.e., impacting on economic growth through the labour productivity and education channel presented above.

The empirical literature gives an apparent mixed picture of the relationship between health and economic outcomes at the aggregate level, particularly as concerns developed countries. In a review of growth regression studies that are based on a world wide data sample, Bloom et al. (2004) find that countries having a 5–year lead in life expectancy at birth typically experience a 0.3 to 0.5% faster GDP growth rate per year. More recent empirical studies tend to confirm that better health promotes

[16] There is also a literature exploring the role of health in economic development in specific countries over longer periods (centuries). A prominent study within this methodology is that of Fogel (1994), who reported that the combined effects of the increase in dietary energy available for work and of increased human efficiency in transforming dietary energy into work output account for 50% of the economic growth in the United Kingdom from 1790 to 1980. A large part of economic growth (around 0.33% per year) in this period reflected increases in effective labour inputs that resulted from workers' better nutrition and improved health.

economic growth (Table 1), although the prominent study by Acemoglu and Daron (2006) shows that there might even be a negative impact of health on growth (due to land being an increasingly scarce resource with a rising population).

Is there a health effect on welfare going beyond the impact on GDP?

Acknowledging that a higher quality of life—as an extra dimension that may be separated from GDP—is an important aspect of enhancing health care outcomes, such an effect should be taken into account in the total assessment of the achievements attributable to increasing spending efficiency in health care.

The empirical evidence on the relationship between health and welfare, however, is rather scarce. This should come as no surprise insofar as welfare is intrinsically difficult to measure. There is nevertheless a growing literature studying the links between different measures of health outcomes and individual or subjective well–being (the latter being a proxy for welfare). In a study based on a world wide data sample covering 178 countries, White (2007) finds that subjective well–being is most correlated with health outcomes (i.e., measured by life expectancy), followed by wealth and education. In another study based on data on 16 European countries, Blanchflower and Oswald (2007) find that happier nations (i.e., measured by the Eurobarometer life–satisfaction scores) report lower levels of hypertension (problems of high blood pressure).

Table 1. Empirical Studies Assessing the Impact of Health on Economic Growth

Authors	Data	Methodology	Health indicator	Results
Bloom et al. (2004)	104 countries, 1960–1990	Growth regression	Life expectancy	Health has a positive and significant effect on growth. A 1 year increase in life expectancy results in a 4% increase in GDP level.
Suhrcke and Urban (2006)	74 countries, 1960–2000	Growth regression	Cardio–Vascular Disease (CVD) mortality rate	Increasing CVD mortality rates has negative effects on subsequent 5–year growth rates in per capita incomes for rich countries, but not for low and middle–income countries. A 1% increase in the mortality rate in rich countries would result in a 0.1% decline in per capita income growth.
Li et al. (2007)	149 countries, 1960–2004	Growth regression	Life expectancy	The elasticity of GDP per capita with respect to life expectancy at birth is 0.024.
Finlay (2007)	62 countries, 1960–2000	Growth regression	Adult mortality	A 45% decrease in adult mortality implies raising the steady state level of per capita income by about 2.7%. The effect of health is working through the incentive effect on education and through a fertility effect.
Acemoglu and Johnson (2006)	59 countries, 1940–1980	Growth accounting	Life expectancy	No evidence that a large exogenous increase in life expectancy has led to a significant increase in per capita income growth.
Weil (2007)	92 countries, 1960–2000	Growth accounting	Height, adult survival rate, age at menarche	Eliminating cross–country differences in health would reduce the variance of log GDP per worker by around 10% (and close to 20% if accounting for indirect effects). It implies reducing the ratio of GDP per worker at the 90th percentile to GDP per worker at the 10th percentile by nearly 13%.

III. Illustrating the Impact on Per Capita Incomes of Boosting Spending Efficiency in Health Care

The above literature review suggests that bringing more countries up to best international practice as concerns spending efficiency in the health care sector may have potentially important effects on economic growth and welfare—working through the different mechanisms outlined above. To illustrate the potential impact order of enhancing spending efficiency in OECD on economic growth, a two–stage procedure is here followed. *First,* the potential for improving spending efficiency is computed by means of data envelopment analysis (DEA). *Second,* the resulting efficiency scores are calibrated with the estimates reported in the literature on the contribution of health outcomes to key growth channels[17].

Step 1: Measuring spending efficiency in the health care sector in OECD countries

The production of health care outcomes is in its nature a complex process and is typically associated with multiple outcomes and inputs. In this paper a relatively simple production process has been assumed where health care outcomes are measured by life expectancy at birth[18], while health care spending per capita is used as a measure of input. In addition, a socioeconomic index of occupational status (HISEI) is used as an input variable to capture differences in environmental factors. All data are obtained from the OECD Health Data.

Cross–country differences in cost efficiency are computed by means of the DEA method (Box 2) — the efficiency scores being based on 2004 data, and computed under the assumption of non–increasing returns to scale production technology. The DEA method can be used to derive two types of efficiency scores (Sutherland et al., 2007). Input–oriented scores measure the extent to which inputs could be scaled back while holding constant the actual level of health status. Output–oriented scores assess how much the health status could be improved while holding inputs constant (Figure 2). The output–oriented approach is the one most relevant to the theme of this paper, but in principle a decision as to whether efficiency gains should be used to expand health outputs should be evaluated against the opportunity costs of putting resource savings to other uses.

The DEA results suggest that life expectancy at birth could be increased by 3.5% in the OECD on average by letting inefficient countries catch up to best international practice, without having to increase health care spending (Table 2). Alternatively, health care spending could be reduced by

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[17] It should be noted that the focus is not on the country ranking of health care spending efficiency *per se*, but rather on the order of magnitude of the potential efficiency gains. Thus, the measurement of spending efficiency in health care serves the purpose of anchoring the potential health effect on economic growth and welfare.

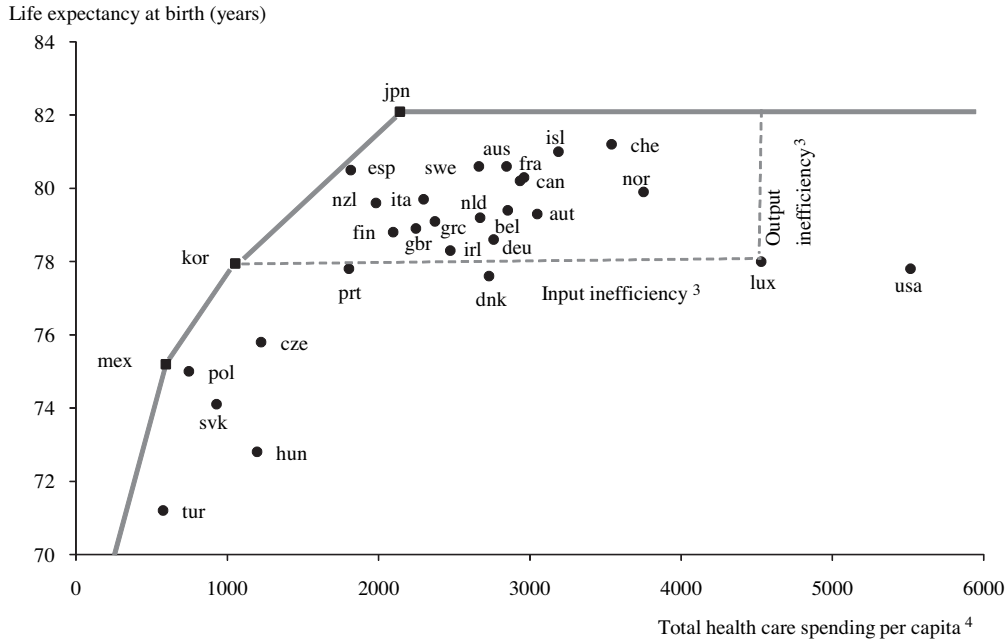
[18] The use of life expectancy at birth as an output variable in the DEA computation is partly determined by the fact that most empirical studies, estimating the contribution of health to economic growth, have relied on this specific measure of health outcomes. Life expectancy at birth is also an extensively used proxy for the health status of the population. Higher life expectancy is typically associated with better health status and lower morbidity. Although other measures such as Quality Adjusted Life Years (QALYs) would be a more appropriate measure of health care outcomes, the lack of comprehensive and internationally comparable data does not allow comparisons based on QALYs to be carried out (see the survey by Häkkinen and Joumard, 2007).

17.9% on average, without reducing life expectancy at birth. According to Table 2, the potential for enhancing health outcomes is 0.3 and 0.8 percentage point lower, on average, in countries with high health care spending per capita compared to the two groups of countries spending less on health care. In contrast, the potential for cutting spending (without reducing life expectancy at birth) is 2.2 and 3.4 percentage point greater for high spending countries compared to low and middle spending countries, respectively.

Ideally, the robustness of the DEA results should be tested by using alternative output or input specifications—so as to check whether the computed potential for increasing health outcomes or reducing spending remains relatively stable. Recent research at the OECD, reported in Joumard et al. (forthcoming), which includes an additional input variable for diet, suggests that the results reported here are relatively robust to alternative specifications. However, several factors hamper the application of sensitivity tests. First, most of the alternative outcome variables available from the OECD Health Data are highly correlated with life expectancy at birth (the correlation coefficient is in most cases well above 0.90)—reducing the extent to which alternative specifications are likely to produce very

Figure 2. DEA: The Efficiency Frontier and the Measurement of Inefficiency—An Illustration[1]

(Scenario with one output and one input[2], 2004 or latest year available)



Notes: 1. The "efficiency frontier" has been designed under the assumption of non–increasing returns to scale. Abbreviations for country names correspond to ISO codes.

2. The main scenario accounts for three inputs (health care spending, ESCS, consumption of fruits and vegetables) and one output (life expectancy at birth).

3. Potential efficiency gains are derived by measuring the distance from the efficiency frontier as a ratio of the distance from the axis to the efficiency frontier. They can be defined as the amount by which input could be reduced while holding constant the level of output (input inefficiency) or as the amount by which output could be increased while holding constant the level of input (output inefficiency).

4. Expressed in 2000 US dollars and PPP.

Source: OECD Health Data 2007.

different efficiency results. Second, other measures of health outcomes that appear as a more attractive alternative to life expectancy at birth (e.g., disability–free years of life) are available only for a subset of OECD countries—reducing the extent to which the computed DEA results would be comparable to the baseline specification. Third, even if alternative outcome measures should be available, the fact that the resulting DEA results would be sensitive to the unit of measurement raises the issue of to what extent the results from different DEA computations can be meaningfully compared[19].

To sum up, there are a number of circumstances hampering the extent to which the DEA results can convincingly be checked for robustness. Thus, the efficiency results shown in Table 2 should be interpreted as the outcome of a computation based on the chosen specification of output and input variables, the number of countries included, and the year focused on.

Step 2: Calibrating the DEA results with the health effects on growth channels reported in the literature

The DEA results on the potential for raising life expectancy at birth (while keeping health care spending constant) need to be calibrated with the estimates reported in the literature on the contribution of health to different growth channels. In empirical studies studying the effect of health on different growth channels, health is frequently proxied by life expectancy at birth. For these studies, the DEA results can easily be transformed into health effects, say in terms of inducing higher labour supply or raising educational attainment. However, in empirical studies where measures other than life expectancy at birth have been used as a measure of health care outcomes, links would need to

Table 2. DEA Results on Cost Efficiency in Health Care in OECD Countries

Country group	Potential for increasing health outcomes (%)	Potential for reducing health care spending (%)
Low spending countries	3.4	17.6
Middle spending countries	3.9	16.4
High spending countries	3.1	19.8
All countries	3.5	17.9

Note: Countries have been ranked according to health care spending per capita, measured in US$ and PPP adjusted. Thus, low spending countries are defined as the 10 OECD countries with the lowest health care spending per capita, while high spending countries are the 10 OECD countries with the highest health care spending per capita. Middle spending countries are defined as the 10 OECD countries placed between these two groups of countries. The figures reflect unweighted averages.

[19] Using life expectancy at age 65 could be considered as a more relevant measure of health care outcomes than life expectancy at birth insofar as a large spending share is being allocated to older people. Since the potential for increasing life expectancy at age 65 by improving the health care system is likely to be smaller than the potential for increasing life expectancy at birth, using the former as a measure of health care outcomes would result in a smaller computed potential for increasing health outcomes (all things equal). Another example is using potential years of life lost (PYLL) as a measure of health care outcomes—also available from the OECD Health Data. To make this outcome measure a "positive" variable, it would first have to be transformed in such a way that increasing values correspond to increasing efficiency (for given levels of resource use). Using a standard formula from the literature to perform this transformation, however, would result in very large values for the outcome variable with relatively small cross–country differences. In this case, the DEA results would show a relatively small computed potential for increasing health outcomes (which also is confirmed in a test carried out by the OECD). Thus, the DEA results on the potential for increasing spending efficiency are likely to be highly influenced by the unit of measurement for the variables used.

Box 2. Data Envelopment Analysis

Data envelopment analysis (DEA) constructs an efficiency frontier based on the input and output data from all the countries of a sample. In essence, as shown in the set of charts below, the frontier is constructed from the countries that *envelop* the remaining observations and thus provides a benchmark by which the others can be judged. By assumption, the frontier determines best practice, and potential efficiency gains for specific countries are measured by their position relative to the frontier or the envelope. In the "one input–one output" case given in the figure, a measure of the efficiency shortfall in terms of unachieved output is given by the ratio of a country's output to the output on the frontier for the same level of inputs (i.e., the point on the frontier vertically above the country observation). Conversely, the ratio of inputs on the frontier to the country's inputs at the same output (measured horizontally) is a measure of inefficiency in terms of potentially excess inputs. In the case of multiple inputs or outputs, the measures of efficiency are determined in a similar fashion by holding the relative proportions of either inputs or outputs constant in measuring the distance to the frontier. Countries can then be benchmarked on the basis of potential efficiency gains compared to the measures of best practice.

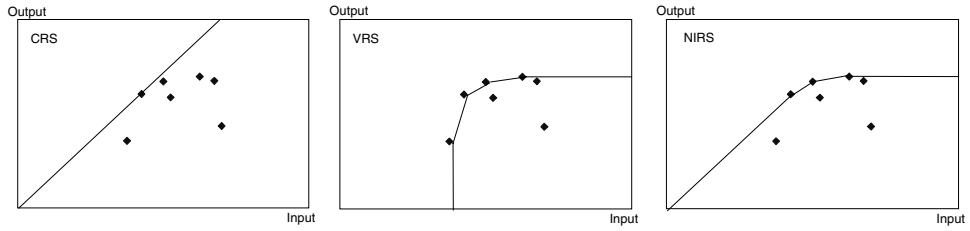
The shape of the DEA efficiency frontier depends on the assumptions about returns to scale:

- *Constant returns to scale (CRS).* This assumption describes the efficiency frontier as a ray from the origin through the observation(s) with the highest output/input ratio (Box figure, left panel).
- *Variable returns to scale (VRS).* This approach identifies the countries that define the frontier by starting from the observations of units that use the least of each input and ending with the observations producing the highest amount of each output (middle panel).
- *Non–increasing returns to scale (NIRS).* This assumption combines the constant returns to scale assumption between the origin and the observation with the highest output/input ratio, and variable returns to scale thereafter (right panel).

The health status of the population has many determinants but, given the size of the sample, the number of inputs and outputs needs to be limited in order to obtain reliable DEA estimates. In this study, one output—life expectancy at birth of the total population— and two inputs are included. The inputs represent the main dimensions of health outcome production: health resources (measured by health spending) and a socio–economic environment index. In the latest OECD analysis, lifestyle (measured by *per capita* consumption of fruit and vegetables) has also been incorporated as an input. DEA results can be rather sensitive to the set of inputs selected.

Since estimates are sensitive to measurement errors, statistical noise and outliers, computing confidence intervals around DEA scores is important. The bias may be corrected through "bootstrapping," which is a statistical method for estimating the sampling distribution of an estimator. In addition, the bootstrap provides confidence intervals for the efficiency scores. However, it should be kept in mind that the reliability of an efficiency score depends on the density of observations in the region of the frontier where a country is located. Countries with atypical levels of inputs and outputs tend to be considered as efficient but this result is merely a consequence of the lack of comparable observations.

Box Figure. DEA Efficiency Frontiers



Source: Sutherland and Price (2007).

be established between these alternative outcome measures and life expectancy at birth (since the DEA results are based on life expectancy at birth). Different types of literature have been reviewed as well as estimations carried out so as to establish these links.

To summarise, since the DEA results show that life expectancy at birth could be increased by 3.5% in the OECD on average, without increasing health care spending, this implies that average life expectancy in the OECD increases from 78.35 to 81.09 years. The 2.74 increase in average years of life expectancy is found to correspond to the following average impact on the abovementioned growth channels:[20]

- *Labour supply*. Labour force participation could be increased by 0.3 percentage points. In addition, annual working hours could be increased by 0.48%.
- *Education*. time spent at school could be raised by 0.23 year (i.e., almost 3 months).
- *Savings*. The aggregate saving rate could be increased by 0.85 percentage points.
- *Labour productivity*. Wages could be increased by 8.1%.

In order to calibrate the impact of health on economic variables, we have used the following assumptions:

- *Labour supply*. A correlation between life expectancy at birth and perceived health status shows that a 2.74 increase in years of life expectancy is associated with an increase in the share of the population with perceived "good" or "better" health status by 8.4 percentage points (from 68.5 to 76.9). Cai (2007) estimates that the predicted conditional probability of labour force participation for those in "good" health or "better" (based on Australian data for perceived health status) is 0.818 compared to 0.782 for those in "less than good health." The difference in predicted probabilities of labour force participation combined with the potential increase in the share of those with "good" health or "better" would result in a 0.3 percentage point increase in participation. According to Pelkowski and Berger (2004) in a study based on US data, those with a permanent illness supply on average (unweighted average for males and females) 5.7% less working hours per year. Assuming that the labour market behaviour of those with perceived health status "less than good" according to the OECD Health Data resembles those with a permanent illness, raising the share of those with "good or better" health by 0.084 (see above) is equivalent to increasing hours worked by (0.084 × 5.7=) 0.48%.
- *Education*. Finlay (2007) estimates (based on US data) that a 1 year increase in life expectancy raises the years of schooling by 0.041. The computed potential of increasing life expectancy by 2.74 years is thus associated with increasing years of schooling by 0.11. Strauss and Thomas (1998) find that a 1 cm gap in height corresponds to 0.1 year of extra schooling. Baten and Komlos (1998) have estimated that 1 cm in additional height corresponds to about 1.2 years of life expectancy. The computed potential for enhancing life expectancy is thus equivalent to (0.1 × 2.74/1.2=) 0.23 increase in years of schooling. Behrman and Rosenzweig (2004) estimate in a study based on US twins data that 1 cm additional height is equivalent to 0.175 extra years of schooling. Hence, the potential for increasing life expectancy by 2.74 years—using the Baten and Komlos estimate mentioned above—correspond to a 0.4 increase in years of schooling. Black et

al. (2007) estimate in a study based on Norwegian twins data that 1 cm of additional height is equivalent to 0.07 extra years of schooling. Calculated equivalently as in the case of the Behrman and Rosenzweig study, the potential for increasing life expectancy by 2.74 years correspond to 0.16 additional years of schooling. Taking the average of these four guesstimates gives the 0.23 increase in years of schooling.

- *Savings*. Li et al. (2007) find in a large cross–country study that a 1 year increase in life expectancy corresponds to a 0.2 percentage–point increase in the aggregate saving rate. In another study, Bloom et al. (2006) estimate that a 1 year increase in life expectancy is associated with a 0.424 percentage–point increase in the steady state saving rate for countries having a fully funded social insurance system with universal coverage and mandatory retirement. Taking the average of these two estimates and multiplying by the computed potential for increasing life expectancy gives the guesstimate of (0.312 × 2.74=) 0.85 percentage points reported above.
- *Labour productivity*. Weil (2007), based in part on available estimates of the return to health from variation on birth weight between twins, finds that a 1 cm additional height raises log wages by 0.034, keeping the level of education constant. This estimate is based on the Behrman and Rosezweig study (which found that a 1 cm additional height increases log wages by 0.033) and the Black et al. study (which found that a 1 cm additional height increases log wages by 0.035). Using the Baten and Komlos estimate that 1 cm in additional height corresponds to 1.2 years of life expectancy, the computed potential for improving life expectancy by 2.74 years is equivalent to raising wages by (exp (2.74*0.034/1.2)–1=) 8.1%.

The above estimates suggest that policies aimed at getting more value for money in the health care sector may have an impact on economic growth which is far from being negligible. The main benefit of reforms aiming at increasing health outcomes (while holding spending constant) would stem from the increase in labour productivity. These estimates, however, should not be taken at face value since they result from rather heroic assumptions. They should further be compared with the impact of other types of efficiency–enhancing reforms, including those aimed at reducing spending (hence taxes) while keeping health outcomes constant.

IV. Concluding Remarks

The above estimates can be taken as illustrative of the extent to which improvements in the efficiency of healthcare spending could achieve both better health outcomes and better economic performance. However, it gives no information as to how such outcomes may be achieved. In this context, further research at the OECD sheds light on this issue by identifying the institutional factors behind cross–country differences in health–sector performance. This research is based on panel data analysis, which allows for a more effective control of lifestyle and other environmental factors (smoking behaviour, alcohol consumption and diet) that determine health outcomes, and broadly

[20] The DEA results allow also for the calculation of country–specific effects.

confirms the conclusion of the DEA analysis presented above, namely, that potential health gains from more efficient spending are considerable (Joumard et al., forthcoming). The next stage of research—to identify the institutional factors that help explain international differences in health performance—involves unravelling the complex interactions among such factors. From the existing evidence, however, it is already clear that there is a substantial double dividend from more efficient health care spending in terms of both health and economic outcomes.

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