A CROSS-COUNTRY ANALYSIS OF HEALTH CARE EXPENDITURES
Understanding the US Gap*

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Abstract. This paper is concerned with growth patterns of US health care expenditures. Within a representative sample of OECD countries, we lay out a growth accounting exercise for health care expenditures to assess the influence of several explanatory variables. We show that the relative price of medical care and some health care laws explain the differential increase in US medical expenditures over the 1970-2007 period. We then reexamine potential drivers of US medical care prices such as hospital and professional services, pharmaceutical products, and malpractice insurance costs.

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JEL classification. I10, I11, I18, E31.

1 Introduction

The ratio of US health care expenditures (HCE) over total consumption (TC) displays an upward trend. Indeed, according to OECD data HCE accounted for less than one twelfth of TC in 1970, while it is now over one fifth.[1] Mounting US medical expenditures have become an issue of national concern and a continuing challenge for policy makers (e.g., the Clinton Health Care Plan of 1993 and more recently the Obama Affordable Care Act).

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[1]Most researchers consider HCE over GDP [e.g., Chernew and Newhouse (2012)]. This expenditure share does not essentially change when conditioning on TC. As a matter of fact, our theoretical framework below requires HCE over all other consumption goods. We prefer to condition on TC because the consumer price index (CPI) is readily available for all countries in the sample.

Our goal is to identify key macroeconomic forces driving these well-known patterns of US medical expenditures, using as a comparison group a sample of ten other OECD countries with high quality data: Australia, Canada, Denmark, Finland, France, Germany, Ireland, Japan, Spain, and the United Kingdom. Our main quantitative analysis aims to assess deviations of US medical expenditures from common forces over the sample period 1970-2007.

One major difficulty in uncovering HCE growth patterns for US expenditures is the high degree of uniformity in the categories of sources and uses of funds. Figure 1.1 breaks down HCE into various categories by source. Some public programs such as Medicare and Medicaid have gained prominence at the expense of private funding and out-of-pocket expenditures, but such extra growth seems too small to account for the general evolution of HCE.

[Figure 1.1: The Evolution of US Health Care Expenditures by Source 1980-2007]

Figure 1.2 breaks down HCE into various categories by use. A substantial increase in the categories of other personal health care and prescription drugs is observed, as well as a slight decline in physical and clinical services, and hospital care.[2] Again, these changes are just small departures from overall trends in HCE.

[Figure 1.2: The Evolution of US Health Care Expenditures by Use 1980-2007]

Thus, for the matter in question, we would need to identify a group of variables that jointly drive all the expenditure categories.

We should emphasize that the structure of our exercise makes our findings not readily comparable with other related studies that focus on global HCE trends. Indeed, it is not clear whether previous studies could account for growth patterns of US medical expenditures over the various time subperiods described in the ensuing paragraphs. For instance, Hall and Jones (2007) propose a model in which the HCE share is propelled by income and technology growth with the end result of increasing life expectancy. As is well known, there has been some leveling of income by European countries. Moreover, US life expectancy has been slightly below the OECD average.[3] Hence, life expectancy could be instrumental in explaining global increasing trends in HCE, but other factors appear more adequate to replicate the observed differences at the cross-country level over shorter time periods.

Some researchers [cf. Anderson and Frogner (2008)] argue that even though the US presents the highest ratios of medical spending among all OECD countries, its residents are not granted the highest value per dollar spent in health care – suggesting a higher level of inefficiency in the US. Our analysis focuses on medical spending growth rates – rather than levels – within a selected group of OECD countries. Hence, for our cross-country study one would have to show that the US inefficiency gap, or the gap in defensive medicine,[4] has grown over time. Our results do not pick a

[2] As discussed below, relative prices could be shaping these expenditure categories.

[3] According to OECD health data, in 1970 average life expectancy at birth was 70.1 years in the OECD and 70.9 years in the US. In 2007 average life expectancy at birth was 78.8 years in the OECD and 77.9 years in the US.

[4] Defensive medicine is referred as the practice of diagnostic or therapeutic measures conducted primarily not to

higher increasing residual for the US.

The spread of health care insurance has been suggested as an explanatory variable for the growth in US medical expenditures. Finkelstein (2007) estimated that between 1965 and 1970 the introduction of Medicare produced an increase in hospital spending six times larger than a private insurance program would have produced. At roughly the same time, however, many OECD countries did undergo notable expansions of their universal health care systems (e.g., Japan in 1961, Denmark in 1973, and Spain in 1986). Thus, it seems that expansionary trends in insurance markets cannot account for observed differences in HCE between the US and the rest of the OECD countries. Some international medical reforms will be echoed in our quantitative study.

Ample literature has linked the rapid increase in HCE in the US to technological change.[5] For example, Di Matteo (2005) finds that technological change accounts for two thirds of health care spending growth over the 1975-2000 period. An excellent review of this literature is presented in Chernew and Newhouse (2012). In our study, we control for the impact of technological change by considering a sample of developed countries with similar technologies. We make the identifying assumption that the US technology gap within the OECD remains constant over the sample period. Smith *et al*. (2009) point out that early diffusion of new technologies is frequently linked to similar GDP levels [Moise (2003)].

Broadly speaking, our analysis attests that the various time episodes of HCE growth in the US can be replicated by similar responses of the ratio of the price of medical care over the aggregate price of all the other goods. Therefore, what we will call the US medical care expenditure gap will be generated by the US medical care price gap. Within our OECD sample, the US underwent the most acute inflation in medical care consumption with respect to all other goods. As will become clear throughout our paper, by combining the expenditure and price gaps we obtain a real quantity gap for HCE over TC, while most of the literature has centered on nominal expenditures.

We support these findings with a further analysis of health care prices. In our country sample, the US price gap grows over time. We explore related price indexes as well as potential drivers of US medical care prices such as hospital and professional services, and pharmaceutical products. Malpractice insurance costs and health insurance premiums underwent steep increases – considerably higher than our CPI index. Physicians' services, however, do not appear to be a major source of the continued inflation in the medical sector. In spite of substantial job creation, the labor income share has remained roughly constant over the period. It appears that inflationary episodes in the US health care sector have greatly benefited companies in the industry.

The paper is organized as follows. In section 2 we highlight some basic empirical facts on medical expenditures. In section 3 we define our framework of analysis, and derive our main quantitative results from a growth accounting exercise. In section 4 we reexamine medical price data. In section

ensure the health of the patient but as a safeguard against possible malpractice liability.

[5]The economics literature usually estimates technological change from price data. According to the Boskin report (1996) the US consumer price index does not take into account a 3 percent yearly increase in the quality of health care goods. Unfortunately, we were not able to find data on technological change for the other OECD countries.

5 we detail a financial factor analysis to assess the impact of health care expenditure growth on profitability and the evolution of income shares. We conclude in section 6.

2 Basic Empirical Facts

As indicated in the introduction, our comparison group is comprised of eleven OECD countries (including the US). All these countries contain good quality data over the 1970-2007 sample period. Yearly HCE are available for all countries, with the exception of France, which has data available every five years during the 1970-1990 period. Subsequent data for France, for the 1991-2007 period is annual. For prices we use the consumer price index (CPI) and the consumer price index-medical care (CPIMC). Again, a few observations are missing for price data and simple interpolations were performed whenever necessary. All expenditure and price measures reported in this section are explained in a separate appendix.

2.1 The US medical care expenditure gap

We define the US medical care expenditure gap as the ratio HCE/TC of the US over the average ratio HCE/TC of the other OECD countries. The US was already among the top health care spenders in 1970 but was still far from being an outlier. In fact, the US medical care expenditure gap went from 1.1 in 1975 to 1.55 in 1990. Then, the gap trended downwards during the eight-year period of the Clinton presidency, and it has slightly risen during the last decade.

[Figure 2.1: The US Medical Care Expenditure Gap 1970-2007]

Figure 2.1 suggests the existence of three well differentiated periods: (*i*) *The* 1970-1977 *period*: The US medical care expenditure gap hovered around 1.1; (*ii*) *The* 1978-1990 *period*: The US medical care expenditure gap increased steadily from 1.1 to 1.55; and (*iii*) *The* 1991-2007 *period*: The US medical care expenditure gap roughly stabilized around 1.5. The 1978-1990 period stands out as a transitional time episode with a rather sharp increase in the US medical care expenditure gap. Of course, this transition episode is certainly puzzling. It does not seem plausible to explain such an increase in HCE by some aggregate variables with smooth long-term trends such as GDP, life expectancy, the size of the elderly population, defensive medicine, the prevalence of some modern health care trends (e.g., obesity), and new medical treatments. Note that during this transition episode there are no noticeable changes in HCE in the various categories by source and use; *viz*. Figures 1.1 and 1.2 above.

2.2 The US medical care price gap

The medical care price gap reflects the evolution of the consumer price index–medical care (CPIMC) over the consumer price index (CPI). That is, we define the US medical care price gap as the US ratio CPIMC/CPI over the average ratio CPIMC/CPI of the other OECD countries. Again, these prices along with their data sources are formally defined in the Appendix. Note that by combining these two gaps we can get a corresponding US gap for real expenditures: The ratio of real HCE over real TC.

Figure 2.2 considers changes in the CPIMC and CPI for our sample of countries over the entire sample period 1970-2007. The solid line displays the final increase in the ratio CPIMC/CPI over the reported period. Some countries in the sample experienced similar rates of inflation in both medical care and total consumption, and so the ratio CPIMC/CPI remains close to one. In the US, however, the ratio CPIMC/CPI has doubled over the sample period. Hence, the US saw the most acute inflation in medical care consumption. It should be stressed that inflation in US medical care is not higher than in many other countries. What seems high is the change in the *relative* price of medical care with respect to the entire basket of final consumption goods.

[Figure 2.2: The Medical Care Price Gap 1970-2007]

2.3 The US medical care expenditure gap vs. the price gap

Figure 2.3 plots the US medical care expenditure gap against the price gap; both ratios are normalized to 1 in 1977. The figure forcefully makes the case that the price gap is a major driving factor of the medical care expenditure gap in the 1978-1990 period, in which both increased by about 35 percent. Then, there is a mild disconnect: The relative price of medical care appears to increase faster than HCE. More precisely, between 1993 and 2007 the US medical care price gap goes from 1.35 to 1.50, whereas the US medical care expenditure gap appears quite flat. This suggests that in relative terms real medical consumption may have declined in the US in the last part of the sample period. Indeed, it follows from these definitions that if the US medical expenditure gap grows less than the price gap, then the ratio of real HCE over real TC will go down in the US as compared with the other OECD countries.

[Figure 2.3: The US Medical Care Expenditure Gap vs. the Price Gap 1970-2007]

2.4 The stability of real HCE over real GDP in the US

For the 1970-2007 sample period, HCE per capita at constant TC prices in the US has increased by 300 percent. For the same time period, HCE per capita at constant medical care prices (real HCE) in the US has increased less than 100 percent. Further, there is no significant growth when real HCE per capita is adjusted for real TC growth or for real GDP growth. More precisely, real HCE over real TC increased by 28 percent, and real HCE over real GDP did not increase at all.[6] Hence, Figure 2.4 reports: (*i*) HCE per capita at constant TC prices; (*ii*) Real HCE per capita: HCE per

[6]For the 1970-2007 sample period, the ratio between nominal TC and nominal GDP was quite stable – it just went down by 4.5 percent. Hence, the above difference mainly stems from the unequal evolution of the CPI and the GDP price deflator. The ratio between the CPI and the GDP deflator went up by 22.5 percent over the sample period.

capita at constant medical care prices; (*iii*) Real HCE over real TC; and (*iv*) Real HCE over real GDP.

[Figure 2.4: The Evolution of US Health Care Expenditures 1970-2007]

Therefore, real HCE has not increased faster than real income. Of course, this is not to deny that certain regulations are shaping these trends. First, the Medicare and Medicaid programs have gained weight over time (see Figure 1.1). Second, there has been a shift to "managed care" [Cutler *et al*. (2000)], which was mainly accomplished by the late 1990s.[7] Indeed, over this time period, Figure 2.5 documents the progressive shift from private indemnity plans and conventional insurance to more incentive-compatible mechanisms for private health insurance such as HMOs, PPOs, and POSs. This could be reflected in the relative decline of hospital care expenditures (Figure 1.2). In the 2000s, among other things, the Bush reforms appear to have increased pharmaceutical expenditures (Figure 1.2).

[Figure 2.5: The Structure of the Insurance Market]

2.5 Economic growth and inflation, public health care expenditure, and the Clinton presidency

Underlying these medical expenditure patterns, are changes in real GDP growth and inflation as well as the relative size of public health care. Figure 2.6 [Panel (a)] portrays the actual evolution of (nominal) HCE over GDP in the US. It breaks down this aggregate into public and private health care; roughly, these two sub-aggregates move *in tandem*. Panel (b) of this figure plots the rates of real GDP growth and differential inflation in the health care sector. According to some researchers [cf. Smith *et al*. (2009)], there could be lags in the response of these variables that may go up to five years. That is, the short-run price elasticity of a given variable may be smaller than the long-run price elasticity.

[Figure 2.6: Health Care Expenditures over GDP, Real GDP Growth, and the Relative Health Care Price]

In light of this evidence, we can now analyze the aforementioned time breaks in US medical expenditures. Note that the 1970-1978 period presents *moderate* excess inflation in the health care sector and high real GDP growth. The 1978-1990 period presents the *highest* excess inflation in the health care sector and uneven real GDP growth. Finally, the 1990-2007 period presents the *lowest* excess inflation in the health care sector and moderate real GDP growth.

Again, US time-series data seem to point at the relative health care price as the major explanatory

[7] As in the case of the GDP deflator, we should point out that the personal consumption expenditures-health care price (PCEHC) index of the US Bureau of Economic Analysis (BEA) suggests an upward bias in the CPIMC. The PCEHC mimics the CPIMC during the 1980s but it grows at a slower pace afterwards. The cumulative upward bias is about 10 percent.

factor for the medical care expenditure gap. For instance, in the 1993-2000 period of the Clinton presidency, nominal HCE over GDP *remained flat*. In this time episode, real GDP growth clearly dominates excess inflation in the health care sector. Therefore, one should expect the ratio of real HCE over GDP to grow at a slower pace. As a matter of fact, the 1990s also witnessed a shift to "managed care" leading to a relative decline of hospital care (Figure 1.2), and to a decrease of indemnity health insurance plans in favor of HMOs, PPOs and POSs (Figure 2.5). These changes might have affected the evolution of US medical expenditures and prices. Cutler *et al.* (2000) suggest that for certain treatments and procedures "managed care" organizations like HMOs may have lowered costs by about 30 or 40 percent as a result of price declines of medical services and treatment intensities. In spite of all these changes, "managed care" did not seem to substantially affect the composition of public and private expenditures [Figure 2.6 [Panel (a)]]. Indeed, our next figure confirms that the distribution of the insured and uninsured population and those publicly insured remains quite stable over the sample period.

[Figure 2.7: Distribution of the Population by Health Insurance]

Let us conclude with a summary of these basic empirical facts. First, major trends in the US medical care expenditure gap are explained by changes in the US medical care price gap. The correlation between the expenditure and price gaps is quite strong during the 1978-1990 transition period. There is a mild disconnect between these two gaps at the end of the 1990s, which comes along with a progressive shift to "managed care," as well as a noticeable divergence between the CPIMC and PCEHC indexes to be explained below. Second, the ratio of real HCE over real GDP (and over real TC) has been fairly stable in the US over the last forty years. This suggests that the income elasticity of medical expenditures must be close to one,[8] the price elasticity must be close to zero, and there appears to be a relatively neutral effect of technological change on medical expenditures. In the next section, our cross-country analysis is intended to offer further insights into the technology residual. Third, the weight of the public sector in the provision of health care has slightly gone up. The distribution of the population by health insurance (publicly and privately insured and uninsured) has remained stable over the last three decades.

3 A Simple Model of Health Care Expenditures

This section presents our quantitative assessment of the evolution of US medical expenditures. Certain key parameters will underlie this computational approach such as the income elasticity for health care expenditures (assumed to be equal to one), the price elasticity, and the pace of technological change. In our growth accounting exercise, technological change is subsumed under the technology residual. We later report simulations for a calibrated version of the model under the

[8] Extensive cross-country empirical evidence [e.g., Gerdtham and Johnson (2000)] suggests income elasticities about one.

identifying assumption that the US technology residual is equated to the sample average.

3.1 The economic environment

We consider an endowment economy with a representative agent. At every time $t = 0, 1, \cdots$, the economy receives y_t units of an aggregate commodity which can be transformed into two types of consumption goods: A composite consumption good c and a variety of health care consumption goods m_s for $s \in [0, \sigma(a_t)]$, where a_t denotes the technology level at time t and $[0, \sigma(a_t)]$ is the mass of available varieties. Preferences are represented by a CES utility function. All health care varieties m_{ts} at time t enter symmetrically into a utility aggregator $M(t) = \left[\int_0^{\sigma(a_t)} m_{ts}^{\gamma} ds\right]^{\frac{1}{\gamma}}$.

The representative agent solves the following budget-constrained maximization problem:

$$\max_{c,h,m_s} \sum_{t=0}^{\infty} \beta^t \left[\lambda c_t^{\rho} + (1-\lambda)\left(\phi(a_t)^{\frac{1}{\rho}}\left[\int_0^{\sigma(a_t)} m_{ts}^{\gamma} ds\right]^{\frac{1}{\gamma}}\right)^{\rho}\right]^{\frac{1}{\rho}} \tag{1}$$

subject to:

$$c_t + q_t h_t = y_t \tag{2}$$

$$\int_0^{\sigma(a_t)} m_{ts} ds_t = a_t h_t \tag{3}$$

$$0 < \beta < 1, 0 < \lambda < 1, 0 < \gamma < 1, -\infty < \rho < 1 \tag{4}$$

where $q_t h_t$ represents nominal health care expenditures, q_t is the relative price, and h_t represents real expenditures.

Parameter λ is called the consumption share parameter. Parameter ρ determines the degree of substitution between the composite consumption good c and the health care utility aggregator $M_t = [\int_0^{\sigma(a_t)} m_{ts}^{\gamma} ds]^{\frac{1}{\gamma}}$. Parameter γ determines the degree of substitution of the health care varieties m_s. Function $\phi(a_t)$ is introduced to allow for shifts in the expenditure share as a result of technological change.

An increase in the technology level a_t may change the composition of expenditures through the following three channels: (i) *The Price Effect*: An increase in a_t lowers the relative price of health care varieties q_t/a_t in terms of the numeraire good. This effect is present in economic growth models of embodied technological change [e.g., Greenwood, Hercowitz and Krusell (1997)]. (ii) *The Productivity Effect*: An increase in a_t results in higher productivity because it expands the mass of available varieties $[0, \sigma(a_t)]$ to allow for a more efficient production of health care utility $M(t) = \left[\int_0^{\sigma(a_t)} m_{ts}^{\gamma} ds\right]^{\frac{1}{\gamma}}$. That is, for $0 < \gamma < 1$, the same utility level M_t can be obtained under lower spending. This effect is present in economic growth models with a continuum of product varieties [cf., Romer (1990)]. And (*iii*) *The Expenditure Effect*: An increase in a_t may shift the consumption expenditure share because technological change may expand the domain of application of health care varieties. This effect is reflected in function $\phi(a_t)$, and allows for an increase in the health expenditure share under a unitary income elasticity as documented in several studies [Chernew and Newhouse (2012)]. Note that for an inelastic demand (i.e., $\rho < 0$) both the price and productivity effects (*i*)-(*ii*) may lead to a decrease in the health care expenditure share under an increase in a. Hence, function $\phi(a)$ builds in some further flexibility to model the effects of a change in a_t on health care expenditures $q_t h_t$. There are some other well-known models in which technological change may generate non-linear Engel curves [e.g., Becker *et al.* (2005) and Hall and Jones (2007)].

While this rich form for the utility function contemplates various channels for the influence of technological change, we should stress that in our growth accounting exercise all these effects will be pulled together as a quantity residual.

3.2 Optimality conditions

The representative agent assumes that the relative price q_t and the level of technological change a_t are exogenously given. In an optimal solution, consumption must be constant across medical varieties, i.e., $m_{ts} = m_t$ for all s. Then, from the first-order conditions of the agent's optimization problem we obtain the optimal ratio of average consumption of health care varieties m_t over the composite consumption of all other goods c_t:

$$\frac{m_t}{c_t} = \left(\frac{1}{q_t}\right)^{\frac{1}{1-\rho}} \left(\frac{1-\lambda}{\lambda}\right)^{\frac{1}{1-\rho}} \left(a_t \phi(a_t) \sigma(a_t)^{\frac{\rho-\gamma}{\gamma}}\right)^{\frac{1}{1-\rho}} \tag{5}$$

Now, multiplying both terms by relative price q_t, after using identities (2)-(3) we can express the ratio of health care expenditures over total expenditures in non-health care goods as follows:

$$\frac{q_t h_t}{c_t} = \left(\frac{1}{q_t}\right)^{\frac{-\rho}{1-\rho}} \left(\frac{1-\lambda}{\lambda}\right)^{\frac{1}{1-\rho}} a_t^{\frac{\rho}{1-\rho}} \phi(a_t)^{\frac{1}{1-\rho}} \sigma(a_t)^{\frac{\rho(1-\gamma)}{\gamma(1-\rho)}} \tag{6}$$

Equation (6) provides an expression for the evolution of health care expenditures relative to non-health care expenditures as a function of the relative price between the two goods and a residual term A_t driven by the technology level a_t:

$$A_t = \left(\frac{1-\lambda}{\lambda}\right)^{\frac{1}{1-\rho}} a_t^{\frac{\rho}{1-\rho}} \phi(a_t)^{\frac{1}{1-\rho}} \sigma(a_t)^{\frac{\rho(1-\gamma)}{\gamma(1-\rho)}} \tag{7}$$

We allow this residual term to be different for each country i.

3.3 A cross-country analysis of the technology residual A_t

We now perform our growth accounting exercise. The objective is to filter out the price effect from the expenditure ratio, qh/c. We are then left with the technology residual A_t^i for each country i at all times t.

More precisely, combining equations (6)-(7) we obtain:

$$\frac{q_t h_t}{c_t} = \left(\frac{1}{q_t}\right)^{\frac{-\rho}{1-\rho}} A_t \tag{8}$$

Therefore, for each country the residual A_t can be computed as:

$$A_t = \frac{q_t h_t}{c_t} \left(\frac{1}{q_t}\right)^{\frac{\rho}{1-\rho}} \tag{9}$$

Ringel *et al*. (2000) report estimates for the price-elasticity of demand for health care around -0.17. This makes $\rho = -5$. Hence, we shall compute the residual A_t under $\rho = -5$, which leads to a price-elasticity of demand for health care of $-1/6$. We have also performed computations of the residual A_t under $\rho = -4$, and $\rho = -3$, with similar trend patterns.

In order to map the model into the data, note that qh is health care expenditures (HCE), c is total consumption (TC), and q is the ratio between the consumer price index-medical care (CPIMC) and the consumption price index (CPI). Using equation (9), we then generate the residual A_t^i for each country i. For comparison purposes, the technology residual is set up to 100 at year 1977. Figure 3.1 displays the evolution of the technology residual for France, Spain, the US, and the average of our sample of OECD countries (excluding the US). France and Spain are presented in this figure because these are the countries with the sharpest changes in the technology residuals upon enactment of some health care laws.

[Figure 3.1: A Growth Accounting Exercise: The Technology Residual for France, Spain, the US, and the OECD average]

Observe from this figure that the US displays a technology residual A_t^{US} fairly close to that of the average of the other OECD countries. Roughly speaking, there are not noticeable differences in the residual between the 1978-1990 transition period and the rest of the sample. For reasons already discussed, the US technology residual declines after 1992, which suggests either a relative loss in US real health care consumption or an upward bias in the US price index. Hence, in this exercise technology does not appear to be a differential source of growth for US health care expenditures. In a way, this was to be expected because of the stability of health care expenditures per capita documented in the previous section. Therefore, increasing trends in defensive medicine and in the intensity of medical technologies are not echoed in our analysis.

The French National Health Care System initial program was created in 1928 but was not comprehensive (Rodwin and Sandier, 1993). France expanded its public health insurance programs at various stages, and it became universal for all its citizens and residents in 2000 (Rodwin 2003). Spain shows sharp trend breaks in 1986 and 2003 corresponding to two major medical reforms. The General Health Law of 1986 recognized the right to health care services for all citizens and foreign residents in Spain, and the Law of Cohesion and Quality of 2003 modernized and broadened the scope of the previous law.

3.4 A calibration exercise

In our second quantitative exercise we ask the following question: What is the predicted path of US medical expenditures under our model? To address this question, we make the identifying assumption that the US technology residual A_t^{US} is equal to the OECD average, A_t^{OECD}, excluding the US. We begin these computations under our baseline calibration of $\rho = -5$, and then perform a sensitivity analysis by letting $\rho = -4$ and $\rho = -3$.

More formally, let us rewrite our demand equation:

$$\frac{q_t h_t}{c_t} = \left(\frac{1}{q_t}\right)^{\frac{-\rho}{1-\rho}} A_t \tag{10}$$

As already explained, q is the relative price of medical care in the US. Now, the technology residual A_t^{US} is equated to the OECD average A_t^{OECD} without the US. Therefore, the HCE share is simulated by the right-hand side of equation (10). As a matter of fact, to isolate from the effects of some important health care laws in France and Spain, we also consider an average of A_t without the US, France, and Spain. In a third scenario ($filtered\ A_t^{OECD}$), we contemplate an average of A_t for the ten other OECD countries in which the technology residuals for France and Spain have been filtered out within five-year windows of their main health care reforms.

As shown in Table 3.1, the Root Mean Square Error (RMSE) generated by the model for simulated data using the period 1970–2007 is always around 1 percent or less in every scenario. The model is able to replicate the evolution of the observed US ratio HCE/TC and only minor variations in the goodness of fit occur when we let parameter $\rho = -3$ or $\rho = -4$. Therefore, acute inflation in the health care sector over the 1978-1990 transition period appears to be the main driving force behind the steep increase in US health care expenditures over total consumption.

[Table 3.1: Root Mean Square Errors]

4 Understanding the Medical Care Price Gap

Our analysis so far has centered on the CPI-medical care (CPIMC) published by the US Bureau of Labor Statistics (BLS) since 1935. The PCE-health care (PCEHC) is another major price index published by the US Bureau of Economic Analysis (BEA) since 1994. As already mentioned, there are certain important differences between these two medical price measures, but their evolution is quite *similar* over the 1978-1990 transition period.

Inflation in the health care sector has been greater than average inflation in the economy at almost every year. As explained in the Boskin report [Boskin *et al.* (1996)], the CPIMC and its various subcategories had an estimated annual upward bias of 3 percent between 1970 and 1995 when adjusting for quality. During the same time period, the overall CPI has an estimated annual upward bias of 0.6 percent, leading to an estimated yearly bias in the growth rate of the CPIMC over CPI of 2.4 percent. In our quantitative analysis we controlled for this bias by conditioning upon a comparison group of OECD countries with similar health care quality and comparable data sources.

To support our control variable, we shall now look at some indicators of health care quality across our OECD countries. Figure 4.1 shows the evolution of some of these quality proxies, which again are expressed as gaps: the corresponding US value over the average value of our OECD country sample (excluding the US) – letting 100 be the initial value at the starting year 1970. More specifically, we consider the evolution of the US gap for infant mortality, neonatal mortality, perinatal mortality, and life expectancy at birth.[9] We can observe that while the life expectancy gap has remained quite stable, the gap of each other variable has increased – meaning that in fact the quality gap has evolved against the US. These outcomes may partially be explained by the relatively large size of the uninsured population in the US (around 12 percent of the population has permanently been uninsured in the last three decades).

[Figure 4.1: Quality Indicators over Time]

For narrower quality indicators we have not been able to gather data over the whole sample period. Table 4.1 reports 2003 data for the following quality measures: life expectancy, breast cancer five-year observed and relative survival rates for females, cervical cancer five-year observed and relative survival rates for females, and colorectal cancer five-year observed survival rates for males and females.[10] For each of these indicators the Standard Deviation over the Mean is usually less than 0.1 – which confirms that there is very little variability in all the quality proxies across the OECD countries. The US has the lowest life expectancy, the maximum survival rates for breast cancer, and appears below the maximum for cervical and colorectal cancers.[11] Overall, the assumption about

[9] Infant mortality is the yearly number of deaths of children under 1 year of age per 1,000 live births. Neonatal mortality is the yearly number of deaths of children under 28 days of age per 1,000 live births. Perinatal mortality is the yearly number of deaths of children within 1 week of birth (early neonatal deaths) plus foetal deaths of minimum gestation period of 28 weeks or minimum foetal weight of 1,000g, per 1,000 births (source: http://stats.oecd.org/).

[10] Except for life expectancy, the set of countries used to construct the quality estimates in Table 4.1 is different from the eleven countries of our comparison group. Since we could not find data for some of the countries in our original sample, we decided to use all the OECD countries with available data. Five-year observed survival rates are defined as the number of people diagnosed with cancer (age 15-99) within a certain period surviving five years after diagnosis, over the number of people diagnosed with cancer (age 15-99) within a certain period. Five-year relative survival rates are defined as the observed rate of people diagnosed with cancer (age 15-99) surviving five years after diagnosis, over an expected survival rate of a comparable group from the general population (see http://stats.oecd.org/).

[11] Life expectancy is not necessarily a good measure of quality since it can be affected by genetic differences, different dietary customs, and many other variables. Similarly, survival rates are not necessarily a good proxy for the quality

similar health care quality across OECD countries seems to be supported by the data.

[Table 4.1: Quality Indicators for Year 2003]

Before getting into a comparative study of health care prices, it may be worth discussing some other issues involved in the construction the CPIMC. We should emphasize that all these issues do not appear to be salient features of the 1978-1990 transition period. First, for many countries public provision of health care is the norm. Hence, medical care costs should be estimated as a public good by counting the cost of intermediate inputs (such as pharmaceutical products) and labor, and excluding capital rents. Therefore, medical price indexes in those countries are driven by prices of intermediate inputs and labor. For many of those countries, medical labor costs appear to follow average economy wages.

Second, a pioneering work by Griliches and Cockburn (1994) found that US pharmaceutical price indexes were upward biased because of a shift from branded to generic drugs, which has been neglected. After 1995, the BLS implemented corrective measures for the construction of its pharmaceutical price indexes, including generic drugs (Berndt *et al*. 2000). Danzon and Chao (2000) found that the large differences between US prices and those of other countries reported on many studies might be smaller than previously thought.

It seems that neglecting generic drugs in the price index should have a very limited impact during the 1978-1990 transition period. The market for generic drugs expanded after the Waxman-Hatch Act of 1984 (Berndt and Aitken, 2010). The generic drugs' share of total dispensed prescription drugs in the US retail market represented just 18 percent in 1984. It increased to 36 percent by 1994, then 56 percent by 2004, and 74 percent by 2009. At the same time, the revenue share of generic drugs has been relatively small. For example, in 2004 generic drugs were 56 percent of the dispensed drugs but its revenue share was only 17 percent. The revenue share of generic drugs rose to 24 percent by 2009 (Berndt and Aitken, 2010). Hence, during the 1978-1990 transition period the upward bias would seem rather limited. At the same time, generic drugs are dispensed in every OECD country. Danzon and Furukawa (2011) found that generic drugs are more expensive in the US than in most of the OECD countries right after the branded drug's patent expires (around 75 percent of the branded drug price). Three years after patent expiration, prices of generic drugs decline more sharply in the US than in other OECD countries, and after eight years of patent expiration generic drugs are cheaper in the US than in all other OECD countries except the UK. Again, these patterns further reduce the possible upward bias of neglecting generic drugs on our relative price measure during the 1978-1990 transition period.

A major component of the CPIMC is Hospital and Related Services. There is evidence that this component is also upward biased because list prices are usually affected by discounts. Indeed, this

or outcome of a procedure either. A better proxy would be for example the quality of life after the procedure is performed. Drösler et al. (2009) report findings on various new quality indicators regarding patient safety across OECD countries. The US is always about average in every category.

bias has been the norm under the expansion of HMOs and PPOs since managed care organizations are able to bargain on hospital's list prices (Dranove *et al*. 2008). In a recent study, Koechlin *et al*. (2010) circumvent this problem by comparing what they call hospital quasi-prices across several OECD countries. These quasi-prices are defined as negotiated or administrative prices or tariffs on various hospital services items. They still found that US hospital services are 60 percent above average. Further, this possible upward bias may have been rather small during the 1978-1990 transition period since the HMOs and PPOs became prevalent in the late 1980s (see Figure 2.5). In 1997 the BLS started to implement corrective measures to the CPIMC-hospital and related services to remove this sampling error (Cardenas, 1996).

Berndt *et al*. (2000) discuss another source of overstatement of the CPIMC-hospital and related services component: the switch from inpatient procedures to outpatient procedures – mainly because of the cost-containment efforts supported by managed care organizations. The switch from inpatient to outpatient treatments may have increased the average complexity and cost of medical procedures for both types. Indeed, very complex procedures were still left as inpatient care, and those shifted to outpatient care were more complex than the average procedure of this category. Since outpatient and inpatient procedures enter separately and with fixed weights in the index calculation, the possible cost reduction of the shift to outpatient care may have not been reflected in the CPIMC-hospital and related services. This upward bias may have been exacerbated after 1987 with the expansion of managed care organizations. The BLS did not take corrective measures until 1998 (Berndt *et al*. 2000). Again, this bias should be rather small for the 1978-1990 transition period.

4.1 The CPI-medical care vs. the PCE-health care

As stated in Fixler and Jaditz (2002), there are three main differences between the BLS's CPIMC and the BEA's PCEHC: "First, the two indexes use different formulas. The CPI is a Laspeyres index, while the BEA product is a Fisher Ideal index. Second, the two indexes have different underlying concepts. The BLS product measures the prices paid by (urban) consumers, while the BEA product measures the prices of final consumption goods, wherever they are purchased. Finally, differences in how the detailed components are implemented lead to differences in how prices are measured and the weights attached to specific series."

As of December 2004, the medical care category as a whole has a weight of 6.1 percent in the CPI while health care has a weight of 20.3 percent in the PCE. The CPIMC is made up of two broad categories: Medical Care Services (with a weight of 2/3 in the overall basket) and Medical Care Commodities (with a remaining weight of 1/3); see Figure 4.2. Within Medical Care Services the items Hospital and Related Services and Professional Services are the main subcategories accounting for almost 45 percent of the CPIMC. Within Medical Care Commodities, the main category is Prescription Drugs, accounting for almost 20 percent of the overall index. Similar categories can be found in the PCEHC. Here, Hospital Services carries a weight of 36 percent, Physicians Services carries a weight of 20 percent, and Pharmaceutical Products carries a weight of 16 percent. Importantly, the CPIMC is based on private out-of-pocket expenditures, including employees' contribution to employment-based insurance. Thus, the CPIMC leaves out all government payments.

[Figure 4.2: The CPI–Medical Care Basket]

Figure 4.3 plots annual growth rates of the ratio of the CPIMC over the CPI [Panel (a)]. Again, it is evident the relatively sharp annual increases over the 1978-1990 transition period (2.31 percent annually) as compared to the other two periods (1.52 percent annually). A positive growth rate of the CPIMC over CPI can be interpreted as excess inflation in the medical care sector with respect to the average inflation in the economy. We can observe positive growth rates for almost every year. In Panel (b) we plot the ratio of the CPIMC over the PCEHC together with the corresponding ratios of their three main categories already mentioned. Again, the transition period is highlighted by two vertical lines. Observe that both indexes grow at similar rates until 1992. Then, the CPIMC grows at a faster pace than the PCEHC.

Hospital and Related Services has experienced the highest overall growth rate (3.76 percent annually for the CPIMC over CPI since 1978). Further, after 1993 this category grows faster in the CPI than in the PCE. Prescription Drugs shows the lowest growth rate before the transition period starts (-3 percent annually for the CPIMC over CPI), and grows faster than in the PCE after 1978. From the beginning of the transition period, the lowest growth rate corresponds to Physician's Services (1.35 percent annually for the CPIMC over CPI). In both cases Professional Services appreciate at a slower pace than the overall index since 1978, while Hospital Services appreciate at a much faster pace. Therefore, for both price indexes the highest increases relative to average inflation are observed within the 1978-1990 transition period, and the category of Hospital and Related Services seems to be the main driver of inflation in the US health care sector. The PCEHC grows at a slower pace than the CPIMC after 1992.

[Figure 4.3: The Evolution of the CPI–Medical Care and PCE–Health Care]

4.2 US medical prices, malpractice insurance costs, and health insurance premiums

We now study the evolution of related price measures that support excess inflation in the US medical care sector. Price increases for medical products and services have come along with cost hikes in other economic variables. Table 4.2 reports the evolution of costs for several related items:

(i) *Cost per Inpatient Day over CPI*: An independent measure of health care inflation reported by the American Hospital Association (sources: Goldman and McGlynn (2005), and the BLS).

(ii) *Direct Losses Incurred per Capita over CPI*: A proxy variable for the evolution of insurance companies' malpractice costs. It reflects insurers' expectations of the quantities that would have to be paid on claims reported in a year and any amounts expected to be paid out on claims from previous years (sources: the *2003 GAO Report on Medical Malpractice Insurance*, and the BLS).

(*iii*) *Direct Losses Paid* per *Capita over CPI*: it is also a proxy variable for the evolution of insurance companies's malpractice costs. It consists of cash payments that insurers make in a given period, such as a calendar year, on claims reported during both the current and previous years (sources: the *2003 GAO Report on Medical Malpractice Insurance*, and the BLS).

(*iv*) *Insurance-Premium Malpractice Index over CPI*: A measure of malpractice insurance costs for the providers of medical services. It is the average change in the cost of malpractice insurance for three physicians' specialties: General Medicine, General Surgery, and Obstetrics/Gynecology. Data from 1976 to 1986 are from Danzon (1991). Data from 1987 to 1990 are from Harrington *et al*. (2008). Data from 1991 to 2007 are from authors' computations from insurance costs for the specialties (Medical Liability Monitor Reports) over fifty-one states.

(*v*) *Private Health Insurance Premium per Enrollee over CPI*: The cost of health insurance for a privately insured person (sources: Cohen *et al*. (2009), the US Department of Health and Human Services – Centers for Medicare and Medicaid Services, and the BLS).

(*vi*) *Cost of Medicare per Enrollee over CPI*: Government's expenses per publicly insured elderly person (sources: the US Department of Health and Human Services – Centers for Medicare and Medicaid Services, and the BLS).

(*vii*) *HCE per Capita over CPI*: Real HCE per US inhabitant (sources: US Department of Health and Human Services – Centers for Medicare and Medicaid Services, and the BLS).

(*viii*) *CPIMC over CPI*: A measure of excess inflation in the US medical care sector with respect to the average inflation in the US economy (source: the BLS).

There are two main points to be highlighted from this table: All the variables grow faster than the CPI over the sample period, and the CPIMC displays the lowest growth. In fact, increases in the CPIMC seem quite modest in comparison with these other measures of medical costs.

Observe that the Cost per Inpatient Day over the CPI shows a steep cumulative increase of about 70 percent over the 1978-1990 transition period, whereas the CPIMC over CPI presents a cumulative increase of around 35 percent over the same period. All measures of malpractice insurance costs almost triple during the 1978-1990 transition period. The health economics literature [e.g., Harrington *et al*. (2008)] usually refers to the 1980s as the "crisis" of medical malpractice because of the frequency and severity of claims and the dramatic increase in the cost of malpractice insurance. A main argument against using malpractice as an explanatory variable is that these costs are rather low: About 1.25 percent of HCE expenditures. Of course, changes in malpractice insurance costs may be affecting medical care prices. Hence, malpractice insurance costs could be blamed for both increasing real medical care consumption and prices in the 1978-1990 transition period. Nevertheless, we find that changes in malpractice insurance costs are not strongly correlated with either changes in medical care prices or changes real quantities (the US technology residual) over the whole sample period (the contemporaneous correlation coefficients are 0.07 and -0.27 respectively).

Private Health Insurance per Enrollee over CPI more than doubles over the 1978-1990 transition period. In this case, changes in Private Health Insurance per Enrollee over CPI are contemporaneously correlated with changes in CPIMC over CPI (a correlation coefficient of 0.43). Moreover, Private Health Insurance per Enrollee has grown faster than HCE per Capita over the entire sample period. This increment came along with decreasing out-of-pocket expenditures. Changes in out-of-pocket expenditures seem correlated with changes in medical consumption (a correlation coefficient of -0.43) but not with changes in CPIMC over CPI.

It should be noted that the Cost of Medicare per Enrollee and HCE per Capita have moved together over the sample period. Since the distribution of the population over the categories of uninsured, privately and publicly insured remained quite stable over the last three decades (Figure 2.7), aging and the size of the elderly population appear to be a minor factor for accounting for the observed increase in the US medical care expenditure gap over our sample period.

[Table 4.2: US Medical Prices, Malpractice, and Health Insurance Premiums]

To sum up, related measures of medical care costs show much steeper increases than the CPIMC over both the 1978-1990 transition period and the entire sample period. On these grounds, the CPIMC seems a conservative measure of health care costs. Medical care quantities seem to be positively influenced by out-of-pocket expenditures, while malpractice insurance costs seem uncorrelated with either quantities or prices. Changes in health care prices and changes in private insurance costs are positively correlated.

4.3 Microeconomic evidence of international health care prices

Several studies and international institutions have reported marked cross-country differences in health care prices. Figure 4.4 presents costs of several health care items in five OECD countries as of year 2011. These costs are reported as fractions of the corresponding US cost. Switzerland exhibits the second highest costs: Around 65 percent of US dollar costs. For the remaining countries in the sample, the unitary prices observed are around one fifth of US costs.

[Figure 4.4: International Health Care Prices over US Health Care Prices 2011]

There is a large international market for prescription drugs, and the cross-country variability in wholesale drug prices is well documented. An early study by Jacoby and Hefner (1971) reported prices for twenty drugs in nine countries. The study confirms a great variation from country to country for a single product by the same manufacturer. Some on-patent drugs were even three times cheaper outside the US. Using 121 drugs to compare US prices with those of Canada and seventy-six drugs to compare with the UK, two GAO reports (GAO 1992, 1994) found that manufacturers prices in the US were on average 32 percent higher than in Canada and 60 percent higher than in the UK.

Later research has expanded the range of sample products to provide accurate price measures. Danzon and Furukawa (2003) consider a sample of 249 leading US molecules for nine representative countries including the US. The sample represents 30 to 60 percent of sales in these countries.

Manufacturer prices in the eight countries are usually between 20 to 40 percent lower than in the US. While on-patent brands may be almost 50 percent cheaper in some of these countries, generic drugs are usually cheaper right after patent expiration, but later on they become relatively more expensive than in the US (Danzon and Furukawa, 2011). A related study by the US Department of Commerce (2004) on patented prescription drugs reports price indexes that could be 50 percent lower than their US counterparts (*op. cit.*, p. 38). Several factors have been advanced to justify the high prices of prescription drugs in the US:

(*i*) *Products Liability*: Manning (1995) argues that both the litigation experience of specific pharmaceutical products and measures of substantial risk may have significant effects on the ratio of US to Canadian prices. Manning (1995) estimates that the observed distribution of price differences between the two countries has a mean of 69 percent higher in the US and a median of 43. Adjusting for the effects of product liability reduces the predicted mean and median to 36 and 33 percent respectively. The virtual effect of the liability is to eliminate the upper tail of the distribution of price differences for risky and highly advanced prescription drugs.

(*ii*) *Market Interventions*: According to the aforementioned study of the US Department of Commerce (2004) the pharmaceutical sector in the US follows guidelines which are closest to the free market. Most OECD countries engage in various forms of market intervention: Price controls, price reductions through monopolistic pricing and reimbursement policies, reference pricing (international or therapeutic reference pricing), volume limitations, profit controls, price floors to support local generic products, approval delays, and procedural barriers. The study argues that these restrictions influence drug prescription prices, the number of launches of new active substances, and drug availability.

(*iii*) *Income per Capital Levels*: Income levels could be reflected in higher quality requirements, higher prices for non-tradable goods (the Balassa-Samuelson effect) and lower elasticities for the pricing of international goods. From cross-country evidence [Summers and Heston (1991)], a 10 percent increase in income per capita may lead to a 3 percent increase in the relative price of non-tradable goods and services such as health care.

5 Who Benefits From High Prices?

5.1 Physicians' compensation, relative productivity, and labor supply

Table 5.1 reports some indicators of physicians' compensation, productivity, and labor supply between 1970 and 2000. In row (*i*) we observe that total physicians' compensation over HCE has decreased from almost 15 percent in 1982 to 13.1 percent in 2000. Physicians' compensation over the average worker compensation in the economy increased between 1980 and 1990 but ended at a similar ratio in 2000 [row (*ii*)] while physicians' productivity has outpaced average worker productivity [row (*iii*)].[12] Row (*iv*) of the table shows the evolution of the average compensation of a non-physician health care worker with respect to a physician. This ratio does not vary over the sample period.

[Table 5.1: Physicians' Compensation, Relative Productivity, and Labor Supply]

HCE growth has expanded the labor force in the sector. In the 1970-2000 period, the number of active physicians increased from 15 per 10,000 people to 26 per 10,000 people [row (*v*)]. The composition of the health care labor force has also changed. Row (*vi*) shows that the quantity of physicians over total health care workers has decreased from almost 11.7 percent in 1970 to 7.2 percent in 2000. With the introduction of Medicare and the subsequent expansion of the health care sector we observe a considerable increase in the number of non-physician workers in the health care industry [row (*vii*)]: The ratio of health care workers over the total number of workers in the economy has more than doubled between 1970 and 2000.

Is the increase in the quantity of health care workers driving the increase in health care costs? To answer this question we estimate the relative income share of health care workers. This is total compensation for workers in the health services industry over HCE. As seen in row (*viii*), the labor income share increases between 1970 and 1980 and then remains almost constant at around 30 percent. There is a sharp increase between 1966 and 1974, right after the introduction of the Medicare program in 1965. We conclude that the labor share in the health care sector cannot account for the observed increase in the ratio of HCE over GDP, especially during the 1980s.

5.2 Profitability of publicly traded companies in the health care industry

Several studies analyze the degree of competition in the US medical care sector. For instance, Dunn and Shapiro (2011) claim that physicians' market power may bias medical care prices and the quantity of health care services provided. Skinner *et al*. (2005) argue that Medicare spending appears to be highly inefficient: About 20 percent of Medicare expenditures do not provide any increase on survival rates or quality of life for the elderly population.

As already discussed, physicians did not particularly benefit from the observed HCE growth. Are private companies able to take advantage of existing frictions and regulations in the health care market? And do abnormal returns occur in periods of high or low HCE growth? It seems natural to approach these questions using standard tools from the empirical asset pricing literature. Abnormal returns may be linked to market inefficiencies, distorting regulations, or entry barriers in the health care industry.

Let us first compare the returns obtained by private companies in the health care sector with those of other competitive markets. Large differences can be interpreted as abnormal returns directly linked to the possibility of arbitrage opportunities. It is well known that competition leads to an

[12] We calculate average worker compensation as the ratio of *compensation of employees* (NIPA table 2.1) over *full-time and part-time employees* (NIPA table 6.4). NIPA tables are available at http://www.bea.gov/iTable.

equilibrium in which the law of one price holds.

We use data on publicly traded firms in the US between January 1979 and December 2009 from the Center for Research in Security Prices (CRSP). Based on the Standard Industrial Classification (SIC) code, we select *SIC 80* and *SIC 632* as industries comprising health care companies.[13] We retrieve monthly observations to construct annual data. We delete firms with missing information: A firm must have data on returns (including dividends), end of the month closing price, and total number of shares outstanding.[14]

We compute abnormal returns as the difference between the observed market returns and the returns predicted by an equilibrium model. Several models have been proposed to estimate equilibrium expected returns. The Capital Asset Pricing Model (CAPM) is a well known example in which the expected return is given by the amount of non-diversifiable risk (also called systematic risk). An abnormal return is a statistically significant difference between the expected return predicted by the model and the realized return observed in the market. The source of systematic risk in the CAPM is the market portfolio, which is the value-weighted portfolio of all the valuable assets in an economy. The following econometric version of the model has been widely tested:

$$r_i - r_f = \alpha_i + \beta_i(r_m - r_f) + \varepsilon_i \tag{11}$$

where r_i is the vector of returns of the assets under study (in our case i=*SIC80*, *SIC632*), r_f is the risk free rate, r_m is the vector of returns of the proxy used for the market portfolio, and ε_i is the vector of asset specific returns or non-systematic risk.[15] If asset i is properly priced given its quantity of systematic risk (β_i), then α_i should be statistically not different from zero, which implies the absence of abnormal returns.

In addition to the CAPM, we use two other popular models in the empirical asset pricing literature: The Fama-French (FF) three-factor model, and the FF model augmented with the momentum factor – known as the Carhart model. These models have been proposed to control for sources of systematic risk that the CAPM might be missing. Using standard OLS techniques, we test the

[13] *SIC 80*: Establishments primarily engaged in furnishing medical, surgical, and other health services to persons. Establishments of associations or groups, such as Health Maintenance Organizations (HMOs), primarily engaged in providing medical or other health services to members are included, but those which limit their services to the provision of insurance against hospitalization or medical costs are classified as Insurance, Major Group 63. Hospices are also included in this major group and are classified according to the primary service provided.

SIC 632: Establishments primarily engaged in underwriting accident and health insurance. This industry includes establishments which provide health insurance protection for disability income losses and medical expense coverage on an indemnity basis. These establishments are operated by enterprises that may be owned by shareholders, policy holders, or other carriers. Establishments primarily engaged in providing hospital, medical and other health services on a service basis or a combination of service and indemnity are classified under Industry 6324.

Definitions available at http://www.osha.gov/pls/imis/sicsearch.html are from the US Department of Labor.

[14] The list of companies used to construct each SIC portfolio is available from the authors upon request.

[15] The proxy for the market portfolio is the Value-Weighted Market Index published by The Center for Research in Security Prices (CRSP) that includes stocks that trade on the NYSE, AMEX and NASDAQ stock exchanges. The proxy for the risk free rate corresponds to the 1-month TBill return from Ibbotson and Associates, Inc. Data are downloaded from Kenneth French website (http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html).

following econometric versions of the FF and Carhart models:

$$r_i - r_f = \alpha_i + \beta_{i1}(r_m - r_f) + \beta_{i2}SMB + \beta_{i3}HML + \varepsilon_i \tag{12}$$

$$r_i - r_f = \alpha_i + \beta_{i1}(r_m - r_f) + \beta_{i2}SMB + \beta_{i3}HML + \beta_{i4}MOM + \varepsilon_i \tag{13}$$

where SMB captures size, HML captures book to market value, and MOM captures momentum profits.[16]

Table 5.2 reports coefficient estimates for equations (11)-(13) for sectors SIC 80 and 632. For each regression we report R^2 and p-values. The abnormal return α is positive and significant for both health care industry portfolios across all three models. For the *SIC 80* portfolio, the p-value for α is always less than 0.001. For the *SIC 632*, the p-value for α is always less than 0.025. For the Carhart model, the monthly α for *SIC 80* portfolio is equal to 1.11 percent. This translates to a yearly cumulative abnormal return of about 14.16 percent. Therefore, the results in Table 5.2 provide solid evidence of abnormal returns for publicly traded firms in the health care industry over the last thirty years.

[Table 5.2: Tests of Abnormal Returns 1979-2009]

Let us next move to the second question: Are abnormal returns driven by HCE growth? In Figure 5.1, we plot yearly abnormal returns from each SIC portfolio against the growth rate in HCE. The yearly abnormal returns are computed under the CAPM.[17] Since financial variables are much more volatile than macro variables, we consider a five-year moving average to smooth out the estimates. The figure displays the five-year moving average of the abnormal returns and growth rates of HCE. These variables display similar trends – suggesting a link between abnormal returns observed in the health care industry and HCE growth. Therefore, we find evidence of abnormal returns in the health care sector. This evidence signals existence of market frictions such as entry barriers: Abnormal returns occur at times of high HCE growth.

[Figure 5.1: Abnormal Returns and Health Care Expenditures 1979-2009]

6 Concluding Remarks

In this paper we are concerned with the evolution of US health care expenditures. Since 1980, the US features the highest health care expenditure share of all the OECD countries. With the approaching retirement of the baby-boom generation, it is feared that the US medical care expenditure gap will

[16] SMB, HML and MOM are generally considered to be sources of non-diversifiable risk; see Fama and French (1993) and Carhart (1997). Data are downloaded from Kenneth French website.

[17] In this figure we use a constant beta estimated over the entire sample. We also estimated rolling betas and alphas based on sixty consecutive monthly returns. Results are qualitatively the same and are available from the authors upon request.

continue to increase. Thus, managing health care expenditure growth has become a topic of national concern, and a tall order for balanced economic growth.

To guide this discussion, we examine a sample of eleven OECD countries with similar income and quality data, during the years 1970-2007. We define the US medical care expenditure gap as the US medical expenditure share over the average medical expenditure share of the other OECD countries in our study. We distinguish the following time periods: (*i*) *The* 1970-1977 *period*: The US medical care expenditure gap hovered around 1.1, (*ii*) *The* 1978-1990 *period*: The US medical care expenditure gap increased steadily from 1.1 to 1.55, and (*iii*) *The* 1991-2007 *period*: The US medical care expenditure gap stabilized around 1.5. The 1978-1990 period stands out as a transition episode with the sharpest increase in the US medical care expenditure gap.

One major difficulty in uncovering these growth patterns for US medical expenditures appears to be the high degree of uniformity in the various National Health Expenditure Accounts' categories by source and use of funds. These regular trends continue through the 1978-1990 transition period. Moreover, when adjusting for inflation in the medical sector, we obtain that the ratio of real health care expenditures over real GDP is quite flat over the *entire* sample period.

We then perform a growth accounting exercise to filter out the price effect under a price elasticity of the demand for health care around -0.17. Several microeconomic studies exist on the cost effects of various technologies [e.g., Chandra and Skinner (2012)]. Our cross-country macroeconomic analysis is intended to assess the differential effects of technology (and several other residual factors) on health care expenditures across our sample of OECD countries. Three important facts emerge from our study: (*i*) The US technology residual behaves quite similarly throughout all three time sub-periods considered in our sample. Hence, the 1978-1990 period is not particularly characterized by a higher technology residual. This seems to accord with the aforementioned stability of real health care expenditures over real GDP observed in the US economy. (*ii*) The pace of the US technology residual does not differ much from the average pace of the OECD technology residual. And (*iii*) sharp breaks in the technology residuals are usually associated with medical reforms and regulations.

Consequently, this growth accounting study appears to indicate that technological change would not be a major driving force for the pronounced increase in medical expenditures over the 1978-1990 transition period. Of course, as in every growth accounting exercise there are many open issues regarding the measurement of macroeconomic aggregates and quality adjustments. In the macroeconomic literature, these measurement issues are usually quite challenging, and most of the time can become insurmountable. Therefore, the purpose of a growth accounting exercise is to isolate the influence of some key economic factors by grouping together measurement errors with the effects of all other variables that have been neglected in the analysis. We have tried to minimize the quality effect by conditioning over a reduced sample of countries with commensurate technology levels and good data quality.

Our analysis suggests that there is a group of economic variables that cannot account for the observed growth patterns of the US medical care expenditure gap. This group includes GDP growth, life expectancy, defensive medicine, physicians' compensation, and trends in the elderly and insured population. In other words, these variables do not present enough variability in the data to account for the 1978-1990 transition period. US GDP growth has been lower than average OECD growth, and US life expectancy has simply been trailing the OECD average. Also, real Medicare cost per enrollee has been growing at the same pace as real health care expenditures per capita, public and private health expenditures have moved *in tandem*, and the distribution of the population over the categories of uninsured, privately and publicly insured has remained quite stable over the last three decades. Our growth accounting exercise does not leave further room for increasing trends in defensive medicine; indeed, we observe a slight decline in real medical expenditures per capita by the end of the 1990s with the widespread use of "managed care." Lastly, the ratio of total physicians' compensation over health care expenditures has trended downwards, and the labor income share of the health care sector has remained flat over the sample period in spite of considerable job creation.

On the other hand, there is another group of variables, which cannot be discarded as possible explanatory factors over the 1978-1990 transition period: the relative price of medical care, and malpractice insurance costs. Within our OECD sample, the US underwent the most acute inflation in medical care consumption with respect to all other goods. The "crisis" of medical malpractice occurred in the transitional period of the 1980s, along with marked increases in US health care expenditure and the medical price gap. Hence, malpractice insurance costs could be blamed for both increasing real medical care consumption and prices in the transitional period. Nevertheless, we find that malpractice insurance costs are not strongly correlated with either medical care prices or real quantities (the US technology residual) over the entire sample period. Rather weak correlations for both medical care prices and medical consumption are also found for out-of-pocket expenditures.

Some health care programs become noticeable because of trend breaks in our growth accounting exercise. In the US the introduction of Medicare and Medicaid, as well as some other medical reforms have expanded the demand for health care. Increases in health care expenditures as a result of medical reforms, however, seem to be more pronounced in other OECD countries such as France and Spain, which have implemented systems of universal health care insurance.

Besides the aforementioned 1978-1990 transition period, health care prices seem to account for some other important episodes in the recent US health care history. For instance, during the Clinton presidency (1993-2000), aggregate health care expenditures over GDP remained quite flat. This was actually a period of low excess inflation in the health care sector and high GDP growth rates.

Therefore, the issue reduces to the following basic questions: (i) Are US health care prices higher than those of other OECD countries? And, if so, (ii) What are the explanatory factors behind the higher US prices? Section 4 of this paper provides extensive evidence in support of the higher US prices concerning medical care services and prescription drugs. Inflation in the US health care sector can be documented using various sources besides the CPI. Hospital and related services appears to be a main driver of inflation in the US health care sector over the 1978-1990 transition period. Besides, malpractice indicators and health insurance premiums present much higher price increases than the

CPI-medical care. The health economics literature has identified various factors that account for the higher prices of prescription drugs in the US, which may also extend to the observed high prices of hospital and other medical services. Meantime, certain regulations in overseas health care markets appear to be quite effective at suppressing prices.

Medical care expenditures are strongly correlated with corporate profits and stock market returns, but weakly correlated with salaries and labor income shares. Technological innovation and market power may thus be important determinants of health care prices. Physicians' compensation seems unrelated to medical price increases. In this regard, it is employment and not salaries, which has driven the observed growth in US health care expenditures. The labor income share in the US medical sector has been roughly constant at about 30 percent over our sample period.

7 Appendix: Definitions and Data Sources

Total Consumption (OECD data): The sum of government final consumption expenditure and private final consumption expenditure (private refers to household and non-profit institutions serving households. See http://stats.oecd.org/glossary/).

Health Care Expenditures (OECD data): "The expenditure on activities that – through application of medical, paramedical, and nursing knowledge and technology – has the goals of: Promoting health and preventing disease; Curing illness and reducing premature mortality; Caring for persons affected by chronic illness who require nursing care; Caring for persons with health-related impairments, disability, and handicaps who require nursing care; Assisting patients to die with dignity; Providing and administering public health; Providing and administering health programs, health insurance and other funding arrangements.

With this boundary, general public safety measures such as technical standards monitoring and road safety are not considered as part of expenditure on health. Activities such as food and hygiene control and health research and development are considered health-related, but are not included in total health expenditure. Expenditures on those items are reported separately in the chapter on health-related functions." (OECD Health Data 2012 Definitions, Sources and Methods; available at http://stats.oecd.org)

Medical Care Prices:

Medical care prices from 1970 to 1977 for the eleven OECD countries in the sample are from Gillion *et al*. (1985). Remaining data come from the following sources:

Australia: Data from 1989 to 2007 corresponds to the health component of the CPI (available from the Australian Bureau of Statistics at http://www.abs.gov.au). Data from 1978 to 1988 corresponds to the health price index published by the OECD (available at http://stats.oecd.org/).

Canada: Data corresponds to the health and personal care price index component of the CPI (available from Statistics Canada at http://www76.statcan.gc.ca).

Denmark: Data from 1996 to 2007 corresponds to the CPI–health price, available at the FRED database (Federal Reserve Bank of St. Louis). Data from 1978 to 1995 corresponds to the health price index published by the OECD (available at http://stats.oecd.org/).

Finland: Data from 1996 to 2007 corresponds to the CPI–health price, available at the FRED database (Federal Reserve Bank of St. Louis). Data from 1978 to 1995 corresponds to the health price index published by the OECD (available at http://stats.oecd.org/).

France: The CPI–medical care is the union of the following three price indexes: (*i*) The health services up to year 1992 (and then discontinued), (*ii*) The medical services and health care expenditures up to year 1998 (and then discontinued), and (*iii*) The health services from 1998 to 2007 (available from the French National Institute for Statistics and Economic Studies at http://www.bdm.insee.fr).

Germany: Data up to 1983 is from Gillion *et al*. (1985). Data from 1991 until 2007 corresponds to the health component of the CPI (available from the German Federal Statistics Office at https://www.destatis.de/). Data for the missing period 1984-1990 has been interpolated using data from Schieber *et al*. (1994).

Ireland: Data corresponds to the health subcategory of the CPI, which is available from the Irish Central Statistics Office at http://www.cso.ie/.

Japan: Data corresponds to the medical care item of the CPI [available from the Japanese Statistics Bureau, Director-General for Policy Planning (Statistical Standards) and Statistical Research and Training Institute at http://www.stat.go.jp/].

Spain: The CPI–medical care is constructed as the union of several price indexes. From 1977 to 1992 we used the CPI–medicine (IPC–medicina). For the period 1993-2001 we used the average change in five subcategories of the CPI: medical, dental and non-hospital paramedical services (servicios médicos, dentales y paramédicos no hospitalarios), drugs and other pharmaceutical products (medicamentos y otros productos farmacéuticos), machines, therapeutic material and its repairs (aparatos y material terapéutico y sus reparaciones), hospital care (cuidados en hospitales y similares), and medical insurance (seguros médicos). From 2002 to 2007 we used the average change in the three available subcategorios: Drugs, pharmaceutical products and therapeutic material (medicamentos, otros productos farmacéuticos y material terapéutico), medical, dental and non-hospital paramedical services (servicios médicos, dentales y paramédicos no hospitalarios), and hospital services (servicios hospitalarios). Available from the Instituto Nacional de Estadística at http://www.ine.es/.

United Kingdom: Data up to 1983 is taken from Gillion *et al*. (1985). Data from 1988 until 2007 corresponds to the health component of the CPI (available from the Office for National Statistics at http://www.ons.gov.uk/). Data from the missing period 1984-1987 has been interpolated using data from Schieber *et al*. (1994).

United States: Data corresponds to the CPI–medical care (available from the Bureau of Labor Statistics at http://www.bls.gov/).

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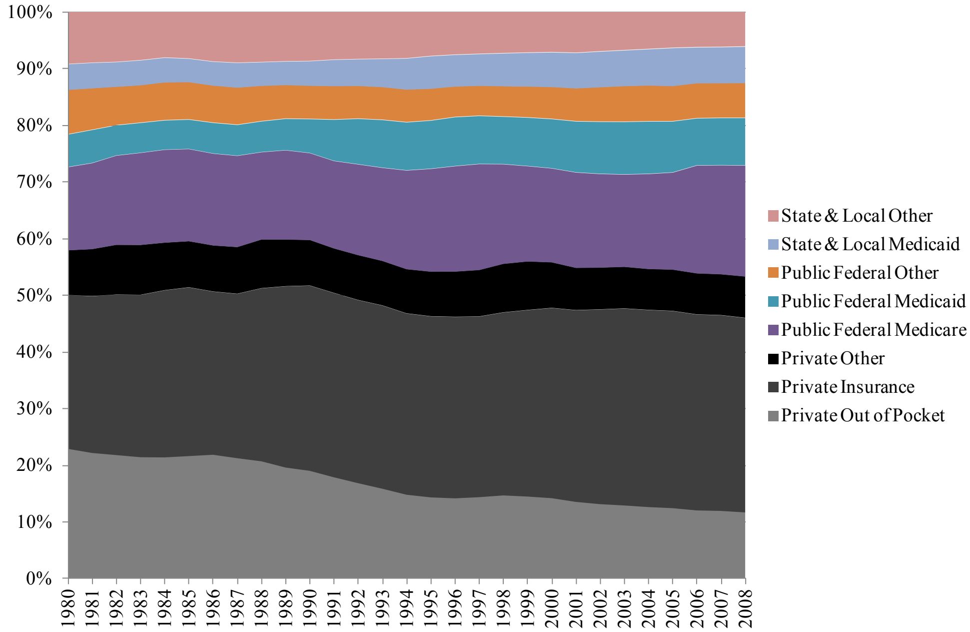
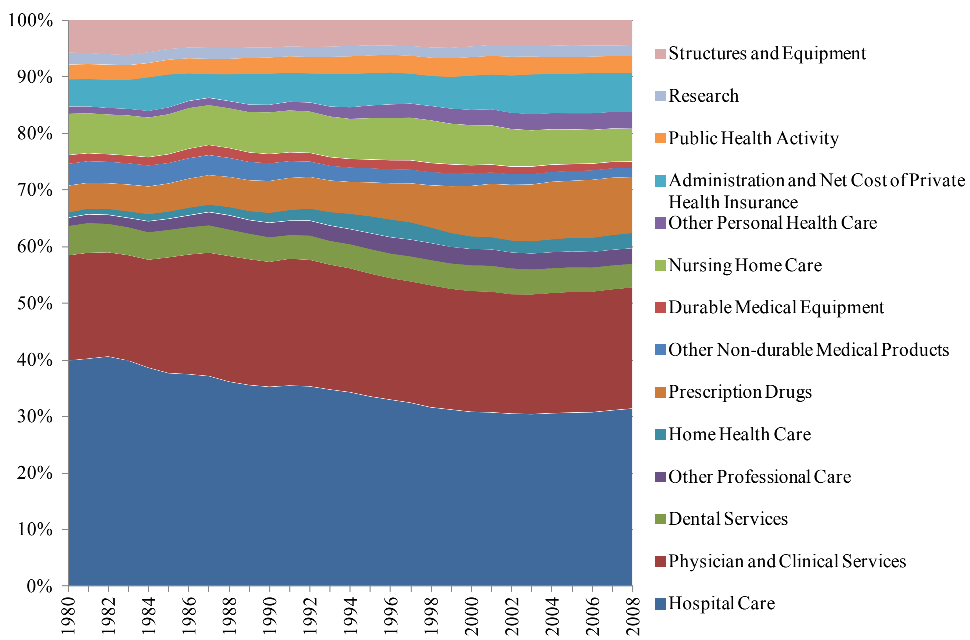
Figure 1.1: The Evolution of US Health Care Expenditures by Source 1980-2007



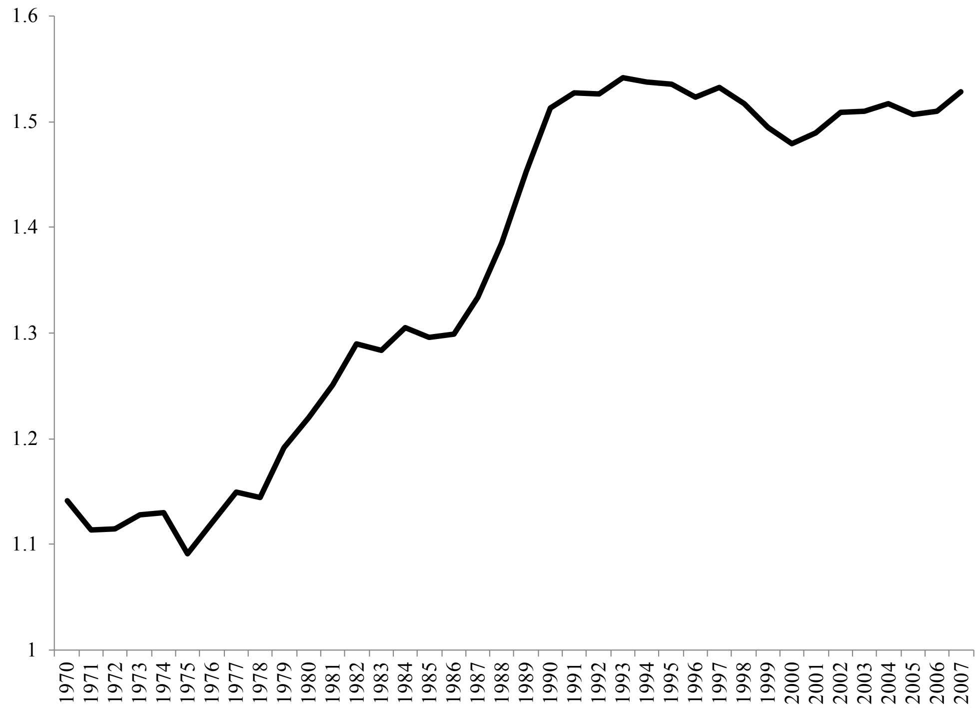
Source: US Department of Health and Human Services - Centers for Medicare and Medicaid Services.

Figure 1.2: The Evolution of US Health Care Expenditures by Use 1980-2007



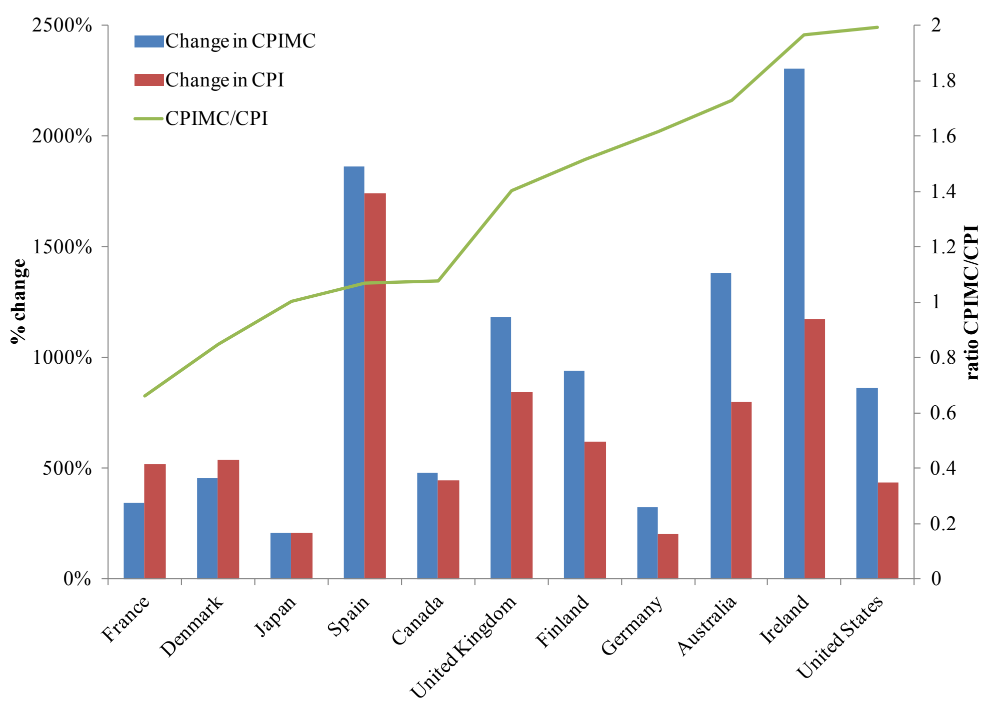
Source: US Department of Health and Human Services - Centers for Medicare and Medicaid Services.

Figure 2.1: The US Medical Care Expenditure Gap 1970-2007



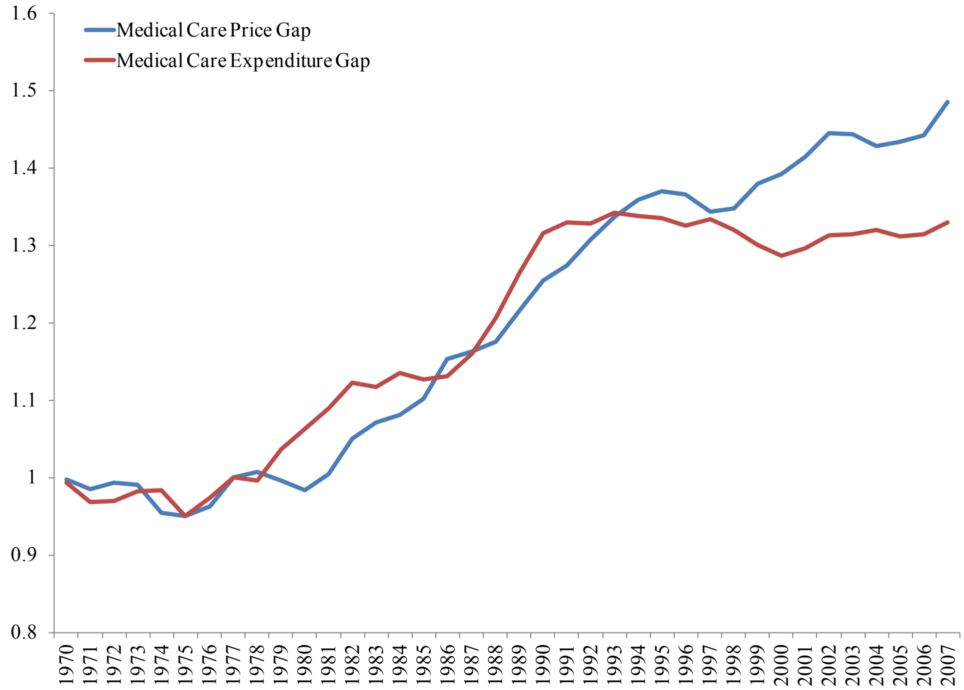
Source: OECD Health Data (June 2012)

Figure 2.2: The Medical Care Price Gap 1970-2007



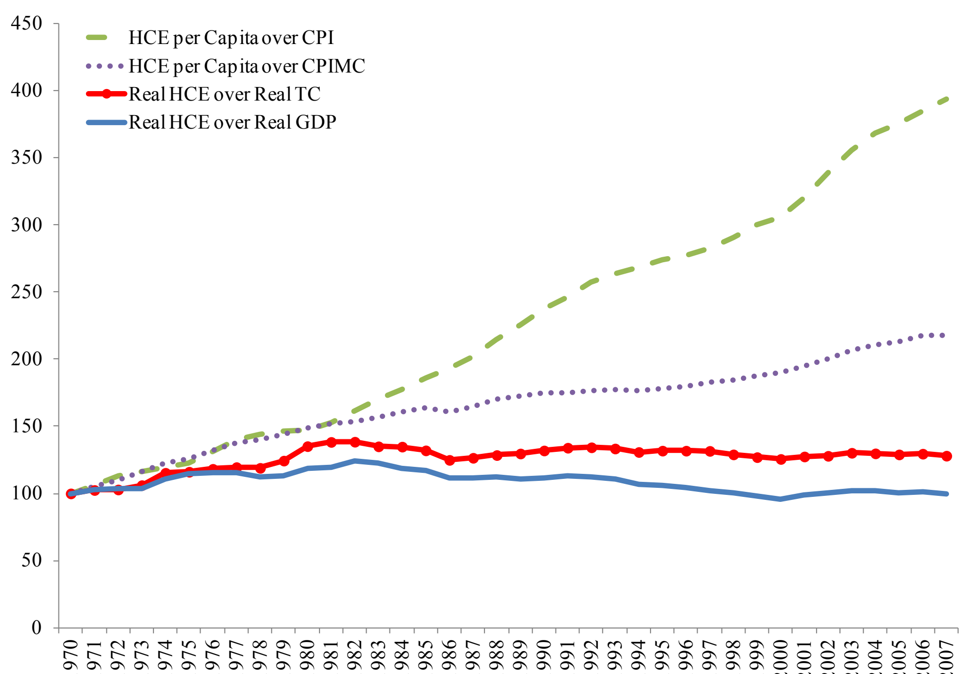
Source: Official statistics of each country and authors' computations.

Figure 2.3: The US Medical Care Expenditure Gap vs. the Price Gap 1970-2007



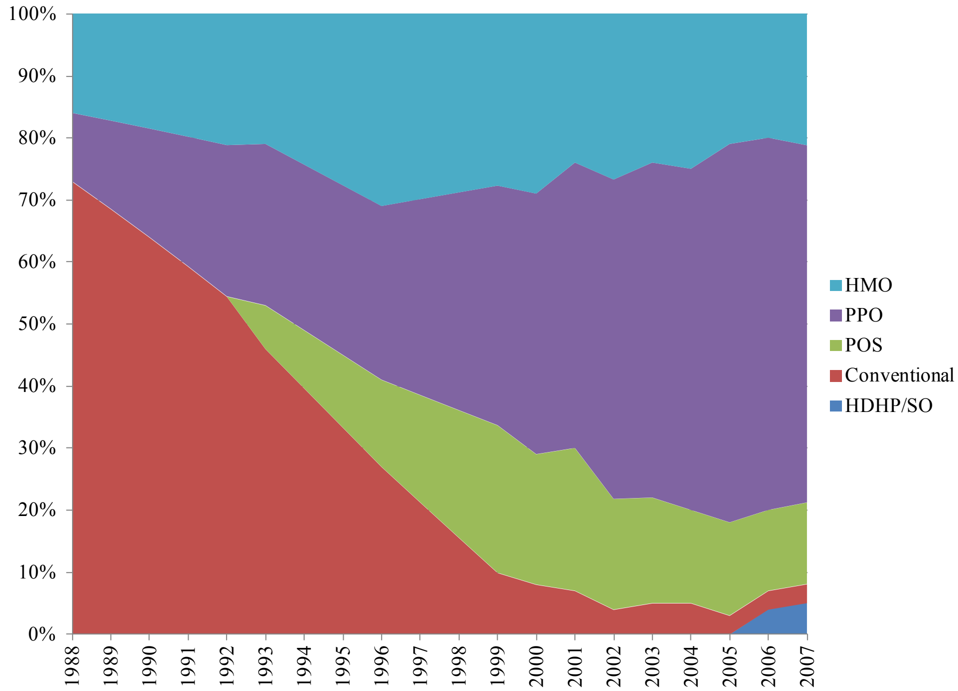
Source: Health Care Expenditures are from the OECD Health Data (June 2012). Health Care Price data are taken from each country's official statistics and authors' computations.

Figure 2.4: The Evolution of US Health Care Expenditures 1970-2007



Source: US Department of Health and Human Services - Centers for Medicare and Medicaid Services and the Bureau of Labor Statistics.

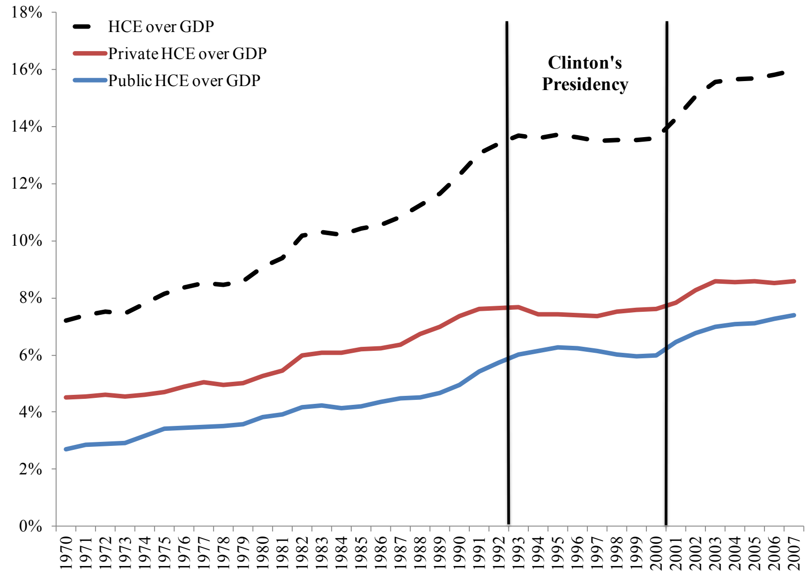
Figure 2.5: The Structure of the Insurance Market



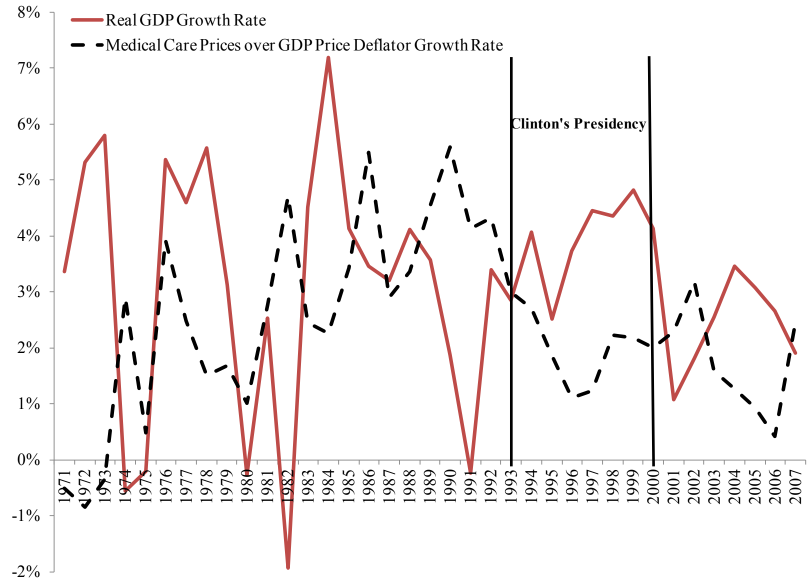
Source: Kaiser Family Foundation

Figure 2.6: US Health Care Expenditures over GDP, Real GDP Growth, and the Relative Medical Care Price

(a) Public, Private and Total Health Expenditures over GDP

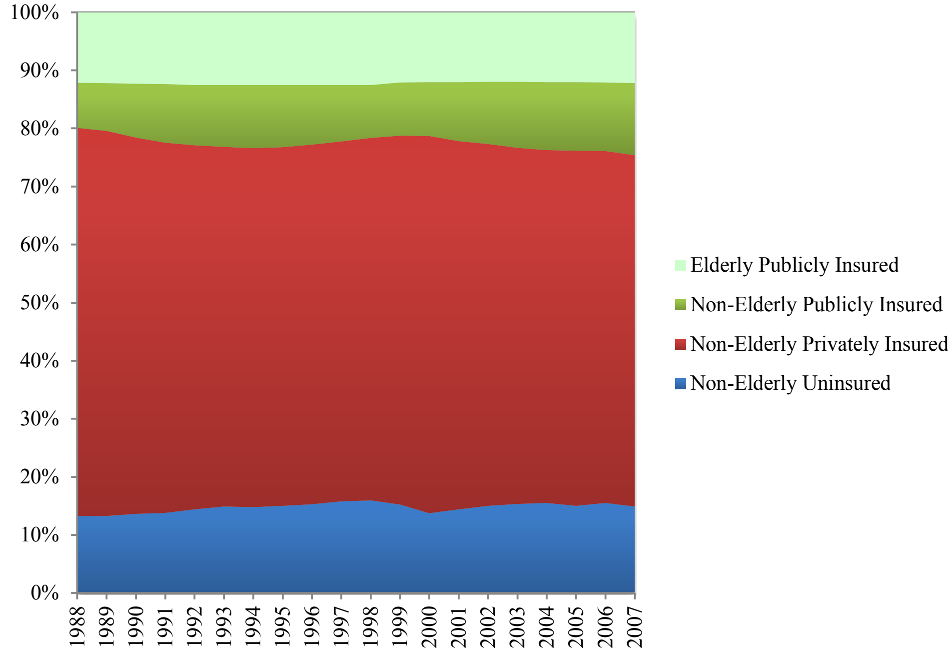


(b) Annual Real GDP Growth and Excess Inflation in the Relative Medical Care Sector



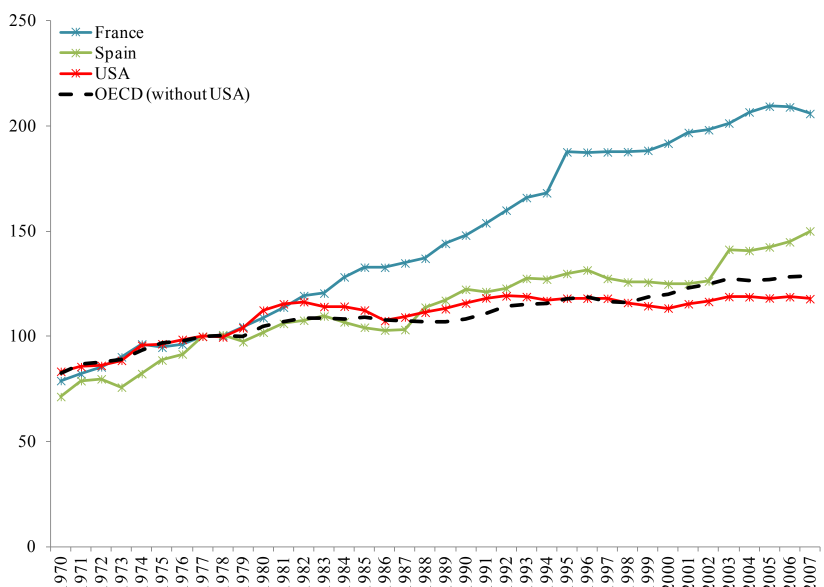
Source: US Census Bureau and US Department of Health & Human Services - Centers for Medicare and Medicaid Services

Figure 2.7: Distribution of the Population by Health Insurance



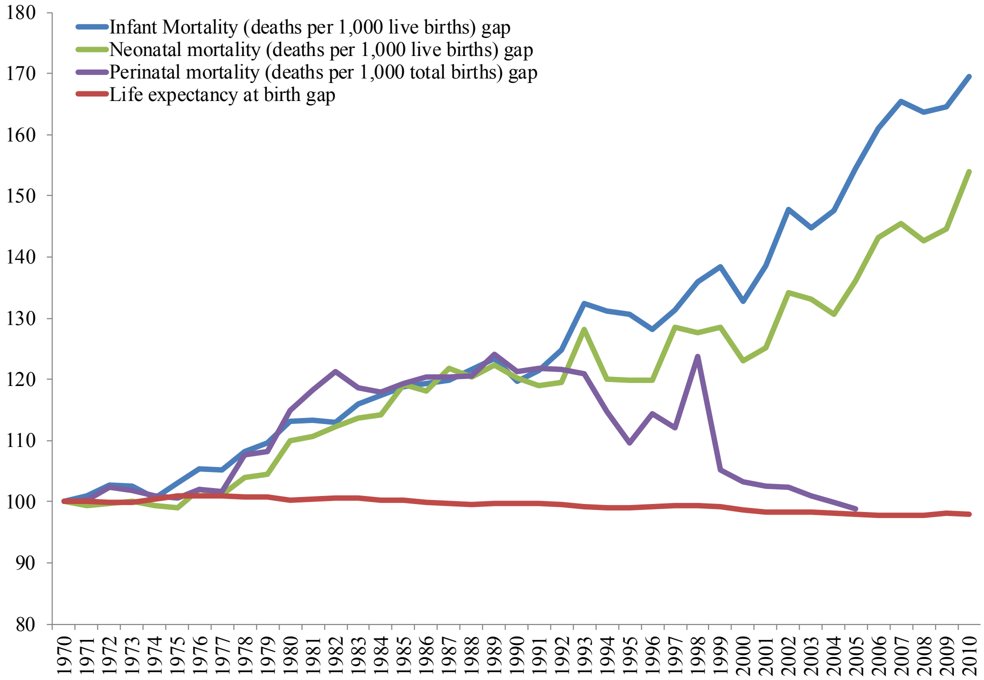
Source: Gruber & Levy (2009) and US Department of Health and Human Services - Centers for Medicare and Medicaid Services.

Figure 3.1: A Growth Accounting Exercise: The Technology Residual for France, Spain, the US, and the OECD average



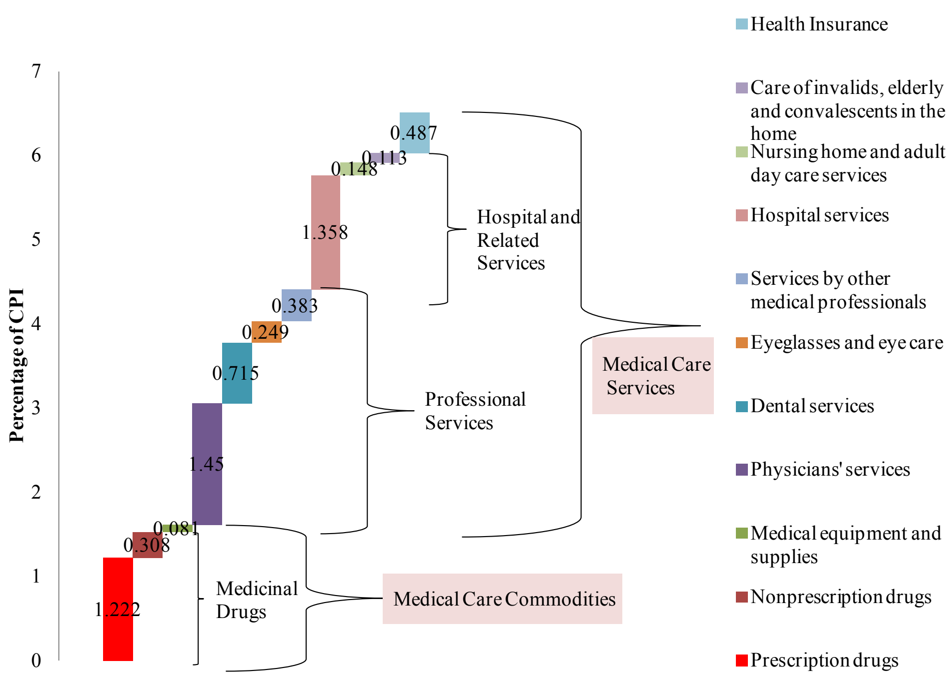
Source: Health Care Expenditure data are from the OECD Health Data (June 2012). Health Care Price data are taken from each country's official statistics and authors' computations.

Figure 4.1: Quality Indicators over Time



Source: OECD Health Data (June 2012).

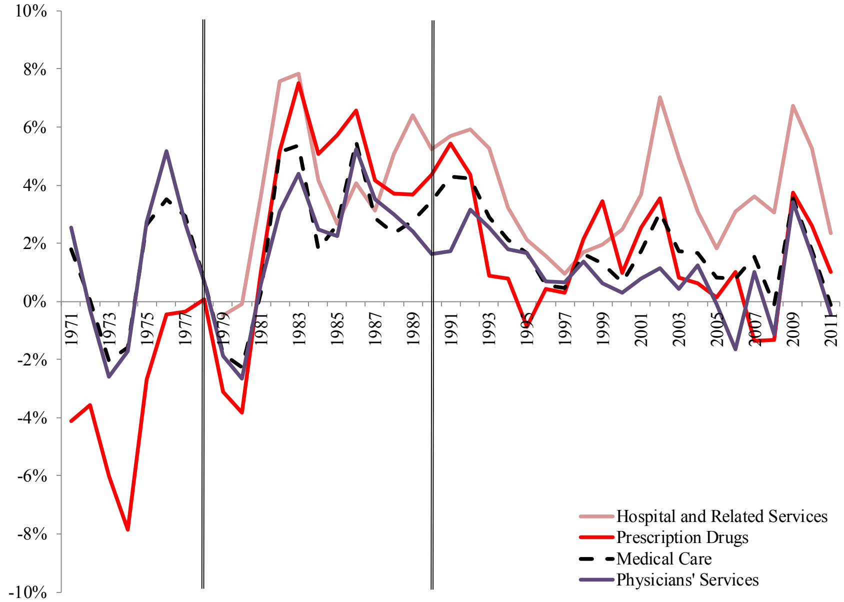
Figure 4.2: CPI--Medical Care Basket



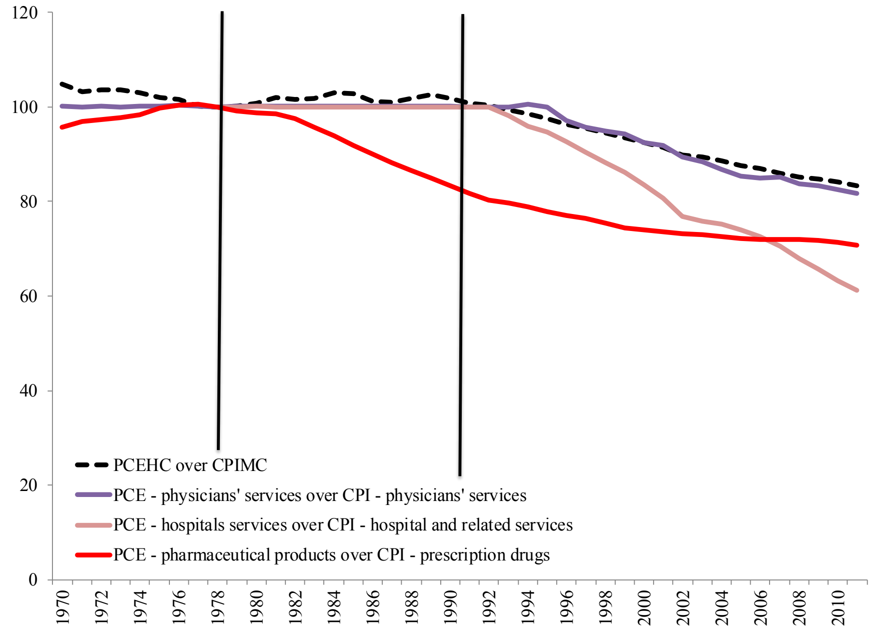
Source: US Bureau of Labor Statistics

Figure 4.3: The Evolution of the CPI--Medical Care and PCE--Health Care

(a) CPI--Medical Care over CPI (Annual Growth Rate)

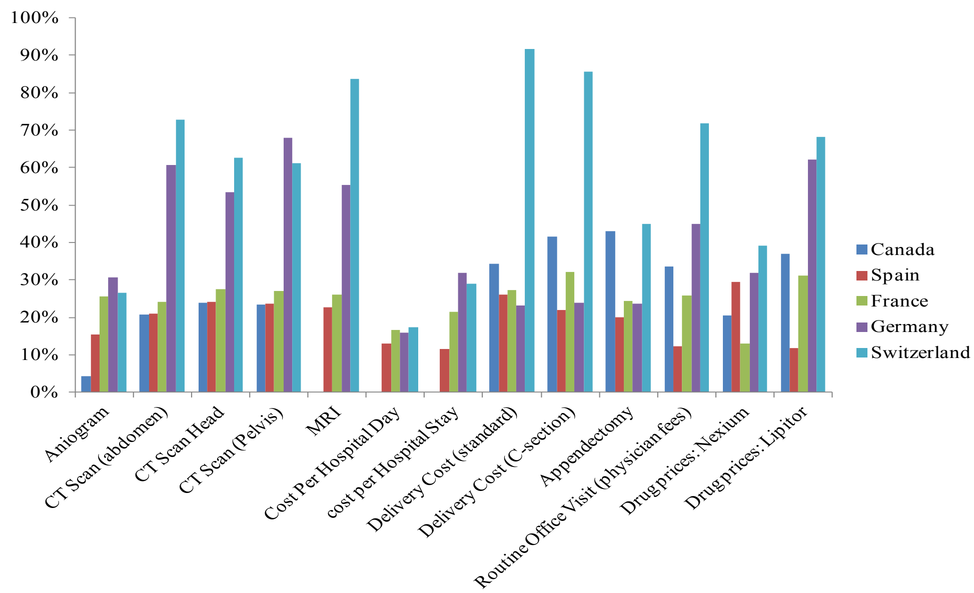


(b) PCE--Health Care over CPI--Medical Care



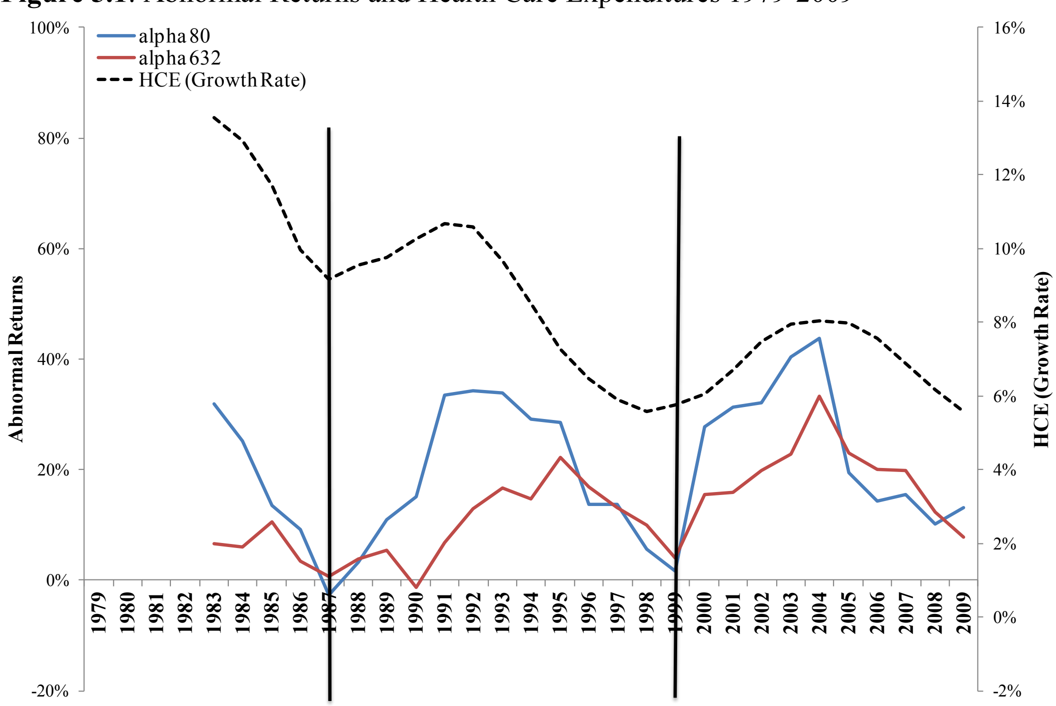
Source: US Bureau of Labor Statistics and Bureau of Economic Analysis

Figure 4.4: International Health Care Prices over US Health Care Prices 2011



Source: International Federation of Health Plans. 2011 Comparative price report: medical and hospital fees by country. http://ifhp.com/documents/IFHP_PriceReport2010ComparativePriceReport29112010.pdf.

Figure 5.1: Abnormal Returns and Health Care Expenditures 1979-2009



Source: CRSP, Bureau of Economic Analysis, US Department of Health & Human Services - Centers for Medicare and Medicaid Services, and Kenneth French webpage.

Table 3.1: Root Mean Square Errors

	ρ = -3	ρ = -4	ρ = -5
A_t^{OECD}	0.59	0.66	0.75
A_t^{OECD} *filtered*	0.68	0.62	0.61
A_t^{OECD} without France and Spain	1.30	1.17	1.08

Table 4.1: Quality Measures for the Year 2003

				2003				
Variable	**Obs**	**Mean**	**US/Mean**	**US/Max**	**Std. Dev.**	**StdDev/Mean**	**Min**	**Max**
Life Expectancy	11	81.82	**0.97**	**0.93**	1.97	*0.024*	79.60	85.30
Breast cancer five-year observed survival rate (female)	18	72.66	**1.07**	**1.00**	4.28	*0.059*	61.11	77.72
Breast cancer five-year relative survival rate (female)	18	84.02	**1.06**	**1.00**	3.12	*0.037*	78.57	89.30
Cervical cancer five-year observed survival rate (female)	19	61.81	**0.97**	**0.82**	5.34	*0.086*	50.92	73.35
Cervical cancer five-year relative survival rate (female)	18	65.81	**0.98**	**0.84**	5.03	*0.077*	57.28	76.69
Colorectal cancer five-year observed survival rate (male)	18	48.25	**1.11**	**0.89**	5.52	*0.114*	38.28	59.80
Colorectal cancer five year observed survival rate (female)	19	52.95	**1.06**	**0.96**	4.24	*0.080*	42.79	58.23

Source: OECD Health Data (June 2012).

Table 4.2: Related US Prices, Malpractice and Health Insurance Premiums

	1975	1980	1985	1990	1995	2000	2005
Cost per Inpatient Day over CPI	100	164	252	315	401	390	N/A
Direct Losses Incurred per Capita over CPI	100	157	348	235	200	262	N/A
Direct Losses Paid per Capita over CPI	100	191	428	537	631	802	N/A
Insurance-Premium Malpractice Index over CPI	100	91	231	261	253	265	502
Private Health Insurance Premium per Enrollee over CPI	100	137	188	282	330	389	517
Cost of Medicare per Enrollee over CPI	100	130	177	203	265	270	335
HCE per Capita over CPI	100	119	151	193	223	248	305
CPIMC over CPI	100	101	116	138	157	164	180

Source: US Bureau of Labor Statistics, US Bureau of Economic Analysis, US Department of Health and Human Services -- Centers for Medicare and Medicaid Services, The 2003 GAO Report on Medical Malpractice Insurance , Goldman and McGlynn (2005), and Cohen et al. (2009).

Table 5.1: Physicians' Compensation, Relative Productivity, and Labor Supply

	1970	1980	1990	2000
(i) Total Physicians' Compensation over HCE	N/A	14.8%*	14.1%	13.1%
(ii) Average Physician Compensation over Average Worker Compensation	N/A	4.95*	5.77	5.16
(iii) Real HCE per Physician over Real GDP per Worker	N/A	20.5	23.8	22.1
(iv) Average Non-Phys. Compensation over Average Physician Compensation	N/A	11.4%*	11.3%	12.0%
(v) Physicians over Total Population	0.15%	0.19%	0.22%	0.26%
(vi) Physicians over Total Health Care Workers	11.7%	8.2%	7.1%	7.2%
(vii) Total Health Care Workers over Total Workers	3.5%	5.5%	6.8%	7.4%
(viii) Labor Income Share in the Health Care Industry	24.3%	32.6%	33.0%	31.1%

* Data from year 1982

Sources: AMA, AMGA, Bureau of Labor Statistics, and US Census Bureau

Table 5.2: Tests of Abnormal Returns 1979-2009

	SIC 632			SIC 80		
	CAPM	FF	Carhart	CAPM	FF	Carhart
α	0.00772	0.005394	0.00609	0.01306	0.012237	0.01111
	(0.00)	(0.02)	(0.02)	(0.00)	(0.00)	(0.00)
β_1	0.8931	0.9921	0.9782	0.9408	0.9173	0.9397
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
β_2		0.0155	0.0027		0.4282	0.4488
		(0.91)	(0.98)		(0.00)	(0.00)
β_3		0.4183	0.3940		0.1658	0.2052
		(0.02)	(0.00)		(0.19)	(0.12)
β_4			-0.0744			0.1207
			(0.36)			(0.16)
R^2	0.45	0.48	0.49	0.41	0.44	0.45

Source: CRSP, Kenneth French website, and authors' computations.
p-values computed from heteroscedastic robust standard errors are reported in parentheses.