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Abstract

The containment of health care expenditure is one of the major challenges facing public policymakers in the developed countries. This paper provides evidence of significant differences in the cross-country level of efficiency of health care expenditure, meaning that potential cost savings for the countries considered least efficient might be very high. Further, a significant relationship is found between the various health care policies and institutions in the OECD countries and the efficiency levels of health care systems. The findings are, however, highly sensitive to the efficiency-estimation methodology used.

Keywords: Health care expenditure, efficiency.

JEL Classification: I12, I18, H51.

Resumen

La contención del gasto sanitario es uno de los retos más importante a los que se enfrentan las políticas públicas de los países desarrollados. En este trabajo se muestra evidencia de que existen diferencias significativas en el nivel de eficiencia del gasto sanitario entre países, de forma que los ahorros potenciales de coste para los considerados menos eficientes podrían ser elevados. Además, se encuentra una relación significativa entre distintas políticas e instituciones sanitarias en los países de la OCDE y los niveles de eficiencia de los sistemas sanitarios. Los resultados son, sin embargo, sensibles a la metodología de estimación de la eficiencia utilizada.

Palabras claves: Gasto sanitario, eficiencia.

Códigos JEL: I12, I18, H51.

1 Introduction

In recent decades health-care expenditure has grown very significantly in most developed countries, from 6% of GDP in 1970 to around 12% of GDP in 2007. Many factors are behind this trend, including a demand for health care services that increases with income and supply factors, related, for example, with the impact of technological change (IMF, 2010). This trend might hold in the future or even become more pronounced, due among other reasons to the phenomenon of population ageing (see Oliveira et al., 2006). The control of health care expenditure or its financing are therefore priority aspects of the design of public policies. This priority has increased in recent years given the need to ensure the success of the fiscal consolidation processes in which most economies are immersed, following the surge in budget deficits and public debt during the economic crisis.

Among the various economic policy options here, those geared to attaining higher levels of efficiency in the provision of health services are particularly appropriate, and less politically controversial. This is because, by definition, they would contribute to containing public spending (using fewer resources) while maintaining the same output and quality of the services.

The alternatives that may give rise to improved efficiency in the provision of healthcare services are potentially very diverse. Among them, the existing literature emphasizes the role played by health policies and institutions, including aspects such as the degree of public coverage, its financing, the public or private nature of the provision of health-care services or the administrative or territorial organisation of the system.

This paper analyses the role of health care policies and institutions. Specifically, use is made of the database constructed by Paris et al. (2010), which encapsulates in a series of indicators information on the health-care policies and institutions in 29 OECD countries. On the basis of these indicators and of the health-care efficiency indices estimated by the OECD (2010), the impact of health care policies on efficiency is empirically estimated.

The rest of the paper is structured as follows. Section 2 analyses the determinants of the growth of health care expenditure in recent years along with the estimates available as to its future trend. Section 3 presents health-care efficiency indices for 29 OECD countries and analyses the potential savings that might be had through gains in efficiency. Given that there is high dispersion in the existing literature regarding the measures of the efficiency of health care expenditure, the findings are presented considering two alternative efficiency indices. Section 4 briefly summarises the existing literature on the effectiveness of different policies on health-care efficiency; it sets out the 20 indicators that summarise the characteristics of national health care systems and the empirical evidence on the relationship between public policies and the efficiency of health care systems. Section 5 draws some conclusions.

2 Determinants of health care expenditure and estimates of its long-term trend

The economic literature highlights a series of determinants of health care expenditure. First, there are some factors linked to demographics. Specifically, there is evidence that health care expenditure increases with age (see chart 1), meaning that a change in the age structure of the population will also give rise to a change in overall health care expenditure. In particular, a rise in the dependency ratio brought on by an increase in life expectancy will lead pressure to be exerted on health spending, even if it is assumed that spending per person for the different age cohorts holds constant.

Nonetheless, per capita health care expenditure may also be affected by demographics. On one hand, an increase in life expectancy may translate into improved quality of life for the elderly, entailing lower per capita spending for these cohorts. On the other, the empirical evidence available shows that the highest health care costs over the life of an individual are concentrated in the final years of life (see, for example, Seshamani and Gray, 2004). Given that an increasing life expectancy means that the mortality rates for each age group diminished, that would give rise to a decline in the average costs for the related age group (Zwiefel et al., 1999).

As regards non-demographic factors, the literature stresses that technology and other supply —and demand— side factors would also have played a most significant role when explaining increases in health care expenditure in the past (Getzen, 2000). Specifically, it is argued that technological progress increases the variety and quality of healthcare products and treatment, which occasionally prove more costly. Moreover, even in those cases in which technological progress generates cost reductions, the associated decline in relative prices might prompt increases in expenditure given the high price elasticity of the demand for health care services[1].

Precisely to analyse the factors behind the growth of public health care expenditure in per capita terms, such expenditure can be decomposed into three groups of factors: demographic, those arising from the increase in per capita income and, lastly, a residual factor that would encompass supply-side factors such as changes in the cost and price of treatments (see Oliveira et al., 2006). This decomposition can be expressed as follows:

$$\Delta \log\left(\frac{GS}{Pob}\right) = \Delta \log(fdem) + \Delta \log\left(\frac{PIB}{Pob}\right) + \Delta \log(nodem)$$

where the variable *fdem* represents the contribution of the demographic factor. The second component seeks to reflect the impact of growth in real per capita income. The variable *nodem* is a residual that would reflect supply-side factors and other non-demographic factors.

Chart 2 shows the growth of per capita health care expenditure in various OECD countries between June 1980 and 2008, and the contribution of the foregoing factors to this

1. For example, Dormont and Huber (2005) find that the decline in the price of certain surgical procedures in France has meant that their frequency increases significantly.

growth, under the assumption that both the demographic factor and that relating to per capita income have unit elasticity. This decomposition uses as a demographic factor the difference between per capita health care expenditure with the 1980 population age structure and per capita health expenditure under the 2008 age structure. Specifically, we calculate per capita health care expenditure as a weighted average of the per capita expenditure for each age group using as weights the population proportions in each age group in 1980 and in 2008. The difference between both per capita expenditures proxies the change in health care spending derived from population ageing. According to this information, a significant portion of the approximately 6% annual growth in per capita health care expenditure in the OECD countries during the period was due to the increase in per capita income (with the contribution of 52%) and in the residual factors (44%), whereas the contribution of the demographic factor was limited[2].Spain shows a similar decomposition in the growth of health care expenditure to the OECD average[3].

These decompositions can also be used to make long-term projections of per capita health care spending. This is particularly significant in a context such as the present in which, according to the estimates available, progressive population ageing is expected in the developed countries. That will raise dependency ratios considerably which, based on the foregoing arguments, would tend to increase health care expenditure. Conversely, improved quality of life among the elderly or the reduction in mortality rates for each age group associated with the increase in life expectancy might prompt a fall in the average health care costs for the various age groups. Lastly, long-term estimates should take into account the role of non-demographic factors which, as indicated, appear to have had more of a bearing on the growth of health care spending observed in the past than purely demographic factors.

Such long-run estimates are made, for instance, in the European Commission's Economic Policy Committee (EPC) reports (see EC, 2009)[4].On the latest EC estimates, health care spending as a percentage of GDP would increase in the European Union by between 0.7 and 2.4 pp between 2007 and 2060 (between 1 and 2.6 pp of GDP in Spain). In its central scenario, the increase in spending as a percentage of GDP is 1.5 pp in the EU in 1.6 pp in Spain (see table 1), under the assumption that the profile of health spending by age group estimated at the initial moment of the projection holds, that an income elasticity of health care spending equal to 1.1 in 2007 converging in a linear fashion to 1 in 2060 is assumed, and that an improvement in the health status of the population is incorporated so that sickness rates are reduced to half of what mortality rates are, which is equivalent to shifting the curve representing per capita health care spending by age bracket in Chart 1 rightwards[5].

The OECD's health care spending projections (see Oliveira et al, 2006) broadly show higher increases in spending on this item than those in the EPC report. Specifically, an increase in health care spending of between 2.0 and 3.9 pp of GDP between 2005 and 2050

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2. Very similar results are obtained when calculating the same decomposition but on the basis of elasticities of the demographic factors and of per capita income estimated drawing on the overall data available for all countries. Specifically, according to these estimates the demographic factor shows and elasticity of 1.8 relative to per capita expenditure, while the elasticity of per capita income is 1.2. In this case, the contributions of these two factors to health care expenditure growth increase slightly but the previous conclusions hold. In addition, the same results are also obtained using the change in life expectancy (instead of the change in the population age structure) as a proxy of the demographic factor.

3. These results are similar to those of the previous literature (for a summary of this literature, see, for example, Casado et al. 2009).

4. See Casado et al. (2009) for a review of other papers with particular reference to Spain.

5. Moreover, the estimates are based on Eurostat 2008 projections (Europop 2008), and on macroeconomic assumptions regarding changes in the rates of participation, unemployment and productivity common to all the countries (see EC, 2009).

on average in the OECD (2.3 and 4.1 pp of GDP in Spain) is estimated, depending on the scenario considered[6]. In relation to demographic factors, a distinction is made in the simulations between average per capita spending by age group of surviving individuals and per capita spending associated with age group deaths for individuals who pass away, which in both cases hold constant over the projection horizon. In any event, demographic factors generate a small effect on health care spending relative to GDP, of around 0.6% on average (0.9% in Spain). As to non-demographic factors, the OECD considers two scenarios. First, the pressure-on-costs scenario (pessimistic), in which it is assumed that expenditure growth per annum exceeds the related growth in income by 1%, which is equivalent to observations in the past two decades and which would give rise to an additional increase in health care spending of around 3 pp of GDP, on average. And second, the cost-containment scenario (optimistic), in which the adoption of measures to eliminate this extra spending over the course of the projection period is assumed, which would restrict the additional increase in spending by approximately half.

Finally, the IMF (2010) estimates the average increase in health care spending projected to 2050 at around 3 pp of GDP, with an increase of 5 pp in the case of the United States and 2 pp in Europe (1.6 pp in Spain). In this case, the projections are based on the assumption that the health care spending profile by age group estimated at the outset of the projection will hold, and an improvement in the health status of the population is incorporated such that sickness rates fall at half the pace death rates do, as in the case of the European Commission's projections. Moreover, included for each country is the effect estimated in the past of what is known as "excess cost growth", which is defined as the excess growth of per capita health care spending relative to per capita GDP growth once the demographic effect is controlled for. As a result, around one-third of the estimated increase in health care spending will be attributable to population ageing and the rest to non-demographic factors derived from income growth, technological progress and health care policies and regulations.

Table 1 offers a summary of the projections made by different agencies. Overall, all the papers may be said to augur a significant increase in the future. Further, although future increases in health care spending due to population ageing will be significant and unavoidable, the impact of supply-side and non-demographic factors might be even greater.

6. In this case the population projections are based on national sources (National statistics institutes), while the assumptions about participation rates were taken from prior OECD papers which basically reflected the impact of cohort effects (Burniaux et al., 2003). Finally, labour productivity growth is assumed to converge in a linear fashion from its initial observed rate in all the countries (see Oliveira et al., 2006).

3 Efficiency of health care systems and potential expenditure savings

Given past developments and —in keeping with the content of the previous section— the foreseeable future course of health care expenditure, it is well worth analysing which factors might allow its growth trend to be broken. The first approach to this question can be made by comparing the degree of efficiency in the cross-country production of health-care services, which illustrates the headroom for reducing costs without this affecting health care output.

Measurement of productive efficiency is based on the relationship between output produced and inputs required for production. This measurement is not free from difficulties. In the particular case of health care efficiency, despite even the definition of output is not exempt from controversies[7], the literature on the efficiency of national health systems appears to have reached a consensus on life expectancy[8] as the main output in the health care production function.

On the other hand, two alternative approaches have been considered in the literature for estimating efficiency indices: data envelopment analysis (DEA) and stochastic frontier analysis (SFA). DEA is deterministic and non-parametric, i.e. as it is non-parametric it need not assume any functional form for the production frontier; however, as it is deterministic, any deviation between the actual production and the frontier is classified as inefficiency without any possibility of randomness. Conversely, SFA is parametric and stochastic. That is to say, using SFA it is necessary to assume a specific functional form for the production frontier, but at the same time we can include a source of randomness in production. The literature that compares both approaches is very extensive but relatively inconclusive regarding the preferred alternative [see, for example, Gong and Sickles (1992), Bjurek et al. (1990), Hjalmarsson et al. (1996)]. Moreover, efficiency estimates crucially depend on the methodology used. For instance, using data compiled by the World Health Organization (WHO, 2000), Hollingsworth and Wildman (2003) estimate DEA indices of health care efficiency for 191 countries while Greene (2004) estimates SFA indices, and the results are significantly different. Also in the sphere of health care efficiency, Chirikos and Sear (2000) and Hollingsworth and Wildman (2003) confirmed that the efficiency rankings resulting from both approaches applied to the same data usually differ considerably, hence the importance of their comparison and the relevance of presenting the results in accordance with both alternatives.

All in all, in this paper we choose to carry out all the exercises considering both approaches separately. More concretely, Section 3.1 presents the health care efficiency indices obtained through non-parametric techniques (DEA) in OECD (2010). In Section 3.2 we estimate and discuss efficiency indices based on the stochastic frontier approach, and, finally, in Section 3.3 we analyze the potential monetary savings resulting from efficiency gains (measured according to both DEA and SFA approaches).

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7. Moreover, the efficiency measures used in the literature may refer to different levels of the health care system. Generally, a distinction is made between those papers that measure gains in health status for each type of illness across the various sub-sectors of the health care system (hospitals, chemist's, etc.) or the health care system as a whole (see Häkkinen and Joumard, 2007, for a discussion of the advantages and drawbacks of these three approaches).
8. Generally, disability-adjusted life expectancy (DALE) is used. See WHO (2000).

3.1 Efficiency measures based on non-parametric techniques (DEA).

As earlier mentioned, DEA relates output (measured by life expectancy) to inputs (health care and the socioeconomic characteristics of the population, essentially). More specifically, DEA analysis conducted by the OECD (2010) for a group of 29 countries in 2007 is based on defining a frontier of production of life expectancy (a measure of the health system's output) using a series of resources such as per capita health care expenditure, the level of per capita income and the level of educational attainment of the population, and the lifestyle characteristics of each country (i.e. the inputs the national health system disposes of to "produce" life expectancy). Taking the production frontier estimated through non-parametric techniques, the country will be efficient if it stands on this frontier, i.e. if it cannot produce more output without using more inputs[9]. Accordingly, the efficient country will have a unit efficiency index and the other countries will have efficiency levels that are always below unity and calculated on the basis of their distance from the production frontier on which the most efficient country stands (Farrell, 1957).

The upper panel of Chart 3 shows the DEA efficiency indices estimated by the OECD (2010) for 29 countries. According to these estimates, Australia is the most efficient country of the sample and therefore obtained a unit efficiency index. In Spain's case, high levels of relative efficiency in health care output are observed, although there is some room for improvement when compared with the most efficient countries. Specifically, the efficient frontier stands at 1.5% above that of Spain, the interpretation of which may be that if Spain used its resources optimally in the health care output process, it might obtain greater life expectancy given the resources it currently consumes. Alternatively, if Spain were to use its health care resources more efficiently, it could "produce" the same life expectancy with fewer resources, specifically with lower health care expenditure.

3.2 Efficiency measures based on stochastic frontier analysis (SFA)

As previously indicated, data envelopment analysis is based on the non-parametric estimation of the production frontier using linear programming methods. With a given level of inputs, any deviation between actual output and the frontier is considered inefficiency. Alternatively, we now present the basics of the SFA approach and estimate efficiency indicators for national health care systems based on this stochastic technique. Under this methodology the output frontier is estimated assuming a specific functional form and distinguishing between two components in the error term, one due to inefficiency (always zero or positive) and another due to randomness. The inefficiency term captures unobservable characteristics which systematically make production to lie below its potential level (this term is zero for the efficient unit which lies in the frontier).

Specifically, we consider the following parametric production function:

$$Y_{it} = \alpha + X_{it}^{'}\beta + v_{it} - u_i$$

where Y_{it} represents life expectancy as an output of the health care system in country i in year t. This output arises from inputs included in the vector X_{it} and which include socio-economic factors such as the level of educational attainment, per capita income and pollution, lifestyle characteristics such as fruit and alcohol consumption and, lastly,

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9. The efficient country will be that which has the higher life expectancy given certain inputs. This may arise because life expectancy is higher for the same given level of expenditure, or because for the same life expectancy, there is a lower level of expenditure or of other inputs.

each country's health care expenditure[10]. Namely, the inputs considered in our estimates are the same as those used by the OECD (2010) in the estimation of the DEA index set out in the previous section[11]. Finally, v_{it} represents sources of random change in the model and $u_i \geq 0$ is a non-negative random variable that represents the specific inefficiency of each country.

For estimation purposes, the model can be rewritten as:

$$Y_{it} = \alpha_i + X'_{it}\beta + v_{it}$$

where now $\alpha_i = \alpha - u_i$. Schmidt and Sickles (1984) propose estimating this equation using a fixed-effects estimator due to the possible correlation between the inefficiency and the inputs. In this framework, the country with the biggest estimated fix defects is considered the most efficient country, and that which therefore defines the production frontier ($\tilde{\alpha} = \max(\hat{\alpha}_i)$). To calculate the inefficiencies of each country relative to the benchmark, ensuring in turn that they are all positive, we estimate:

$$\tilde{u}_i = \tilde{\alpha} - \hat{\alpha}_i$$

We can thus define the stochastic efficiency index as follows[12]:

$$TE_i = \frac{E(Y_{it} \mid \tilde{u}_i, X_{it})}{E(Y_{it} \mid \tilde{u}_i = 0, X_{it})}$$

Using a panel of 29 OECD countries with annual observations between 1997 and 2009, we estimate the SFA health care efficiency index presented in the lower panel of Chart 3. As was to be expected, the country ranking for health care efficiency differs depending on whether we use the SFA or DEA approach; specifically, the correlation between both indices is 0.4 and significant at the 5% level. According to the SFA index, the most efficient country in health care output is Japan (which was in fourth place according to the DEA index) while Spain is seventh (according to the DEA index it was in twelfth position).

3.3 Potential expenditure savings from efficiency improvements

Given the observed differences in health system management efficiency levels across countries, one can argue that if a given country combines its resources efficiently, it could "produce" the same output (i.e. the same life expectancy) with fewer resources, in particular, with lower health expenditures.

With the aim of quantifying this potential saving in monetary terms, we consider the following equation relating life expectancy to expenditure and health care efficiency:

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10. Note that dummy variables are also included for each year, reducing the potential correlation between each country's error terms. This is a vital prerequisite for the consistency of the estimates.

11. In fact, the OECD (2010) also performs very similar panel regressions to that considered in this paper. However, it does not calculate SFA efficiency indices in the proper sense of the term; it rather uses estimated residuals as proxies of efficiency.

12. Readers interested in more details can consult Coelli et al. (2005), which is an excellent reference for the different methods for estimating efficiency indices and which places particular emphasis on the stochastic frontier approach (SFA) and data envelopment analysis (DEA).

$$EV_i = \beta_1 EF_i + \beta_2 GS_i + X_i^{'} \gamma + U_i$$

where EV_i is the life expectancy of country *i* in 2007, EF_i is that country's level of health care efficiency, GS_i per capita health care spending and X_i is a vector with other socio-economic characteristics that may affect a country's life expectancy and which are habitually used in the literature, such as per capita income, the level of educational attainment and tobacco and alcohol consumption. The equation in question is estimated using data for 29 OECD countries.

The estimated coefficients for the level of efficiency and per capita health care expenditure are both positive and significant (t-ratios of 5.89 and 4.51, respectively). That is to say, both a higher level of efficiency and a higher level of health care expenditure would increase life expectancy, as might be expected. However, the estimated elasticity for the level of efficiency is 0.71 against the elasticity of 0.06 estimated for per capita health care expenditure. This means that an increase of 1% in health care efficiency would translate into an improvement in life expectancy of 0.71% compared with an improvement of 0.06% that would result from increasing health care expenditure by 1%[13].

Subsequently, the following counterfactual exercise is performed: given the estimated parameters that relate life expectancy to efficiency and health care expenditure ($\hat{\beta}_1$ and $\hat{\beta}_2$), the per capita health care expenditure (GS_i^*) that would be compatible with the *ith* country maintaining its life expectancy constant (EV_i) is calculated, but situating the level of efficiency at its maximum (EF^{MAX}), this latter variable corresponding to the most efficient. That is to say:

$$GS_i^* = GS_i + \frac{\hat{\beta}_1}{\hat{\beta}_2}\left(EF_i - EF^{MAX}\right)$$

Once the health care expenditure needed to hold life expectancy constant —but assuming the maximum level of efficiency of the sample— has been calculated, we can obtain the potential saving in country *i*'s health care expenditure (AP_i^*) as a percentage of GDP if the maximum level of efficiency is attained in the following way:

$$AP_i^* = \frac{GS_i - GS_i^*}{PIBpc_i}$$

where $PIBpc_i$ is the per capita GDP for country *i*.

The upper panel of Chart 4 shows the potential savings for the countries of the sample obtained on the basis of this methodology considering the DEA efficiency index. By definition, Australia, the most efficient country in the sample, would have no intentional saving since it is already situated on the frontier. The estimated margin of saving on health

13. For example, life expectancy in Spain in 2007 was 81.1 years of age, meaning that if the efficiency of the Spanish health care system improved by 1%, life expectancy could, maintaining health care expenditure constant, rise to 81.7 years of age.

care expenditure for the OECD countries on average is 2.6% of GDP and 1.6% in Spain's case, which, given the forward-looking health care expenditure projections described in the previous section, may be considered a significant potential saving.

In the lower panel of Chart 4, we present the potential savings emerging from the approach when the SFA efficiency index is considered. In this case, the average potential saving for OECD countries is 2.5% of GDP and 1.2% for the Spanish case. Therefore, the magnitude of the potential savings in terms of health expenditure reductions (due to efficiency improvements) is high and very similar according to both efficiency indices.

4 The role of policies and institutions in improving the efficiency of health care systems

In view of the potential savings that may be inferred from an improvement in the efficiency of health care systems, the next step is to analyse how to achieve this improved efficiency, and in particular what role health care policies and institutions can play. To this end, in Section 4.1 we present an overview of the main institutional factors considered in the literature as determinants of health care efficiency. Later, in Section 4.2 we estimate the impact of these potential determinants on health care efficiency. In particular we rely on a database compiled by Paris et al. (2010) which covers different characteristics of health care policies and institutions across 29 OECD countries. Lastly, in Section 4.3 we check the robustness of our findings considering model averaging techniques.

4.1 Institutions and health care efficiency

Differences in health care systems in developed countries are quite substantial and cover aspects such as the degree of coverage, form of financing, public or private nature of the provision of services, or the administrative and territorial organization of the system. Some of these aspects have been identified in the literature as potential determinants of efficiency. In fact, many of the reforms implemented in recent years in health care systems in order to reduce the pressure on health related expenditures have been based on modifying some of these issues (IMF, 2010).

With respect to the demand for health services, reforms have tended to increase the participation of patients in the coverage of health care costs, with the primary objective of avoiding excessive consumption of certain services. In this respect, the evidence available is abundant[14]. From a theoretical standpoint, price signals on users (or co-payment) understood as a system of user co-participation in the cost of the service introduces a price mechanism that may help allow the demand for health care services to be rationalised. As regards the empirical evidence, most studies show that use diminishes when user co-participation increases in the cost of the health care service. Specifically, the Rand Corporation conducted an experimental study on this in the United States. In 1975, 2,756 families from different US regions were randomly assigned to 5 medical insurance plans with different levels of price signals on users. In subsequent years (to 1982) the state of health of and use of the health care system by all these families was monitored in order to analyse the differences arising as a result of the different degree of co-payment[15]. The main conclusions of the study were: (i) a higher level of co-payment significantly reduces health care expenditure; (ii) this reduction is similar for all health care services (appointments with consultants, drugs…); (iii) no negative effects on the health of the average citizen are observed; (iv) for poorer or initially unhealthier citizens negative effects are observed (see Newhouse et al. 1993 for more details).

In the case of Spain, co-payment is only currently present in the prescription of drugs. Specifically, National Health System (NHS) workers pay 40% of the price of drugs, while retirees are fully exempt[16]. In this respect, Tur-Prats et al. (2011) attribute the increase of 40% in pharmaceuticals consumption to the exemption from co-payment of retirees

14. See Puig Junoy (2001) for a review of this literature.

15. The fact that the allocation of the families to different medical insurance plans with different levels of co-payments was totally random ensures that the differences in the use of the health-care system and in their state of health may be attributed to co-payment.

16. Within the group of workers, co-payment is only 10% for drugs treating chronic illnesses.

precisely at the time of their retirement (when the shift in the level of co-payment is from 40% to 0%). Further, they estimate price elasticities in pharmaceutical consumption of approximately -0.2, in line with the estimated elasticities for the United States in the Rand Corporation experiment[17].

Some countries have also chosen to introduce price control devices both for the inputs and the output, ranging from wage controls of health professionals to reference prices of pharmaceutical products and price controls for specific treatments. Regarding the regulation of prices billed by doctors and hospitals, from a theoretical point of view, it is often argued that greater price regulation may give rise to a substitution effect, i.e. if the prices set are very low, the treatment of patients becomes less lucrative, meaning that the number of consultations would fall. However, an income effect might also be generated, i.e. doctors attend more patients to offset the loss of income caused by low prices. Grytten et al. (2008) find that the income effect is small, whereby greater price regulation might reduce the number of unnecessary consultations. On the other hand, there also exist different mechanisms of wage determination with different potential effects on efficiency. For instance, the systems that set a fixed amount per visit or service can generate incentives for providers to fully satisfy the demand, although, again, they also have the risk of generating an induced demand from the supply side (Shafrin, 2010).

As for the regulation of drug prices, the literature shows that it is not always effective in reducing spending, especially in the medium and long term (Moreno-Torres et al., 2010; Sood et al., 2009)[18]. In general, the literature emphasizes that reference prices for drugs may be more effective if a series of conditions are met. More specifically it is vital that the excessive drug spending is due to high prices and not to excessive prescriptions, that there are substantive differences between the prices of different equivalent drugs and that the generic drugs market is sufficiently developed (López Casasnovas and Puig Junoy, 2000).

On the other hand, some reforms have been aimed at incorporating market mechanisms into the health sector, for example, the creation of internal markets, the separation of the purchase of services provision to facilitate competition among providers, the introduction for patients the possibility of choice between providers and insurers, or providing further information to users about the quality and prices of services. In general, the literature (e.g. Ennis, 2006, in the case of hospital services) indicates that a higher level of development of private coverage can generate competitive pressures that in turn generate cost reductions and quality improvements and incentives to innovate. However, it also emphasizes that the impact of competition may largely depend on how it is introduced, to which services it is applied, and, in general, what is the regulation of the entire health care

17. On the other hand, civil servants in Spain are covered by MUFACE (a purpose-designed social security scheme for civil servants) and not by the NHS which covers all other workers. The co-payment of drugs for MUFACE civil servants is 30%, while for NHS workers it is 40%. In the case of NHS retirees, the Czar, as indicated, exempt from co-payments while MUFACE retirees continue paying 30%. On the basis of the information available, Puig-Junoy (2007) shows that MUFACE employees spend 45% more per person per annum than NHS workers, and yet MUFACE retirees spend 49% less than NHS retirees, which would be indicative of the capacity of co-payment to reduce the health care bill.

18. In particular, Moreno-Torres et al. (2010) analyse the effects of 16 regulatory policies in Catalonia between 1995 and 2006, classifying the policies in five groups: (i) those aimed at reducing the margins of drug distributors and retailers; (ii) those based on lists of drugs excluded from receiving public funding; (iii) those in which the public authorities unilaterally impose a reduction on drug manufacturers' maximum selling prices; (iv) those based on reference prices, i.e. when there are several drugs with the same characteristics and end-use and a reference price is set on the basis of the cheapest drug in the group, which will be the maximum amount that the public health system may reimburse for any drug in the group; (v) regulations whose purpose is to economically generic drugs. Given these five types of policies, the results in the paper indicate that, on one hand, 12 of the 16 regulations were not effective in reducing spending on drugs; and, on the other, of the four regulations that were effective in the short term, none had significant effects in the medium/long term. Sood et al. (2009) obtain the same result using different data and methodology.

system (OECD, 2006), so that its introduction under unsuitable conditions could generate not only a very low pressure on public spending but also in an increase in total health expenditure (López Casasnovas, 2006).

Finally, other reforms have been aimed at modifying various organizational or coordination aspects of the health system by introducing greater decentralization, setting limits on budgets of personnel or medical equipment, modifying the mechanisms for defining the objectives and the assessment of their fulfilment, or reforming the gate keeping system. For instance, the target control indicator reflects how public health objectives are defined and the way in which their fulfilment is assessed. Thus, while some countries have developed target control in health policy to a high degree with bodies dedicated exclusively to this task (e.g. the National Institute for Health and Clinical Excellence [NICE] in the United Kingdom), other countries such as Greece merely have general guidelines on health care priorities. Sabik et al. (2008) find that independent bodies for the control of targets like NICE have been successful in containing health care expenditure. Regarding control over access to consultants (i.e. gate keeping), it is argued that general practitioners can play a crucial role not only in terms of properly monitoring patients but also in controlling efficiently consultants' review of patients, reducing patients' search costs and controlling the demand for more specialised health care services (Dranove and Satterthwaite, 2000). Brekke et al. (2007) find that when prices are regulated, gate keeping may reduce efficiency and social well-being because it generates and excessive specialisation in health care, meaning that the general practitioner becomes a receptionist who simply directs patients to the corresponding consultant without contributing any value to the health care chain. This hypothesis is confirmed empirically to some extent in Velasco et al. (2010) and Barros (1998), who find that larger degrees of gate keeping do not reduce health care costs.

4.2 The impact of health care institutions on efficiency across OECD countries

The cross-country comparison of health care policies and institutions is not exempt from difficulties given the existence of crucial country-specific characteristics in national health care systems. Fortunately, the OECD has made recently available a homogenised database that contains this information for 29 OECD countries. The information draws on a survey in which the health authorities of each country respond to 269 questions on their health care system[19]. Paris et al. (2010) then summarises the information in 20 health care policy indicators that take values between 0 (minimum) and 6 (maximum). These indicators include information on the influence of the market and regulations on health care users, insurers and suppliers. They further summarise the characteristics of basic health care coverage, the management of the health-care budget and the decision-making process in the provision of health care systems. Specifically, OECD (2010) draws these 20 indicators together into four main groups of issues: (1) the health care system's degree of dependency on market mechanisms; (2) intensity of regulation on the provision of health care; (3) degree of budgetary restriction on the health care system and (4) degree of decentralisation of decision-making.

Table 2 offers a brief description of each of the 20 indicators and the respective values for Spain alongside the minimum and maximum observed value in the OECD countries. According to this information, the characteristics of the Spanish health care system may broadly be said to be similar to those of the other developed countries (see Chart 5). However, certain differentiated features of the Spanish system may be highlighted: (i) Spain

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19. More detailed information on the definition of the indicators and their construction can be found in Paris et al. (2010) and OECD (2010).

has a considerably greater degree of decentralisation than the other OECD countries owing to the fact that in Spain responsibility for health care expenditure is in the hands of the regional governments; (ii) the ability of Spanish users to choose their doctor is limited compared with other OECD countries; (iii) the degree of private health care provision[20] is also limited compared with the OECD average; and (iv) in Spain there is a high degree of control over access to consultants, given the need to pass through a general practitioner, the professional who will decide whether to direct the patient to a consultant; (v) in Spain, health care personnel and materials are highly regulated, and incentives-based arrangements are relatively few[21].

In principle, given the definition of the foregoing indicators, most of the policies included in them might be expected to positively affect the efficiency of the health care system whereby, for example, greater competition in the provision of healthcare assistance might be expected to be accompanied by greater efficiency. However, for some of these indicators, the sign of the effect on the level of efficiency is not always clear a priori. Accordingly, to determine the sign and to quantify the impact on the efficiency of the various health care policies and institutions that these indicators proxy, an estimation is made of the following relationship between country levels of health care efficiency (described in the previous section) and the characteristics of the health care system defined by the 20 indicators also in each country:

$$EF_i = \theta_0 + \sum_{h=1}^{20} \theta_h IN_{ih} + V_i$$

where EF_i represents the level of efficiency (whether DEA or SFA) estimated for country *i*, IN_{ih} is the indicator of policy *k* in country *i*, and θ_h reflects the impact of policy *h* on the level of efficiency.

Panel A in Table 3 includes the results of the estimate using as a measure of efficiency that derived from the DEA methodology. Specifically, a statistically significant effect is found for 5 indicators, namely price regulation, gate keeping, control of objectives, co-payment and the development of private coverage[22]. All these positively affect efficiency, with the exception of control over access to consultants, which evidences a negative coefficient.

We repeat below the estimation of the impact of the 20 health care policy indicators compiled in OECD (2010) on efficiency, but using the SFA index instead of the DEA index as a proxy (see Panel B of Table 3). The policies that prove most important on considering the SFA index are the degree of universality (+), gate keeping (-), the degree of delegation to insurers (-) and price regulation[23]. Of these four policies, only gate keeping and price regulation also emerged as key policies for improving health care efficiency under the DEA approach shown. However, the degree of delegation to insurers and the degree of universality did not prove significant under the DEA index, which shows once again the sensitivity of the results to the

20. Measured as the percentage of hospitals and doctors outside the public health system.

21. For example, a payment system based on fixed wages to doctors is prevalent, which is less sensitive to demand compared with a payment system based on the number of patients attended.

22. In IMF (2011) a similar exercise is performed, which finds that a high degree of decentralisation, central government control over budgetary ceilings, the possibility of patients choosing their insurance in basic coverage, the possibility of insurers competing and the degree of private provision all significantly affect efficiency.

23. The sign with which each policy affects the level of SFA efficiency is in brackets.

efficiency measure used[24]. Regarding the magnitude of the coefficients, we must bear in mind that the dependent variable is different across panels so that estimates' magnitudes are not directly comparable.

Given the estimated elasticities of each regulation indicator (see last column of Table 3) and also taking into account Spain's relative position in respect of the OECD countries in each of these policies (see columns 2 and 3 of Table 3), one can estimate the potential gain entailed, in terms of efficiency, were Spain to situate its health care policy at the maximum OECD level. For instance, according to DEA estimates there would be room for efficiency gains based on increases in the level of price signals on users. This is so due to the high elasticity[25] associated to this indicator[26] and the relatively low level of the indicator for Spain.

4.3 Robustness analysis

It should be stressed that the analysis conducted in the previous section is based on regressions in which we estimate 21 parameters (the constant plus the elasticities of each of the 20 policy indicators) drawing on only 29 observations (one for each country in the sample). Accordingly, the resulting t-ratios may give rise to mistaken conclusions given the scantiness of degrees of freedom. In situations in which the number of observations is on a similar scale to the number of variables, it has been shown that it is usual to select variables that are completely independent from the variable of interest as highly significant (e.g. Freedman, 1983).

An alternative methodology that is suitable for resolving the aforementioned problem of scant degrees of liberty is that of Bayesian model averaging. Given that we have 20 variables (the 20 indicators of health care institutions and policies) that are candidates for explaining the efficiency index, we can estimate 2^{20}=1,048,576 different models, one for each possible combination of variables. Estimating all these models, the Bayesian averaging methodology allows us to calculate, among other things, the relative contributions of each variable to explaining the volatility of our efficiency index. In this way, those variables that explain a bigger percentage of the variance of the efficiency index can be labelled as robust determinants of health care efficiency.

Formally, the starting point is the estimation by OLS of all the models resulting from the possible combinations of the 20 explanatory variables we have. We refer to each of these models as M_i, with $i = 1,...,2^{20}$. From a Bayesian standpoint we can estimate the posterior probability of each model:

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24. The degree of delegation to insurers refers to the involvement of insurers in decision-making relating to the health care system. For example, in career, which scores a maximum level in this indicator, insurers decide are on the means of payment to doctors and hospitals, they finance and maintain health care infrastructure is and they decide are on social contributions to the health care system. Moreover, the degree of universe other team refers to the proportion of the population covered by some type of medical insurers. All the countries in our sample, with the exception of Turkey, have values between 5 and 6 in this indicator.

25. The IMF (see IMF, 2010) also identifies the expansion of private coverage and cost sharing between supplier and user as effective policies in health care cost containment. The IMF uses a different measure of efficiency than the one used in this document. More specifically, the IMF uses the "excess cost growth", i.e., the increase in health spending per capita that is not explained by the increase in GDP per capita and demographic change. On the other hand, the IMF's conclusions are based on the magnitude of the elasticities and not their statistical significance.

26. Note that the indicator of co-payment (or price signals on users) is based on the percentage of health spending through direct payment over total health expenditure in each country (see Table 2).

$$P(M_i \mid y) = \frac{P(M_i) N^{-k_i/2} SSE_i^{-N/2}}{\sum_{j=1}^{2^{20}} P(M_j) N^{-k_j/2} SSE_j^{-N/2}}$$

where $P(M_i)$ is the prior probability of each model set by the researcher, N is the number of observations, k_i is the number of parameters to be estimated in model i and SSE_i is the sum of the squared errors of model i. Furthermore, $P(M_i \mid y)$ is the posterior probability of model i, i.e. a type of measure of goodness of fit from a Bayesian standpoint (note that y refers to the data, i.e. we have the prior probability $P(M_i)$, before seeing the data, and the posterior probability $P(M_i \mid y)$, after seeing the data).

Once we have the posterior probability of each model, we can calculate the probability of inclusion (a posteriori) of each variable, i.e. the probability that the coefficient accompanying the variable is other than zero. This probability will be given by the sum of the probabilities of all the models in which the variable in question is included. Specifically, the probability of variable h being included in the model will be:

$$PIP_h = P(\theta_h \neq 0 \mid y) = \sum_{\theta_h \neq 0} P(M_i \mid y)$$

Those variables with higher posterior inclusion probabilities (PIP) will be those that most contribute to explaining the volatility of the efficiency index and will, therefore, be considered as robust determinants of the level of efficiency. Specifically, we can consider as robust those variables whose PIP is greater than 0.5. This is so because we will assume a priori that each model is equally probable a priori ($P(M_i) = 1/2^{20} \forall i$), meaning that the prior inclusion probability is 0.5 for all the variables. As a result, the variables with PIP>0.5 will be considered robust because the data favour their inclusion in the model or, otherwise expressed, they are those which most contribute to explaining the variation of the dependent variable. Interested readers can consult Hoeting et al. (1999) or Sala-i-Martin et al. (2004) for further details.

Table 4 shows the PIP obtained for each of the indicators considering both efficiency indices separately as a dependent variable. We can see that all the indicators that proved significant in the simple regression presented in table 3 may be considered robust under the criteria set using Bayesian model averaging techniques, i.e. they have inclusion probabilities of over 0.5. We can therefore conclude that the results obtained in this section may be considered robust despite the problem of few degrees of freedom in the estimates.

5 Conclusions

Containing health care expenditure is one of the biggest challenges facing public policy-makers in the developed countries. Although inevitable population ageing will be an important factor in how future health care expenditure develops, it is not the only relevant factor. Indeed, according to the projections analysed in this paper, other supply-side and non-demographic factors might even be more important than the purely demographic factor.

Improving health care system management efficiency may be an alternative to be taken into account in containing health care expenditure. Although the results depend on the indices considered, this paper provides conclusive evidence that there are significant differences across countries in health care management efficiency levels. Accordingly, potential efficiency gains in this sector, and therefore savings in economic terms, are high for many developed countries.

Furthermore, there is a significant relationship between various health care policies and institutions and the levels of efficiency of health care systems. However, the levels of efficiency estimated for the different countries, and as a consequence of the role of regulatory policies in their improvement, are significantly affected by the methodology used.

Finally, it is also worth highlighting that both health production and efficiency in health system management crucially depend on a variety of factors unrelated to the health system that cannot be observed at the aggregate level (Garber and Skinner, 2008). Therefore, results from aggregate exercises such as the one presented here must be interpreted with caution and, ideally, be complemented with exercises at the micro level (López-Casasnovas, 2005). In any event, the findings of this paper are broadly compatible with other available evidence, in particular that drawn from microeconomic data.

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Table 1: Projections of the increase in health care expenditure as a % of GDP

Agency	EC	OECD	IMF
Period	2007-2060	2005-2050	2010-2050
Country	Europen Union	OECD	Developed
Central scenario	1,5 pp.	-	3.0 pp.
Confidence interval	0.7 - 2.4 pp.	2.0 - 3.9 pp.	2.1 - 4.1 pp.
Central scenario (Spain)	1.6 pp.	-	1.6 pp.
Confidence interval (Spain)	1.0 - 2.6 pp.	2.3 - 4.1 pp.	0.8 - 2.4 pp.

SOURCE: EC (2009), Oliveira et al. (2006) and IMF (2010).

Table 2: Summary of indicators on health care system characteristics

Indicator	Description of the content of the indicator	Spain	OECD minimum	OECD maximum
Choice of insurer	Type of coverage (at national or local level and with a single or several insurers). In the event of several insurers, their number, their market shares and the ability of the population to choose between them.	1	0	6
Insurer level for competition	Ability of the insurers to regulate their profits, to decide on coverage and to design contracts with suppliers. Existence of a risk compensation system. Availability of information for consumers on premiums and coverage, and on the insurers' performance.	0	0	5
Over the basic coverage	Percentage of population with private coverage additional to basic cover (duplicated, supplementary), percentage of health care expenditure funded by private medical insurance and degree of market concentration.	3	0	6
Degree of private provision	Breakdown of doctors and hospital services based on public or private status.	0.5	0.3	4.7
Volume incentives	Means of payment to doctors and hospitals based on the incentives they give to generate health care assistance. For example, payment of fixed wages to doctors versus variable wages on the basis of patients attended to.	1.2	1.1	5.7
Regulation of prices billed by providers	Regulation of drug prices and the prices billed by doctors and hospitals.	5.3	2	5.9
User information on quality and prices	Information available to users on the quality and prices of different health care services.	0	0	5.3
Regulation of the workforce and equipment	Quotas for the total number of Medicine students and by speciality, regulation of placements for practice, policies to tackle shortages, regulation of high technology hospital equipment and activities (number of hospitals and beds, specific services, high-cost medical teams) and control of the hiring and remuneration of hospital staff.	4.5	0.8	5.3
Patient choice among providers	Degree of freedom in choice of doctors and hospitals.	0.7	0	6
Gate keeping	Obligations or incentives to consult a general practitioner before seeing a consultant.	6	0	6
Price signals on users	Degree to which patients defray a portion of health care expenses through direct payment. This specifically measures the percentage of health care expenditure made through direct payment.	1.3	0.3	3.1
Priority setting	Definition of health care services to be provided, criteria taken into account in this definition, the effective use of assessments of health care technology, the definition and monitoring of public health objectives.	2.8	0.8	5.7
Stringency of the budget constraint	Rules and/or objectives for setting the health care budget and its allocation through sub-sectors and/or regions.	2	0	6
Regulation of prices paid by third-party payers	Regulation of prices paid by taxpayers for general practitioners, consultants, hospital services and medicine.	4.5	3.2	5.9
Degree of decentralization	Number of main decisions adopted at the level of sub-national governments.	5.5	0	5.5
Degree of delegation to insurers	Number of important decisions taken by insurers.	0	0	3.5
Consistency in responsability	Number of decisions that are within the remit of more than one government (national, regional, local) and consistency in the apportionment of responsibilities.	6	1.3	6
Breadth	Proportion of the population covered by basic medical insurance.	6	4	6
Scope of basic coverage	Range of health care products and services covered by basic medical insurance.	5.6	4.7	6
Depth of coverage	Expenses covered by the goods and services included in the basic-provision package, real level of coverage of basic medical insurance and extra payments necessary for basic primary attention.	5.4	4.1	5.7

SOURCE: OECD (2010).

Table 3: Impact of health care regulation on efficiency

Panel A: DEA Efficiency index as dependent variable

Policy indicator	Level for Spain	Maximum OECD	Elasticity policy-efficiency (a)
Regulation of prices billed by providers	5.3	5.9	0.011
Gate keeping	6	6	-0.005
Priority setting	2.8	5.7	0.009
Price signals on users	1.3	3.1	0.02
Over the basic coverage	3	6	0.003

Panel B: SFA Efficiency index as dependent variable

Policy indicator	Level for Spain	Maximum OECD	Elasticity policy-efficiency (b)
Breadth	6	6	0.413
Gate keeping	6	6	-0.073
Degree of delegation to insurers	0	3.5	-0.162
Regulation of prices billed by providers	5.3	5.9	0.116

SOURCE: Authors' calculations.

a. Obtained from the regression of the DEA efficiency level on 20 health care policy indicators considered by the OECD. All the indicators vary between 0 (minimum level) and 6 (maximum level).

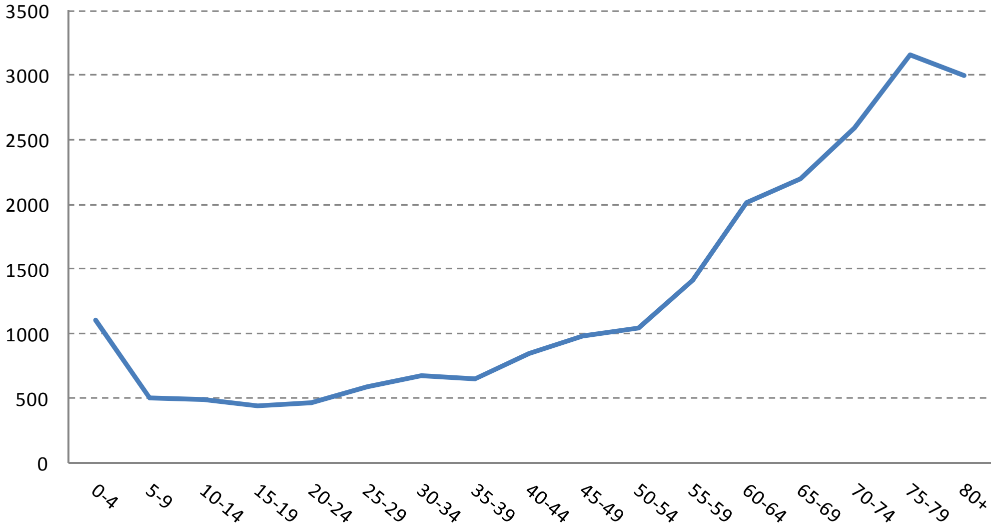
b. Obtained from the regression of the DEA efficiency level on 20 health care policy indicators considered by the OECD. All the indicators vary between 0 (minimum level) and 6 (maximum level).

Table 4: Impact of health care regulation on efficiency using Bayesian model averaging

DEA Efficiency index as dependent variable		SFA Efficiency index as dependent variable	
Policy indicator	PIP	Policy indicator	PIP
Regulation of prices billed by providers	1.00	Breadth	0.99
Priority setting	1.00	Regulation of prices billed by providers	0.92
Gate keeping	1.00	Degree of delegation to insurers	0.90
Price signals on users	1.00	Gate keeping	0.88
Over the basic coverage	0.99	Volume incentives	0.80
Regulation of the workforce and equipment	0.93	Regulation of the workforce and equipment	0.67
Insurer level for competition	0.80	Regulation of prices paid by third-party payers	0.64
Degree of delegation to insurers	0.71	Priority setting	0.52
Choice of insurer	0.31	Patient choice among providers	0.43
Scope of basic coverage	0.28	Stringency of the budget constraint	0.39
User information on quality and prices	0.27	Insurer level for competition	0.36
Patient choice among providers	0.22	Choice of insurer	0.34
Degree of private provision	0.21	Depth of coverage	0.34
Breadth	0.21	Price signals on users	0.30
Depth of coverage	0.21	Scope of basic coverage	0.30
Degree of decentralization	0.21	Over the basic coverage	0.27
Stringency of the budget constraint	0.20	Degree of private provision	0.26
Volume incentives	0.18	Degree of decentralization	0.25
Consistency in responsability	0.18	User information on quality and prices	0.24
Regulation of prices paid by third-party payers	0.18	Consistency in responsability	0.21

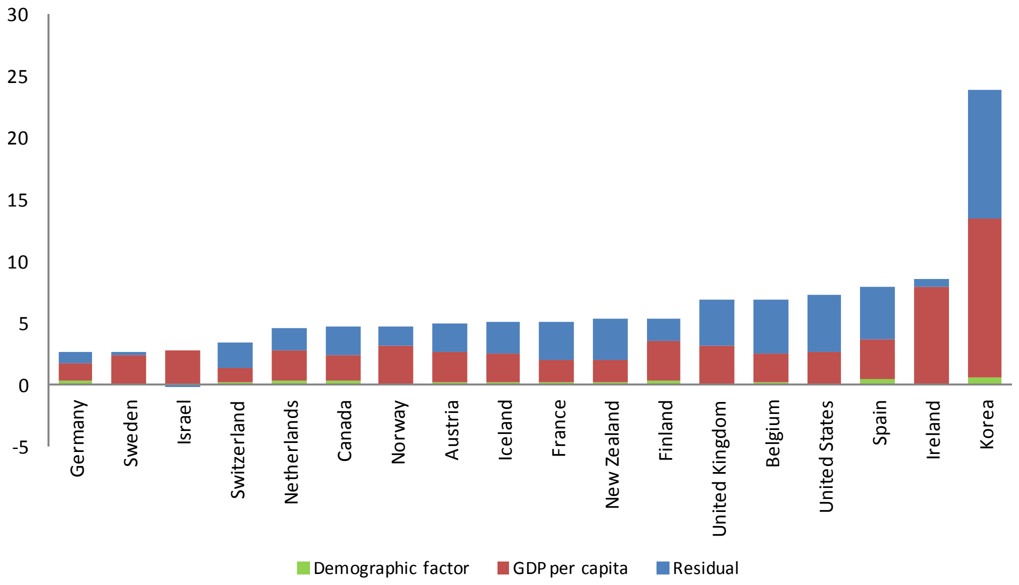
SOURCE: Authors' calculations.
PIP refers to the Posterior Inclusion Probability of each variable. See main text for more details.

Chart 1: Health care expenditure per capita by age group in Spain (2005)



SOURCE: EC (2009).

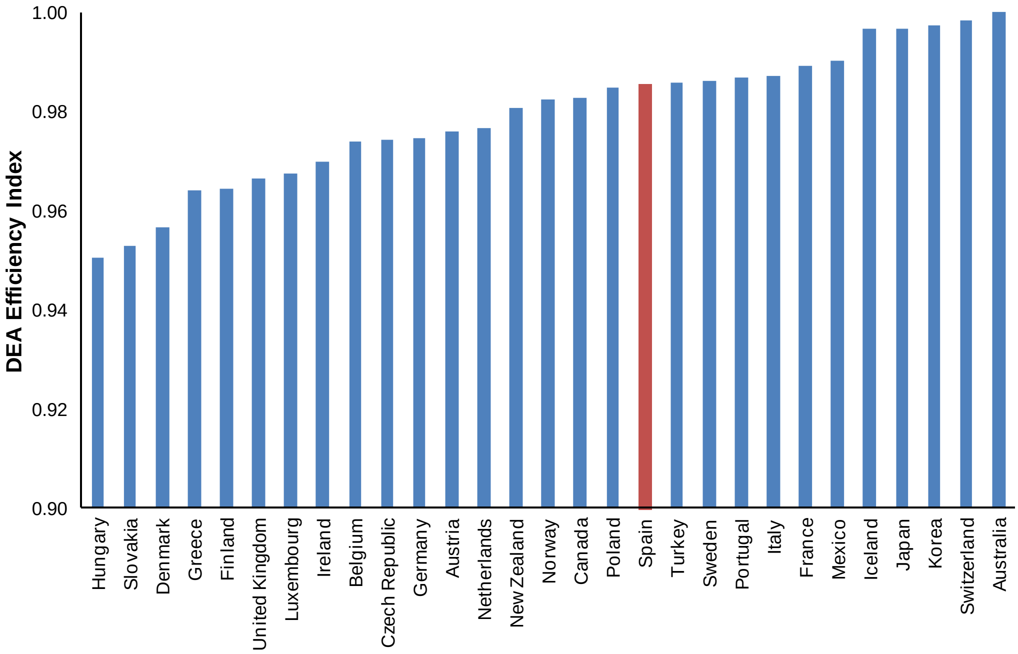
Chart 2. Breakdown of health care expenditure: 1980-2008

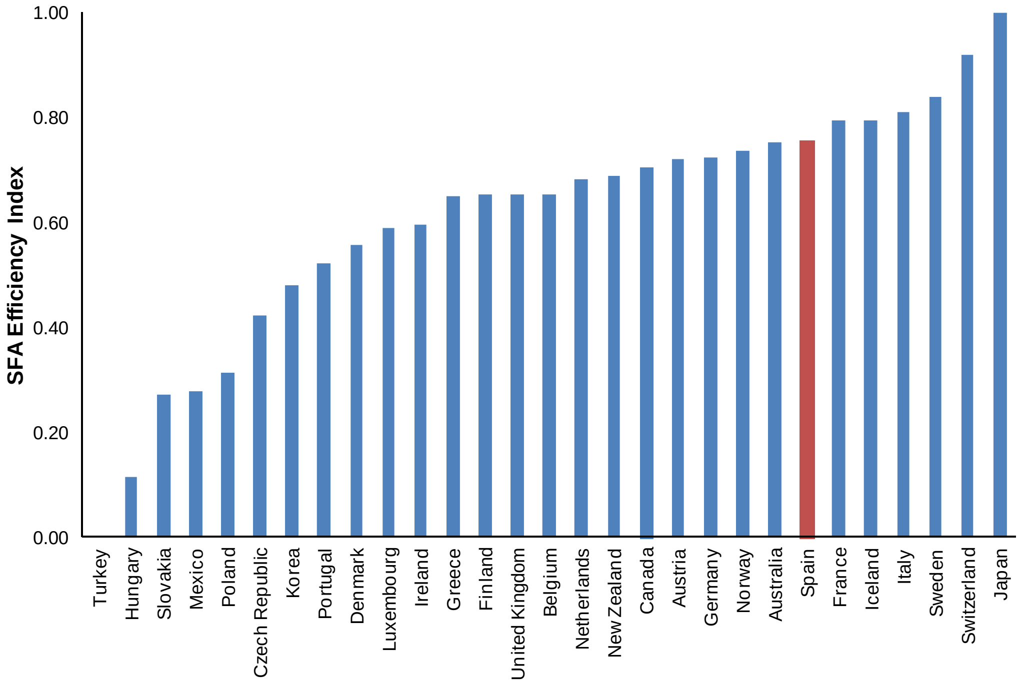


SOURCE: Authors' calculations.

NOTE: This chart shows the growth of per capita health care expenditure in various OECD countries between 1980 and 2008, and the contribution of the foregoing factors to this growth, under the assumption that both the demographic factor and that relating to per capita income have unit elasticity. The demographic factor is proxied by the difference between per capita health care expenditure with the 1980 population age structure and per capita health expenditure under the 2008 age structure (see main text for further details).

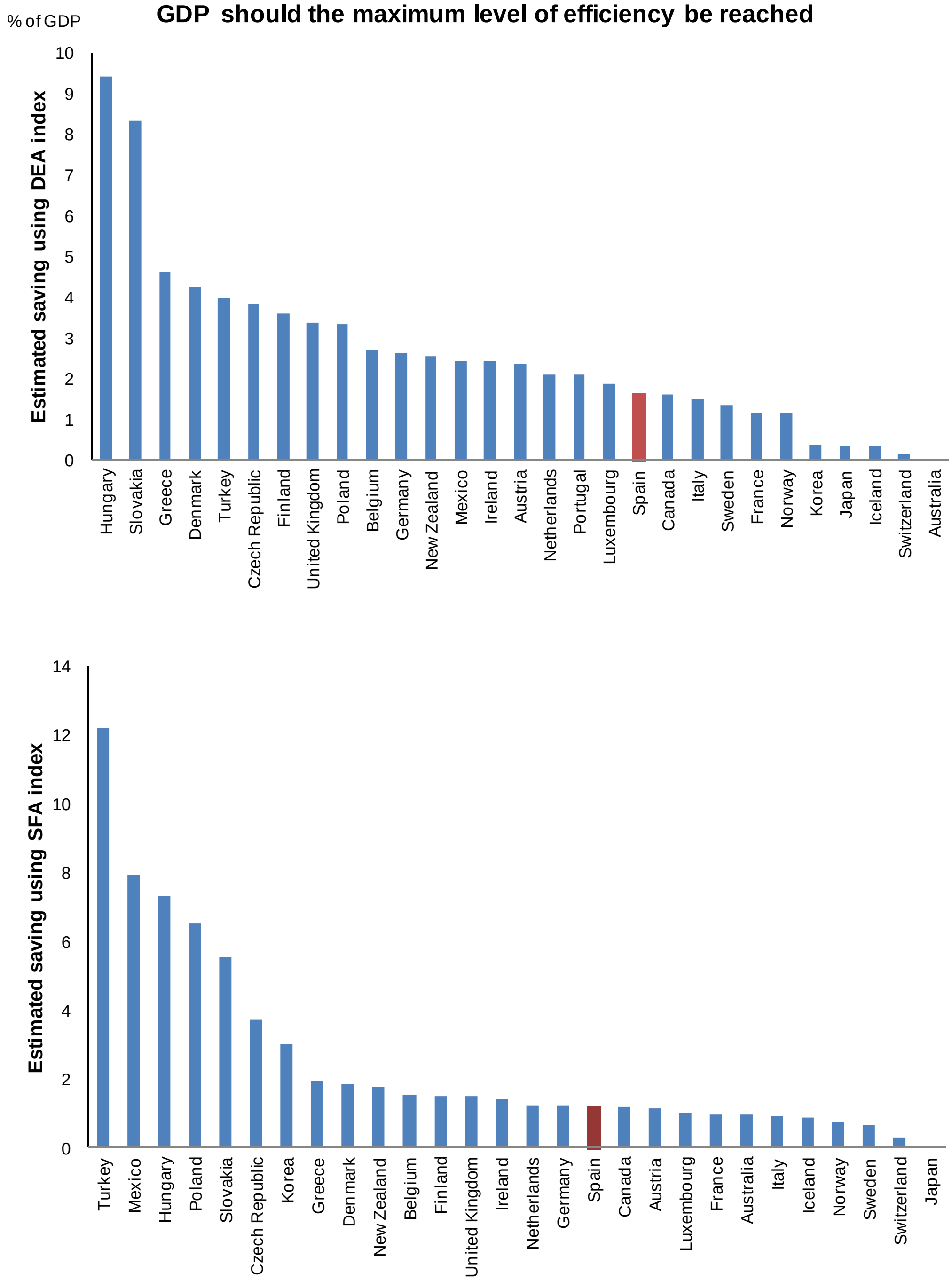
Chart 3: Efficiency indices by country





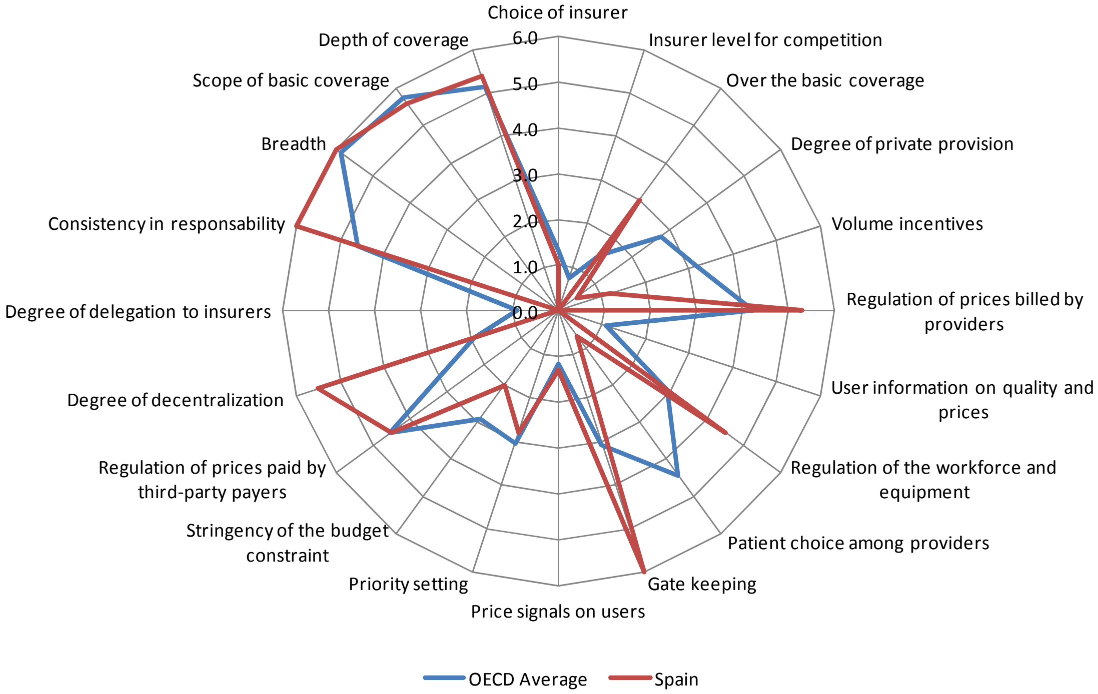
SOURCE: OECD (2010) and authors' calculations.

Chart 4: Potential saving in health care expenditure as a % of GDP should the maximum level of efficiency be reached



SOURCE: OECD (2010) and authors' calculations.

Chart 5: Indicators of Health Care Policies and Institutions



SOURCE: OECD (2010) and authors' calculations.
NOTE: Each of the indicators has values between 0 and 6, with 6 indicating that the policy is highly used.

Data Appendix

Variable	Source	Years
DEA index of health care efficiency	OCDE (2010)	2007
SFA index of health care efficiency	Authors' calculations	2007
Health care policies and institutions	Paris et al. (2010) and OCDE (2010)	2009
Life expectancy (years)	OECD Health Data 2010	1980-2009
Per capita GDP (USD PPP)	OECD Health Data 2010	1980-2009
Per capita health expenditure (USD PPP)	OECD Health Data 2010	1980-2009
Secondary education (as a share of population)	OECD Health Data 2010	1997-2009
Tobacco consumption (in grames per capita)	OECD Health Data 2010	1997-2009
Alcohol consumption (in litres per capita)	OECD Health Data 2010	1997-2009
Fruit and vegetables consumption (in kg per capita)	OECD Health Data 2010	1997-2009
Nitrogen oxide emissions (in kg per capita)	OECD Health Data 2010	1997-2009

NOTE: All variables are available for all the 29 OECD countries appearing in Chart 3.

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