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HEALTH CARE EXPENDITURE GROWTH IN DEVELOPED COUNTRIES: ASSESSING THE IMPACT OF MEDICAL TECHNOLOGY

MINIAR BEN AMMAR SGHARI[1] & SAMI HAMMAMI[2]

[1]Doctor in Economics, Faculty of Management and Economics, Sfax University, Sfax, Tunisia

[2]Economics Professor, Faculty of Management and Economics, Sfax University, Sfax, Tunisia

ABSTRACT

In this paper we examine the role of medical technology in growth of health care expenditure. In recent years, many industrialized countries have been confronted with rising healthcare expenditures. We take a panel cointegration approach in order to explore the possibility of estimating impacts of medical technology. Our empirical analysis is based on 14 developed countries_ France, Allemagne, Italie, Japon, Mexique, Noverge, Espagne, Suisse, Royaume-Uni, Etat-Unis, Turquie, Austria, Germany and Prologne for the period 1980–2012. We find that medical technology exert a statistically significant positive effect on health care expenditure.

KEYWORDS: Health Care Expenditure, Medical Technology, Developed Countries, Panel Cointegration

1. INTRODUCTION

While a particular new technology may either increase or decrease health care spending, researchers generally agree that, taken together, advances in medical technology have contributed to rising overall U.S. health care spending. Rettig describes how new medical technology affects the costs of health care through the following “mechanisms of action:

- Development of new treatments for previously untreatable terminal conditions, including long-term maintenance therapy for treatment of such diseases as diabetes, end-stage renal disease, and AIDS;
- Major advances in clinical ability to treat previously untreatable acute conditions, such as coronary artery bypass graft;
- Development of new procedures for discovering and treating secondary diseases within a disease, such as erythropoietin to treat anemia in dialysis patients;
- Expansion of the indications for a treatment over time, increasing the patient population to which the treatment is applied;
- On-going, incremental improvements in existing capabilities, which may improve quality;
- Clinical progress, through major advances or by the cumulative effect of incremental improvements, that extends the scope of medicine to conditions once regarded as beyond its boundaries, such as mental illness and substance abuse.

Health expenditures continue to grow very rapidly in developed countries since 1970, health care spending has grown at an average annual rate of 9.8%, or about 2.5 percentage points faster than the economy as measured by the

nominal gross domestic product (GDP). As a share of the economy, health care has more than doubled over the past 35 years, rising from 7.2% of GDP in 1970 to 16.0% of GDP in 2005, and is projected to be 20% of GDP in 2015.

A key question from policymakers is why spending on health care consistently rises more rapidly than spending on other goods and services. Health care experts point to the development and diffusion of medical technology as primary factors in explaining the persistent health care expenditure, with some arguing that new medical technology may account for about one-half or more of real long-term spending growth. This paper briefly describes the impact of medical technology in health care expenditure growth.

Evaluating the impact of new innovation can be complicated. For example, a case study that focuses on a single technology or disease may show cost savings based on the costs and benefits of the new technology if it replaces a more expensive technology and provides health improvements, while an analysis of health care system-wide costs may show cost increases if the new technology results in greater utilization than the old.

2. AN OVERVIEW OF THE LITERATURE

Economists have used indirect approaches to try to estimate the impact of new technology on the growth of health care expenditure. In an often-cited article, Newhouse estimates the impact of medical technology on health care spending by first estimating the impact of factors that can reasonably be accounted for (e.g., spread of insurance, increasing per capita income, aging of the population, supplier-induced demand, low medical sector productivity gains). He concludes that the factors listed above account for well under half of the growth in real medical spending, and that the bulk of the unexplained residual increase should be attributed to technological change – what he calls “the enhanced capabilities of medicine.

Member State expenditures on health care per capita vary greatly, though they are closely correlated with GDP per capita. There is a positive relationship between health expenditure per capita and GDP per capita. Higher-income Member States such as Austria, France, Germany and Sweden spend, on average, more on health given their GDP per capita.

A literature review was conducted to explore the current evidence base on the relationship between medical technology and health care expenditures. Unlike previous studies in this area, we considered a wide range of literature to ensure adequate coverage of different methodological approaches and ideological perspectives for assessing this relationship. The categories of literature included in the search and review included general and descriptive analyses, policy analyses, literature reviews, multivariate analyses, cost-effectiveness analyses, and cost impact studies of specific technologies.

Berndt ER, Cutler DM, Frank RG, Griliches Z, JP Newhouse, JE Triplett[1] Ssuggested that although technological innovation is of great significance in health care and has been claimed to be a key driver of health spending. Okunade AA, Murthy VNR[2] measured the potential contributions of medical technology to rising health care costs has been relatively sparse. One possible reason for this neglect, and the predominant reliance on more descriptive or qualitative analyses

[1] Berndt ER, Cutler DM, Frank RG, Griliches Z, JP Newhouse, JE Triplett. Prix des soins médicaux et de sortie. Dans: Culyer AJ, JP Newhouse, éditeurs. Handbook of Health Economics, Volume 1A.Amsterdam, Pays-Bas: Elsevier, 2000.
[2] Okunade AA, Murthy VNR. Technologie comme un facteur important des coûts des soins de santé: une analyse de cointégration de la conjecture Newhouse J Health Econ. 2002; 21:147-159.

among available studies, is that technology itself and its possible implications on health expenditures are insufficiently understood. Other reasons center on the often limited data available to explore this relationship and the complexities of measuring such associations, which we discuss further below.

The available evidence that does exist suggests that, in general, new medical technology is an important determinant in rising health care expenditures. Of the studies reviewed that attempted to quantify this relationship, mainly econometric studies, the overall impact (ie, proportion of the cost increase) ranges from approximately 25% to 75%, averaging at about 50%[3].

Okunade AA, Murthy VNR[4] find that the available evidence that does exist suggests that, in general, new medical technology is an important determinant in rising health care expenditures. Of the studies reviewed that attempted to quantify this relationship, mainly econometric studies, the overall impact (ie, proportion of the cost increase) ranges from approximately 25% to 75%, averaging at about 50%.

The results of our review suggest that medical technology does have a significant role in health care expenditures, albeit a dynamic and complex one. However, there are limitations to the methodological approaches used in the available published literature, which introduce challenges to arriving at a clear assessment of such dynamics. For example, in terms of quantifying this link, the residual approach can yield a reasonable indirect approximation of how medical technology relates to long-term growth in total health expenditure, but it can be sensitive to assumptions regarding the effects of other related factors (eg, personal income, health insurance coverage, technology development) and the dynamics between them. This frequently leads to an overestimation of the effect of technology on spending. Another common method, ie, the proxy approach, is only as good as the proxy indicator used to assimilate the impact of technology on spending. The use of time as a proxy measure for technological change, for example, not only captures such changes, but may also encapsulate variations in policy, patient experiences, preference, and expenditures. (Busse R[5] ; Caro J, Ward A, Moller J[6])

Another method, ie, the case study approach, is useful to explain the impact of certain medical technologies on health care costs, but there are problems of sampling and it is difficult to generalize to an aggregate or national level. Consequently, most analysts using this approach have focused on the most significant conditions (eg, prevalent, contributing to high levels of mortality or disability), such as heart disease. These technical issues also characterize cost-effectiveness and cost impact analyses (Hay JW[7])

Therefore, while examining the role of medical technology in rising health expenditures is indeed an important area of inquiry, it is largely an incomplete exercise, due to some of the noted methodological issues, and also because most new technological innovations are cost-increasing. Even if a given technology increases costs, it may increase benefits by an even greater amount. In addition, the same technology, applied in different settings, or in different groups of patients,

[3] entkover JD, Stewert EJ, Ignaszewski A, Lepage S, Liu P, Cooper J. Les nouvelles technologies et les économies potentielles de coûts liés à la morbidité et à la réduction de la mortalité de la classe III / IV patients atteints d'insuffisance cardiaque au Canada. Int J Cardiol. 2003; 88: 33 -41.

[4] Okunade AA, Murthy VNR. Technology as a major driver of health care costs: a cointegration analysis of the Newhouse conjecture. J Health Econ. 2002;21:147–159

[5] Busse R. Expenditure on health care in the EU: making projections for the future based on the past. Eur J Health Econ. 2001;2:158–161.

[6] Caro J, Ward A, Moller J. Modelling the health benefits and economic implications of implanting dual-chamber vs single-chamber ventricular pacemakers in the UK. Europace.2006;8:449–455.

[7] Hay JW. Hospital cost drivers: an evaluation of 1998–2001 state-level data. Am J Manag Care.2003;9:SP13–SP24.

could be cost-effective in some instances and not in others. Consequently, alongside simply examining costs, it is perhaps more productive to assess whether the additional benefits resulting from the use of the technology justify any increase in costs and under which circumstances technologies deliver greater value in health care. That is, are the resulting spending levels reflected in more effective, cost-effective, and higher quality health care?

Broadly speaking, the term "medical technology" can be used to refer to the procedures, equipment, and processes by which medical care is delivered. Examples of changes in technology would include new medical and surgical procedures (e.g., angioplasty, joint replacements), drugs (e.g., biologic agents), medical devices (e.g., CT scanners, implantable defibrillators), and new support systems (e.g., electronic medical records and transmission of information, telemedicine).[2] There is very little in the field of medicine that does not use some type of medical technology and that has not been affected by new technology.

Heart disease and its consequence, heart attack, is the leading cause of death in the U.S. and a good example of how new technology has changed the treatment and prevention of a disease over time. In the 1970s, cardiac care units were introduced, lidocaine was used to manage irregular heartbeat, beta-blockers were used to lower blood pressure in the first 3 hours after a heart attack, "clot buster" drugs began to be widely used, and coronary artery bypass surgery became more prevalent. In the 1980s, blood-thinning agents were used after a heart attack to prevent reoccurrences, beta-blocker therapy evolved from short-term therapy immediately after a heart attack to maintenance therapy, and angioplasty (minimally invasive surgery) was used after heart attack patients were stable.

In the 1990s, more effective drugs were introduced to inhibit clot formation, angioplasty was used for treatment and revascularization along with stents to keep blood vessels open, cardiac rehabilitation programs were implemented sooner, and implantable cardiac defibrillators were used in certain patients with irregular heartbeats. In the 2000s, better tests became available to diagnose heart attack, drug-eluting stents were used, and new drug strategies were developed (aspirin, ACE inhibitors, beta-blockers, statins) for long-term management of heart attack and potential heart attack patients. From 1980-2000, the overall mortality rate from heart attack fell by almost half, from 345.2 to 186.0 per 100,000 persons

3. DATA AND METHODOLOGY

The literature, discussed in Section 2, that has modelled the the impacts of progress technology on health expenditure. The most commonly used model specification has roots in the early work of Newhouse (1977), who used a bivariate model, treating health expenditure as endogenous and medical technology as exogenous. Thus, this latter is measured by the three following variables:

- Number of bed **(nberbed)**
- Radiologic technology (**radio)**
- Mammography(**mamm**)

$hce_{it} = \alpha_i + \beta_i$ medical $technology_{it} + \varepsilon_{it}$

$hce_{it} = \alpha_i + \beta_{1i}$ **nberbed** $_{it} + \beta_{2i}$ **radio** $_{it} + \beta_{3i}$ **mamm** $_{it} + \varepsilon_{it}$

We expect an increase in this three factors of medical technology (nberbed, radio, mamm) and through more

emissions to positively impact health expenditures. As countries grow they have more to spend on health care is well known, and empirical studies support this relationship. The empirical analysis is based on 14 developed countries_ France, Allemagne, Italie, Japon, Mexique, Noverge, Espagne, Suisse, Royaume-Uni, Etat-Unis, Turquie, Austria, Germany and Prologne.

This sample of countries is dictated by data availability. Time series data are annual and for the period 1980–2012. The per capita health expenditures is measured in US dollars at 1995 prices based on PPP.

4. RESULTS AND DISCUSSIONS

4.1 Descriptive Analysis

It is fairly simple to produce these types of information from the data sets available. Remember that the descriptive analysis can often be presented more accurately for the continuous variables than for categorical variables because of lost information from collapsing it into categories. The descriptive statistics chosen include: Minimum, Maximum, Mean, and Standard Deviation.

Table 1: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
hce	372	1171.752	702.6735	255.6929	2487.594
nberbed	372	271396.6	37755.01	222418	334796
radio	372	348.5995	22.78597	308	375
mamm	372	1814.132	899.3995	310	2825

Let's assume that we want to look at the relationship between the four variables. So the correlation is one of the most common and most useful statistics.

Table 2: Correlation Matrix

	hce	nberbed	Radio	mamm
hce	1.0000	0.9438	0.8539	0.8286
nberbed	0.9438	1.0000	-0.9524	-0.9524
radio	0.8539	-0.9524	1.0000	0.9694
mamm	0.8286	-0.9524	0.9694	1.0000

The correlation matrix exhibited in table 2 underlines that four variables hce, nberbed, radio and mamm are firmly and correlated. There has been much interest in investigating correlation between health care expenditure and medical technology. Although hce is ordinarily hypothesized to be a function of the factors of medical technology, there are some reasons which this could be a bilateral relationship between hce, nberbed, radio and mamm.

Table 3: Estimates for Simple Linear Regression of Medical Technology on Hce

Hce	Coef.	Std. Err.	t-Statistic	P>|t|
Nberbed	0.9299105	.000769	-38.90	0.000
Radio	0.8293241	1.582576	4.61	0.000
Mamm	0.7276259	.0426707	-17.05	0.000
Cons	8066.957	615.492	13.11	0.000

The regression is estimated as follows:

$$hce = 8066.957 + 0.92\ Nberbed + 0.82\ Radio + 0.72\ Mamm + \varepsilon$$

Table 3 confirms the positive and significant influence of three factors of medical technology on hce (because P-value=0<0.05). According to result of these estimations, the increase of number bed in one unit leads to an increase of hce in about 92%.

Also, the increase of radio technology in one unit leads to an increase of hce in about 82%. Moreover, also, the increase of mammography in one unit leads to an increase of hce in about 72%.

Coefficients are highly significant with expected signs in most cases. In particular, medical technology has a positive effect on health care expenditure and the coefficient on the lagged endogenous is over 0.8. This relationship is stronger when the observed time span increases.

4.2 Hausman Test

To decide between fixed or random effects we can run a Hausman test where the null hypothesis is that the preferred model is random effects. The alternative is the fixed effects. Run a fixed effects model and save the estimates, then run a random model and save the estimates, then perform the test.

The fixed-effects model controls for all time-invariant differences between the countries, so the estimated coefficients of the fixed-effects models cannot be biased because of omitted time-invariant characteristics.

Table 4: Estimates for Fixed Effects

Hce	Coef.	Std. Err.	T-Statistic	P>|T|
nberbed	0.9599179	.0007808	-38.31	0.000
Radio	0.928918	1.61171	4.52	0.000
Mamm	0.8276255	.0426707	-16.78	0.000
Cons	8070.722	626.6246	12.88	0.000

Table 4 confirms the positive and significant influence of factors of medical technology (nberbed, radio, mamm) on health care expenditures (because P-value=0<0.05). According to result of these estimations:

- β1=0.9599179 which means that the increase of per number bed in one unit leads to an increase of hce in about 95.99%.
- β2=0.928918 which means that the increase of radio technology in one unit leads to an increase of hce in about 92.89%.
- β3=8070.722 which means that the increase of mammography in one unit leads to an increase of hce in about 82.76%.

CONCLUSIONS

Major technological advances in medical science have allowed health care providers to diagnose and treat illnesses in ways that were previously impossible. In general, such developments have tended to increase health care spending, which has been seen as an important policy concern, especially considering ever-limited health care budgets. However, examining the link between medical technology and health expenditures is only one part of the picture. In order to understand better the dynamics between innovation and spending, it is important to assess whether and under what circumstances do investments in medical technology result in better value in health care.

As Cutler and McClellan[8] 25 assert, "it does not necessarily follow that technology change is therefore bad … costs of technology need to be compared with benefits before welfare statements can be made". Given the current global economic situation, it is ever more important to ensure that we are attaining good value for money from the technologies developed.

To be sure, the question of whether medical technologies result in added value to the health care system is, of course, also difficult to answer. It depends on our ability to determine the value of output from the health services sector, and placing a value on longer or better quality of life is difficult to appraise. As a starting point, much more comparative research is needed to understand better which technologies work best and are most cost-effective, and under what circumstances.

Indeed, as previously discussed, some of the cost-increasing effects of technology arise from inappropriate use, where new treatments are offered to patients for whom there is none to little clinical benefit. Current efforts to support comparative effectiveness research in the US and health technology assessment in Europe and elsewhere may help to foster these aims.

However, it is important to note that medical technologies introduce unique technical challenges to health technology assessment or comparative effectiveness research, so assessment methods should adequately account for or be developed to accommodate such aspects. Moreover, in addressing questions of value, such research should strive, where possible, to assess a broad range of potential benefits beyond clinical or therapeutic benefit, including value for money, higher quality of care, improved quality of life, greater efficiency in care delivery (eg, reduced length of stay, shifting care from inpatient to outpatient settings), and enhanced ability to work or return to work.

If the evidence generated from such research is to have an impact on health care spending, it should be used to inform policy and practice. As such, comparative effectiveness research and health technology assessment should be used to help reward and support the introduction of technologies into practice that confer therapeutic benefit and reasonable value for money, either through use in coverage and payment policies, insurance benefit design, or practice guidelines.

Conversely, use of low-value interventions should be disincentivized through disinvestment or limitation on their use. Such strategies should be coupled with a greater emphasis on evidence-based delivery of care (eg, aligning appropriate financial incentives for providers and consumers), which might further reduce expenditure levels if such incentives support greater use of cost-effective services. However, in parallel, it will be important to monitor carefully the impact of such policy levers in order to ascertain the best way to control costs without denying the benefits of new innovation.

In addition, such measures need to be coupled with other policies and practices to address some of the other drivers of health spending, including initiatives to support healthy aging and improve coordination of care for the chronically ill. Finally, given our ever-limited health care resources, it would be prudent to debate the opportunity costs of funding new (and increasingly expensive) technologies. Even in cases where medical technologies are cost-effective, available resources may be better allocated to other equally or more cost-effective investments outside of the health care sector, such as the environment or education.

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