UNDERSTANDING GROWTH PATTERNS IN US HEALTH CARE EXPENDITURES

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Abstract. This paper is concerned with the evolution of health care expenditures in the US. To remove common trends in technology and product quality, we perform two growth accounting exercises in which we condition for growth of other OECD countries. In our first growth accounting exercise we assess the evolution of labor and capital and obtain a technology residual with minor differences in the growth of value added across OECD countries. In our second growth accounting exercise we filter out the effect of health care prices and obtain a quality residual with comparable growth across OECD countries. Our main conclusion from these two growth accounting exercises is that the relative price of medical care – as well as some health care laws – can account for the observed growth patterns in US health care expenditures over the 1970-2007 period.

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JEL classification. I10, I11, I18, E31.

1 Introduction

One of the most noteworthy stylized facts on the US economy is the pronounced upward trend in the share of health care expenditures (HCE). Indeed, according to OECD data HCE accounted for less than one twelfth of total consumption (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

[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 both: HCE over GDP and HCE over all other consumption goods. In our second growth accounting exercise we condition on TC because the consumer price index (CPI) is readily available for all countries in the sample.

policy makers (e.g., the Clinton Health Care Plan of 1993 and more recently the Obama Affordable Care Act).

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. Two distinct candidates are prices and technology.

Within our sample of OECD countries, the US underwent the most acute inflation in medical care consumption with respect to all other goods in the 1970-2007 period, but growth in both HCE and prices has been quite uneven. The most critical time episode is the 1978-1990 period, in which both the CPI-medical care and the personal consumption expenditures-health care price index (PCEHC) moved swiftly at very much the same pace – considerably outpacing inflation in the general economy. During this same time span, medical prices in the OECD followed the pace of general inflation. In many of those countries, however, health care is mostly a public good. Hence, medical care prices in those countries appear to move along with general price regulations and inflation rates.

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. We filter out the effect of health care prices and conclude that the technology (or product quality) residual is similar in the US and the OECD.[3] In other words, what

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

[3] Smith *et al.* (2009) point out that early diffusion of new technologies is frequently linked to similar GDP levels [Moise (2003)].

we will call the US medical care expenditure gap will be generated by the US medical care price gap. 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.

The US price gap has grown 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 in HCE has remained roughly constant over the period. Remarkably, inflationary episodes in the US health care sector have greatly benefited companies in the industry.

Prices may be picking up quality changes for the provision of goods and services. Accordingly, to make further progress along a diverse set of data we perform a basic growth accounting exercise based on value added. We study the evolution of labor and capital under the following identifying assumption: the pace of technological change in the health care sector as compared to that of the aggregate economy is the same in both the US and the OECD. This essentially assumes that the differential increase in technological change in the health care sector between the US and the OECD is the same as the differential increase in technological change for the aggregate economies.[4] In our sample period, labor displays higher growth in the OECD while capital displays higher growth in the US. From our growth accounting exercise we conclude that the actual shares of HCE over GDP should exhibit similar growth patterns in both economies – while the US medical expenditure gap did grow in the data over the sample period. We should remark that this accounting exercise picks up growth effects – rather than levels – and hence it is compatible with existing stable differences characterizing the US economy as a technology leader with smaller public intervention.[5]

The structure of our exercise makes our analysis not readily comparable with other related studies that focus on global HCE trends. We should remark that we analyze variations of HCE over a group of countries with commensurate technological development and data quality, and we consider expenditure shares to condition by cross-country income levels. Several other studies would not be able to account for the growth patterns of US medical expenditures over the various time sub-periods described in the ensuing paragraphs. Indeed, these time episodes can also be identified

[4] Let A be the technology parameter for the aggregate economy and A_H for the health care sector. Let $g_A = \dot{A}/A$ and $g_{A,H} = \dot{A}_H/A_H$ be growth rates of the technology parameter. Then, our identifying assumption means that $(g_{A,H}^{US} - g_A^{US}) - (g_{A,H}^{OECD} - g_A^{OECD}) = (g_{A,H}^{US} - g_{A,H}^{OECD}) - (g_A^{US} - g_A^{OECD}) = 0$. Note that we are not assuming that the pace of technological change in the health care sector is the same as that of the aggregate economy; that is $(g_{A,H}^{US} - g_A^{US}) = (g_{A,H}^{OECD} - g_A^{OECD}) = 0$. As discussed below, this latter condition appears to be a more restrictive assumption under various calibrations of parameter values.

[5] As documented in Cutler and Ly (2011), three major factors may account for the high level of US HCE: (i) higher cost of production factors, (ii) greater share of administrative expenses, and (iii) more generous provision of medical services. Our growth accounting exercise includes all sources of factor accumulation in the health care sector. Further, we are concerned with the growth of labor and capital over time, and so our focus is on growth of value added rather than on the actual levels of all these economic variables.

with correspondingly different patterns for excess returns – as predicted by simple financial factor models – over a sample of companies in the health care sector. Abnormal returns usually happen at times of high nominal growth in HCE. This suggests existence of monopoly power and other market frictions in the US health care sector not generally observed in the other countries.

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.[6] 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,[7] has grown over time. As already pointed out, our results do not pick a 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, we are led to conclude 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 studies.

Ample literature has linked the rapid increase in HCE in the US to technological change.[8] 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). Again, in our study, we control for the impact of technological change by considering a sample of developed countries with comparable technologies.

The paper is organized as follows. In Section 2 we highlight some basic empirical facts on medical expenditures. On a first pass to the data, in Section 3 we carry out a basic growth accounting exercise

[6] 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.

[7] Defensive medicine is referred as the practice of diagnostic or therapeutic measures conducted primarily not to ensure the health of the patient but as a safeguard against possible malpractice liability.

[8] The economics literature usually estimates technological change from price data. According to the Boskin Commission 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.

based on value added. Then, to assess quality and price effects in Section 4 we propose a second growth accounting exercise using a model of product quality changes. In Section 5 we reexamine medical price data. 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).[9] 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. Most countries in the sample experienced similar rates of inflation in both medical care and total consumption, and thus the ratio CPIMC/CPI remains close to one over the sample period. This is to be expected, as in many of those countries health care is a public good, which is usually valued at the cost of labor and intermediate inputs. 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]

[9] In section 5 we extend the current analysis of health care prices to other price indexes and variables related to health care costs.

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.[10] Hence, Figure 2.4 reports: (*i*) HCE per capita at constant TC prices; (*ii*) Real HCE per capita: HCE per 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. 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 Value added in the health care sector

Since aggregate prices may be picking up quality effects, we will later provide an alternative growth accounting exercise based on the evolution of labor and capital. In this exercise we use the following identifying assumption: the differential increase in technological change in the health care sector as compared to that of the aggregate economy in the US is the same as in the OECD. In other words, the differential increase in technological change in the health care sector between the US and the OECD is the same as the differential increase in technological change for the aggregate economy between the US and the OECD. Formally, let us considering the following Cobb-Douglas production

[10] 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.

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.

functions for the health care sector, $Y_H = A_H K_H^{\alpha_H} L_H^{1-\alpha_H}$, and the economy, $Y = AK^{\alpha}L^{1-\alpha}$. Then, we assume that $(g_{A,H}^{US} - g_A^{US}) - (g_{A,H}^{OECD} - g_A^{OECD}) = (g_{A,H}^{US} - g_{A,H}^{OECD}) - (g_A^{US} - g_A^{OECD}) = 0$, where $g_A = \dot{A}/A$, $g_{A,H} = \dot{A_H}/A_H$ and the dot means differentiation with respect to time.

In the US as well as in the OECD countries, both labor and capital in the health care sector have increased relative to the rest of the economy. In fact, the increase in employment in the health care sector relative to total employment in the economy in the OECD is almost twice as much as in the US, while the opposite happened with capital in the health care sector relative to total capital in the economy. More specifically, in our sample period 1970-2007, employment in the health care sector relative to total employment in the economy grew 45 percent in the US and 88 percent in the OECD. On the other hand, average investment in the health care sector relative to total investment in the economy was 2.7 percent in the US and 1.4 percent in the OECD.[11]

In our growth accounting exercise we find that HCE over GDP should have grown at the same pace in both economies. This result is in line with our first growth accounting exercise in which we condition HCE by TC. Therefore, using our OECD benchmark between 1970 and 2007, the US HCE share should have increased by 60 percent, but it actually increased by 130 percent. These computations are intended to circumvent possible biases contaminating our price data. It follows that higher inflation in the health care sector can only be accounted for by either abnormal profits or changes in the compensation of the production factors. The main problem seems to be abnormal profits.

2.6 Returns to capital and labor in the health care sector

Average returns from publicly traded companies related to the health care sector have soared since the late 1970's. By considering standard factor models for stock valuation, in Section 3 we show that publicly traded companies in the health care sector obtained higher returns than those predicted by arbitrage pricing models. These abnormal returns are non-negligible: a 14 percent annualized rate in excess of those predicted by standard empirical asset pricing models. Furthermore, these abnormal returns are highly correlated with growth in HCE. In contrast, salaries in the health care sector have increased at an almost similar pace as those of the rest of the economy.

Therefore, in periods of HCE expansion, companies in the health care sector have been able to increase their returns to capital – suggesting that these companies are able to exploit market power. Figure 2.6 below compares the average evolution of all publicly traded companies in the US Stock Market with respect to a portfolio of health care sector companies. The average US Stock Market return is a portfolio weighted by market capitalization over all publicly traded companies in

[11] Investment in health care as percentage of HCE data are available from OECD Health Care Statistics (http://stats.oecd.org/). This item comprises gross capital formation of domestic health care provider institutions (excluding retail sale and other providers of medical goods). Public investment on health includes publicly-financed gross capital formation in health facilities plus capital transfers to the private sector for hospital construction and equipment. Private investment on health comprises private gross capital formation in health care provider industries (excluding retail sale of medical goods.) It excludes capital transfers received from the public sector.

the US (excluding Real Estate Investment Trusts and American Depositary Receipts). The health care sector portfolio is a portfolio weighted by market capitalization of companies in the health care sector.[12]

[Figure 2.6: Market Returns vs. Health Care Sector Returns]

The first three panels of the figure correspond to the three periods analyzed in this paper. The fourth panel has been added to show the effect produced by the implementation of the Affordable Care Act (ACA) in March 2010, which was subsequently upheld by the Supreme Court in June 2012. That is, panels (a), (b) and (c) correspond to the 1970-1977 period, the 1978-1990 transition period and the 1991-2007 period, respectively. Only during the transition period did the health care sector outperformed the general stock market, whereas in the other two periods it displays similar profitability.[13] In the 1970-1977 period, the health care sector generated slightly smaller returns than the market, while in the 1991-2007 period, both sectors generated almost the same overall return.[14] Remarkably, panel (d) shows that after the implementation of the ACA – which expanded the potential number of Americans with access to health care insurance – the health care sector again experienced significantly higher returns than the overall market. The share of HCE grew from 15.9 percent to 17.4 percent between 2007 and 2010 and has remained flat afterwards. In line with our analysis, the stock market seems to discount further expansions of HCE as a result of the ACA.

In conclusion, between 1980 and 2007 the return to capital in the health care sector was 60 percent higher than the average return in the economy, but the corresponding excess increase in labor salaries in the health care sector was only 11 percent.[15] In Section 3 we document that fluctuations in capital returns in the health care sector moved *in tandem* with fluctuations in HCE growth. This stylized fact is not observed in the other countries in our sample that mostly rely on public provision of health care.

[12] All data has been downloaded from Kenneth French's webpage. (www.dartmouth.edu/~kfrench/)

[13] Note that here we are presenting raw returns. In Section 3 we analyze risk-adjusted returns

[14] In a way, these results are in line with the equity premium puzzle: pronounced excess returns are observed over certain decades but may become negligible over even longer periods of time [see Mehra and Prescott (1985), table I]. In our case, high excess returns belong to the 1978-1990 transition period.

[15] Growth in salaries in the health care sector with respect to the average growth in the economy is calculated as Average Physician Compensation over Average Worker Compensation. Data sources and details are presented in Section 3. Non-physician health care worker compensation and physician compensation show similar growth rates during the analyzed period.

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

Underlying these medical expenditure patterns, there are changes in real GDP growth and inflation as well as the relative size of public health care. Figure 2.7 [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.

[Figure 2.7: 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 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 2.7 [Panel (a)]]. Indeed. the distribution of the population by age and by health insurance (publicly and privately insured and uninsured) remained quite stable over the sample period. The uninsured were 14.6 percent in 1972 and 14.3 percent in 2007.[16]

Let us conclude with a summary of these basic empirical facts. First, to isolate growth effects of income and technology we define the US medical care expenditure gap and the US medical care price

[16] The data are from Gruber & Levy (2009), US Department of Health and Human Services - Centers for Medicare and Medicaid Services and the US Census Bureau.

gap over a selected group of countries. We find that major trends in the US medical care expenditure gap can be 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[17] and the price elasticity must be close to zero. Third, since aggregate prices may be picking up quality effects, we study the evolution of labor and capital in the health care sector for the US and OECD. Labor has grown faster in the OECD, while capital has grown faster in the US. Fourth, in line with this latter growth accounting exercise we find that expansion periods in HCE come along with high prices as well as marked capital gains and modest salary increases. And fifth, 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 Basic Growth Accounting Exercise for the US Health Care Sector

To advance on this vast array of data, we begin with a growth accounting exercise using the evolution of labor and capital for those countries with available data. Moreover, to avoid data quality issues in some of these countries, we also conduct a parallel growth accounting exercise for the US economy only. We find that labor and capital accumulation have no impact on the differential increase in US HCE. Actually, the ratio of value added from factor accumulation runs in favor of the other countries in our sample.

3.1 Evolution of labor and capital in the health care sector

Table 3.1 reports various dimensions of the evolution of labor and capital in the health care sector and the aggregate economy. Panel (a) reports data for the US while panel (b) reports some international comparisons.

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*)].[18] Row

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

[18] 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.

(*iv*) shows the evolution of the average compensation of a non-physician health care worker with respect to a physician. This ratio remains relatively flat over the sample period. In fact, the ratio of physicians to non-physician health care workers has been quite stable in our sample of countries for the periods in which data is available.

[Table 3.1: Labor and capital statistics]

HCE growth has expanded the labor force in the sector. In the 1970-2000 period, the number of active US physicians increased from 3.46 per 1,000 workers to 4.80 per 1,000 workers [row (*v*)], while the number of active OECD physicians increased from 3.05 per 1,000 workers in 1970 to 5.36 per 1,000 workers in 2000 [row (*vi*)].[19] We nevertheless observe a different pattern when we analyze investment in the health care sector. Rows (*vii*) and (*viii*) report the average investment share in the health care sector in each decade between 1970 and 2000 whereas rows (*ix*) and (*x*) report the average share of aggregate investment. For the health care sector, both the US and OECD show a decreasing investment pattern, but the US health care investment share has always been above – albeit the difference has been diminishing over time. Therefore, labor in the health care sector has grown faster in the OECD while capital has grown faster in the US. We now lay down a growth accounting exercise based on value added to asses observed growth patterns in the US medical care expenditure gap.

3.2 A basic growth accounting exercise based on value added

We actually derive two alternative growth accounting exercises based on value added. In the first exercise we will use capital and labor data from both the US and the sample of OECD countries. In the second exercise we will use capital and labor data from the US only, since data from the other OECD countries may be of lesser quality. Because of data availability, in this section we only use seven countries in our sample: Australia, Canada, Germany, Japan, Spain, United Kingdom and United States.[20]

[19] With the introduction of Medicare and the subsequent expansion of the health care sector there was a considerable increase in the number of non-physician workers in the US health care industry in the late 1960s. For the OECD countries (except the US), we have data for non-physicians health care workers only after 1985. OECD and US data shows that the ratio of physicians to non-physicians health care workers remained almost constant for the period 1985-2007. From our own computations from other US data sources, between 1970 and 1980 this ratio decreased from 13 percent to 8.5 percent and between 1980 and 2007 it slowly decreased from 8.5 percent to 7.3 percent. In our growth accounting exercise we assume that the ratio of physicians health care workers to non-physicians health care workers remains flat in both the US and the OECD.

[20] In unreported results we perform the growth accounting exercise of section 4 with the reduced set of countries used in this section and results remain qualitatively the same. These results are available from the authors upon request.

3.2.1 Growth accounting using capital and labor data from the US and the OECD

Assume that GDP and production in the health care sector can be represented by the Cobb-Douglas production functions:

$$Y = AK^{\alpha}L^{1-\alpha} \tag{1}$$

$$Y_H = A_H K_H^{\alpha_H} L_H^{1-\alpha_H} \tag{2}$$

where A is the technology residual or total factor productivity (TFP) in the economy, K is the aggregate capital stock, L is total employment, and $0 < \alpha < 1$ is the capital share in the economy. Similarly, A_H is the TFP in the health care sector, K_H and L_H are capital and labor used to produce health care goods, and $0 < \alpha_H < 1$ is the capital share in the health care sector. Using equations (1) and (2) we can write the US medical care expenditure gap as $\frac{Y_H^{US}/Y^{US}}{Y_H^{OECD}/Y^{OECD}}$. Note that HCE is conditioned here by GDP rather than by TC. Then, let us make the following identifying assumption over the growth rates of the unobservable factors:

$$(g_{A,H}^{US} - g_A^{US}) - (g_{A,H}^{OECD} - g_A^{OECD}) = (g_{A,H}^{US} - g_{A,H}^{OECD}) - (g_A^{US} - g_A^{OECD}) = 0$$

Now, taking logarithms, differentiating with respect to time, and assuming that the shares are similar between the US and the OECD, we obtain the following expression for growth in the US medical care expenditure gap:

$$(1-\alpha_H)(g_{L,H}^{US} - g_{L,H}^{OECD}) + \alpha_H(g_{K,H}^{US} - g_{K,H}^{OECD}) - (1-\alpha)(g_L^{US} - g_L^{OECD}) - \alpha(g_K^{US} - g_K^{OECD}) \tag{3}$$

Calibration:

Using OECD data we get a capital to GDP ratio K/Y between 2.0 and 2.5 for a subset of countries with available data. The observed investment to GDP ratio is around 0.20, which together with K/Y=2.5 yields an annual depreciation rate (δ) of 0.08 in the steady state. After letting K/Y=2.5 in 1970, we calculate the evolution of K for each country according to the standard law of motion $K_{t+1} = I_t + (1-\delta)K_t$.

The initial K for the health care sector is calculated differently since the share of investment in the health care sector is lower than the observed average share in the economy. We first estimate the average investment in health care over HCE (I_H/Y_H) and call this variable φ. Then, we calculate the initial capital in the health care sector using the formula $K_{H,1970} = (\varphi/\delta)Y_{H,1970}$. Once this is estimated, we again apply the standard equation for the capital's law of motion to calculate the evolution of $K_{H,t}$.

Finally, the last parameter we need to calibrate is the capital share α. The real return to capital in the US has been around 8 percent.[21] Letting K/Y=2.5 and a net capital return of 8 percent yields $\alpha = 0.2$. In our benchmark calculation we let $\alpha = \alpha_H = 0.25$. Arguably, the health care sector has a lower K/Y ratio which would lead to a lower capital share than the rest of the economy. Some authors, however, have stressed the externality effects of equipment investment [e.g., De Long and Summers (1992)]. Hence, the social rate of return may be higher than the private rate of return. Therefore, a higher value for α_H could be justified by invoking potential externality effects and intangible investments.

Results:

We now simulate equation (3) using the calibrated parameters, estimated capital values, and OECD data on health care employment as a proxy for L_H and total employment as proxy for L.[22] Figure 3.1 below shows the US medical care expenditures gap estimated by the model together with that calculated using the data. We also report the US medical care capital gap ($\frac{K_H^{US}/K^{US}}{K_H^{OECD}/K^{OECD}}$) and the US medical care labor gap ($\frac{L_H^{US}/L^{US}}{L_H^{OECD}/L^{OECD}}$). The figure shows an increase in the capital gap and a decrease in the labor gap. Hence, for the health care sector there is a relative increase in the stock of capital in the US and a relative increase in employment in the OECD.

[Figure 3.1: A Basic Growth Accounting Exercise Using Labor and Capital Data from the US and OECD]

As seen in the figure, the US medical care expenditure gap should have remained almost constant during the entire period. The gap actually goes down by 15 percent for our simulation of equation (3) while it goes up by 30 percent in the data. Further, during the 1978-1990 transition period the gap goes down by 5 percent while it goes up by 32 percent in the data.

Sensitivity analysis:

We also consider changes in these baseline values. We let the capital share α range between 0.4 and 0.25, and we let α_H differ from α. We let annual depreciation δ range between 0.06 and 0.08. Table 3.2 shows the percentage change in the predicted US medical care gap for the entire period in panel (a) and for the 1978-1990 transition period in panel (b). For the 1970-2007 period, under

[21] Between 1970 and 2007, the value-weighted portfolio of all the publicly traded companies in the US – excluding ADRs and REITs – yearly gross return was 11.2 percent, which translates into a yearly real rate of return of approximately 8 percent (data available from the Center for Research in Security Prices)

[22] As noted in footnote 18, the ratio of physicians to non-physicians health care worker has been constant for all the countries in our sample between 1985 and 2007.

all pairs (δ , α), we observe a decrease in the predicted US medical care expenditure gap between 10 and 15 percent, as opposed to an increase of 30 percent in the data. Similar results are observed during the 1978-1990 transition period in panel (b).

[Table 3.2: Sensitivity Analysis]

Therefore, the present growth accounting exercise based on value added determines that the US medical care expenditure gap should have remained relatively constant during the period 1970-2007 as well as during the 1978-1990 transition period.

3.2.2 Growth accounting using capital and labor data for the US only

As in our sample of OECD countries labor and capital data could be of lesser quality, we can simulate a variant of equation (3) for US data only. More specifically, we can estimate the evolution of the US medical care expenditure gap (US only) under the following specification:

$$(1-\alpha_H)g_{L,H}^{US} + \alpha_H g_{K,H}^{US} - (1-\alpha)g_L^{US} - \alpha g_K^{US} - g_{Y,H}^{OECD} + g_Y^{OECD} \tag{4}$$

Here, for the US we keep the same values for K, K_H, α, α_H and δ as in the preceding exercise. Also, L and L_H are taken from employment data. For the OECD, we use the observed growth rates ($\dot{Y}^{OECD}/Y^{OECD} = g_Y^{OECD}$) for GDP and ($\dot{Y}_H^{OECD}/Y_H^{OECD} = g_{Y,H}^{OECD}$) for HCE.

[Figure 3.2: A Basic Growth Accounting Exercise Using Labor and Capital Data for the US only]

Figure 3.2 shows the newly simulated US medical care expenditure gap (US only) under equation (4) together with the previously simulated gap using capital and labor data from the OECD countries of equation (3). The figure illustrates that for the benchmark calibration, there is almost no difference between the current and previous growth accounting exercises. Nevertheless, for some other combination of parameter values used in the sensitivity analysis of Table 3.2, the simulated US medical care expenditure gap (US only) is significantly below that obtained from equation (3). Hence, all these computations suggest that TFP in the US health care sector may have grown faster than in the aggregate economy.

Finally, using our values for the growth of labor and capital we compute the growth rate of the share of HCE over GDP. In this case, we consider the equation: $(1-\alpha_H)g_{L,H}^{US} + \alpha_H g_{K,H}^{US} - (1-\alpha)g_L^{US} - \alpha g_K^{US}$. Under our baseline parameters, for the period 1970-2007 our computations suggest that the share of HCE grows by 45 percent, while it grows by 130 percent in the data. For the 1978-1990 transition period the simulated share of HCE grows by 17 percent, while it grows by 47 percent in the data. Therefore, labor and capital cannot account for the observed growth patterns in the share of HCE.

3.3 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.[23] 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 a competitive market leads to an 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.[24] 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.[25]

We compute abnormal returns as the difference between the observed market returns and the

[23] Koijen et al. (2015) use a similar approach to study the link between the US financial and real health care markets.

[24] *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.

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

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:

$$r_i - r_f = \alpha_i + \beta_i(r_m - r_f) + \varepsilon_i \tag{5}$$

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.[26] 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 following econometric versions of the FF and Carhart models:

$$r_i - r_f = \alpha_i + \beta_{i1}(r_m - r_f) + \beta_{i2}SMB + \beta_{i3}HML + \varepsilon_i \tag{6}$$

$$r_i - r_f = \alpha_i + \beta_{i1}(r_m - r_f) + \beta_{i2}SMB + \beta_{i3}HML + \beta_{i4}MOM + \varepsilon_i \tag{7}$$

where SMB captures size, HML captures book to market value, and MOM captures momentum profits.[27]

Table 3.3 reports coefficient estimates for equations (5)-(7) 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 3.3 provide solid

[26] 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).

[27] 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.

evidence of abnormal returns for publicly traded firms in the health care industry over the last thirty years.

[Table 3.3: Tests of Abnormal Returns 1979-2009]

Let us next move to the second question: Are abnormal returns driven by HCE growth? In Figure 3.3, we plot yearly abnormal returns from each SIC portfolio against the growth rate in HCE. The yearly abnormal returns are computed under the CAPM.[28] 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 share 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 3.3: Abnormal Returns and Health Care Expenditures 1979-2009]

4 Price and Quality Effects

To filter out differences in relative prices across these economies we now perform a second growth accounting exercise. As already stressed, prices may be picking up quality effects. Nevertheless, after factoring out price effects we find that our quality residual is comparable across our sample of OECD countries. Of course, a key parameter in this exercise is the price elasticity for HCE, but our results are shown to be robust in a later sensitivity analysis. We begin with a model of health care consumption embedding several sources of technological progress and health care quality.

4.1 A simple model of health care expenditures

We consider an endowment economy with a representative agent. The economy can also be reinterpreted as a social planning problem for the optimal allocation between a variety of medical services and all the other goods. Further, the price elasticity of demand will not be changed when the representative agent has to pay a constant fraction of medical expenditures.

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

[28] 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.

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:

$$\max_{c,h,m_s} \sum_{t=0}^{\infty} \beta^t \left[\lambda c_t^{\rho} + (1-\lambda)\left(\phi(a_t)^{\frac{1}{\rho}} \left[\int_0^{\sigma(a_t)} m_{ts}^{\gamma} ds\right]^{\frac{1}{\gamma}}\right)^{\rho}\right]^{\frac{1}{\rho}} \tag{8}$$

subject to:

$$c_t + q_t h_t = y_t \tag{9}$$

$$\int_0^{\sigma(a_t)} m_{ts} ds_t = a_t h_t \tag{10}$$

$$0 < \beta < 1, 0 < \lambda < 1, 0 < \gamma < 1, -\infty < \rho < 1 \tag{11}$$

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.

4.2 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:

$$\frac{m_t}{c_t} = \left(\frac{1}{q_t}\right)^{\frac{1}{1-\rho}} \left(\frac{1-\lambda}{\lambda}\right)^{\frac{1}{1-\rho}} \left(a_t \phi(a_t) \sigma(a_t)^{\frac{\rho-\gamma}{\gamma}}\right)^{\frac{1}{1-\rho}} \tag{12}$$

Now, multiplying both terms by relative price q_t, after using identities (9)-(10) we can express the ratio of health care expenditures over total expenditures in non-health care goods as follows:

$$\frac{q_t h_t}{c_t} = \left(\frac{1}{q_t}\right)^{\frac{-\rho}{1-\rho}} \left(\frac{1-\lambda}{\lambda}\right)^{\frac{1}{1-\rho}} a_t^{\frac{\rho}{1-\rho}} \phi(a_t)^{\frac{1}{1-\rho}} \sigma(a_t)^{\frac{\rho(1-\gamma)}{\gamma(1-\rho)}} \tag{13}$$

Equation (13) 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 $\widetilde{A}_t$ driven by the technology parameter a_t:

$$\widetilde{A}_t = \left(\frac{1-\lambda}{\lambda}\right)^{\frac{1}{1-\rho}} a_t^{\frac{\rho}{1-\rho}} \phi(a_t)^{\frac{1}{1-\rho}} \sigma(a_t)^{\frac{\rho(1-\gamma)}{\gamma(1-\rho)}} \tag{14}$$

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

4.3 A cross-country analysis of the technology residual $\widetilde{A}_t$

To differentiate this analysis from the growth accounting exercise in Section 3, we will loosely refer to $\widetilde{A}_t$ as the product quality residual, which includes technological progress as well as some other effects. The objective is to filter out the price effect from the expenditure ratio, qh/c. We are then left with the quality residual $\widetilde{A}_t^i$ for each country i at all times t. This residual would then summarize the overall effect of all other driving forces in the economy besides prices.

Combining equations (13)-(14) we obtain:

$$\frac{q_t h_t}{c_t} = \left(\frac{1}{q_t}\right)^{\frac{-\rho}{1-\rho}} \widetilde{A}_t \tag{15}$$

Therefore, for each country the residual $\widetilde{A}_t$ can be computed as:

$$\widetilde{A}_t = \frac{q_t h_t}{c_t} \left(\frac{1}{q_t}\right)^{\frac{\rho}{1-\rho}} \tag{16}$$

Ringel *et al*. (2000) report estimates for the price-elasticity of demand for health care around -0.17. This makes $\rho = -5$. As discussed by these authors, studies consistently find inelastic demands at lower levels of cost sharing, but these elasticities are usually around our estimated value. As already pointed, the fraction of uninsured population for the US remained fairly constant during our sample period. Also, fractional payment policies of medical expenses (as some instances of coinsurance and out-of-pocket expenditures) will not affect the elasticity of demand. Hence, we shall compute the residual $\widetilde{A}_t$ 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 $\widetilde{A}_t$ 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 (16), we then generate the residual $\widetilde{A}_t^i$ for each country i. For comparison purposes, the quality residual is set up to 100 at year 1977. Figure 4.1 displays the evolution of the quality 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 quality residuals upon enactment of some health care laws.

[Figure 4.1: The Quality Residual for France, Spain, the US, and the OECD average]

Observe from this figure that the US displays a quality residual $\widetilde{A}_t^{US}$ 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 quality 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.

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.

In conclusion, the quality residual 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 Section 2. Therefore, increasing trends in defensive medicine and in the intensity of medical technologies are not echoed in our analysis.

4.4 A calibration exercise

In our second quantitative exercise we ask the following question: As compared to the data, what is the predicted path of US medical expenditures under our model? To address this question, we make the identifying assumption that the US quality residual $\widetilde{A}_t^{US}$ is equal to the OECD average, $\widetilde{A}_t^{OECD}$, excluding the US. We assess the goodness of fit to the data by computing the Root Mean Square Error (RMSE) generated by the model for the simulated data. 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:

$$\frac{q_t h_t}{c_t} = \left(\frac{1}{q_t}\right)^{\frac{-\rho}{1-\rho}} \widetilde{A}_t \qquad (17)$$

Again, q is the relative price of medical care in the US. Now, the quality residual $\widetilde{A}_t^{US}$ is equated to the OECD average $\widetilde{A}_t^{OECD}$ without the US. Therefore, the HCE share is simulated by the right-hand side of equation (17). 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 $\widetilde{A}_t$ without the US, France, and Spain. In a third scenario ($filtered\ \widetilde{A}_t^{OECD}$), we contemplate an average of $\widetilde{A}_t$ for the ten other OECD countries in which the quality residuals for France and Spain have been filtered out within five-year windows of their main health care reforms.

As shown in Table 4.1, the 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 4.1: Root Mean Square Errors]

5 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 with data from 1929 and published since 1994 by the US Bureau of Economic Analysis (BEA). 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 Commission Report (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 growth accounting exercise in Section 4 we controlled for this bias by conditioning upon a comparison group of OECD countries with similar health care quality and comparable data sources.

We can support our control variable by illustrating the evolution of some health care indicators across our sample of OECD countries.[29] For example, in the period 1970-2007 life expectancy in the US behaves in a similar way as in the OECD. The ratio of US over OECD infant mortality per 1,000 live births increased by 70 percent – mostly due to a sharp decrease in the OECD. The ratio of US over OECD neonatal mortality per 1,000 live births increased by almost 50 percent and the ratio of US over OECD perinatal mortality per 1,000 total births ended up unchanged. Further, data for narrower quality indicators for the year 2003 illustrates that the US outcomes hovered around the OECD mean values in all the following categories: 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. Overall, the assumption about similar health care quality across OECD countries seems to be supported by the OECD data.

Before getting into a comparative study of health care prices, it may be worth discussing some other issues involved in the construction of 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

[29] The data used in this paragraph comes from the OECD webpage (http://stats.oecd.org/). It can also be requested from the authors.

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 in 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. Of course, generic drugs are also 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 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.

5.1 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 5.1. 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 5.1: The CPI–Medical Care Basket]

Figure 5.2 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 5.2: The Evolution of the CPI–Medical Care and PCE–Health Care]

5.2 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 5.1 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 three main points to be highlighted from this table: (1) all these aggregates grow faster than the CPI over the sample period; (2) consistent with all our previous results, this growth is much more pronounced over the 1980-1990 period (which includes most of the 1978-1990 transition period) than over the remaining part of the sample; and (3) the CPIMC displays the lowest growth. In fact, increases in the CPIMC seem quite modest in comparison with 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 the US medical care expenditure gap over the whole sample period (the contemporaneous correlation coefficients are 0.07 and -0.27 respectively).[30]

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. However, out-of-pocket expenditures have still grown faster than income per capita.

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.

[30]Kessler (2011) argues that although the indemnity payments and administrative expenses of the malpractice system amount to less than 1 percent of health spending, the costs of defensive medicine are likely to be far greater because neither patients nor physicians bear most of the marginal costs.

[Table 5.1: 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. Malpractice insurance costs seem uncorrelated with either prices or the medical care expenditure gap. Changes in health care prices and changes in private insurance costs are positively correlated.

5.3 Microeconomic evidence of international health care prices

Several studies and international institutions have reported marked cross-country differences in health care prices. Figure 5.3 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 5.3: 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.

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 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 two growth accounting exercises. The first growth accounting exercise based on value added has the advantage of circumventing price and quality data, but it requires to impose some regularity assumptions on the pace of technological progress in both economies, and the composition and productivity of labor and capital. As our identifying assumption we consider that the corresponding technology gap between the health care sector and the aggregate economy for the US and the OECD remains constant. The ratio of physicians to non-physician health care workers has been quite stable in our sample of countries for the periods in which data is available. We also documented that physicians' productivity has increased more than the productivity of the average worker in the economy. Buera *et al.* (2015) argue that this sort of skilled-biased technological progress appears to hold for a broad panel of advanced economies. We find that between 1970 and 2007, both labor and capital in the health care sector have grown in relative terms in both economies. While labor in the health care sector has grown faster in the OECD, capital in the health care sector has grown faster in the US. Overall, our growth accounting exercise based on value added indicates that the US medical care expenditure gap should have actually decreased in the period 1970-2007, while it went up by about 30 percent in the data. Therefore, the differential growth rates in health care expenditures between the US and the OECD observed in the data cannot be explained by factor accumulation. Of course, this so called technology residual is a comprehensive measure of the effects of many economic forces, but as already stressed our growth accounting exercise is compatible with stable differences in technology and the composition of public expenditures characterizing the US economy.

In the second exercise we filter out the price effect under a price elasticity of the demand for health care around -0.17. (A sensitivity analysis is performed under several other elasticity values.) Several microeconomic studies have documented various cost effects of technologies in the medical sector [e.g., Chandra and Skinner (2012)]. Our cross-country analysis is intended to assess the differential effects of technology and product quality (together with several other residual factors) on health care expenditures across our sample of OECD countries. Three important facts emerge from our study: (*i*) The US residual – which we call the product quality residual in this second exercise – 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 quality residual. This seems to be in accord with the aforementioned stability of *real* health care expenditures over *real* GDP observed in the US economy and the patterns of growth of labor and capital in the health care sector. (*ii*) The pace of the US quality residual does not differ much from the average pace of the OECD quality residual. And (*iii*) sharp breaks in the quality residuals are usually associated with medical reforms and regulations. Consequently, this growth accounting study appears to indicate that technology and product quality 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 economic aggregates and quality adjustments. In the macroeconomics 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. In the second growth accounting exercise we use price data that might be contaminated by product quality changes – which are not observable. We have tried to minimize the quality effect by conditioning over a reduced sample of countries with commensurate technology levels and good data quality. As our identifying assumption we consider that the quality gap remains constant over the sample period. Hence, we allow for a different level of quality and technology for the US economy. Our quality gap involves the differential increase in product quality in the US health care sector over that in the aggregate economy conditioned by the differential increase in quality in the OECD health care sector over that in the aggregate economy.

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 exercises do 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. Hence, physicians' compensation seems unrelated to medical price increases.

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.

In the empirical exercises in which we explicitly use prices, for the US we have used the CPI-medical care. When we compare the CPI-medical care with other related measures of medical care costs we find that all of them show similar growth patterns. In fact, the CPI-medical care growth rate exhibits the lowest growth. More specifically, during the 1978-1990 transition period, the CPI-medical care and the personal consumption expenditures-health care price index (PCEHC) move at very much the same pace. During the same transition period, medical prices in the OECD followed the pace of inflation in the general economy. This is actually what one would expect. In many of those countries, health care is a public good, where value added is determined by labor and intermediate goods. That is, in the US medical inflation has considerably outpaced general inflation, but this is not so in Japan and all the European countries in our sample except Ireland.

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 5 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. Certain regulations in overseas health care markets appear to be quite effective at suppressing prices.

We also find that US 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 be important determinants of health care prices. There is thus evidence of capital market frictions, and companies' profits and returns appear to be a driving factor of US health care expenditures. These abnormal returns support our basic premise: health care expenditures have grown in nominal terms but remain quite stable in real terms.

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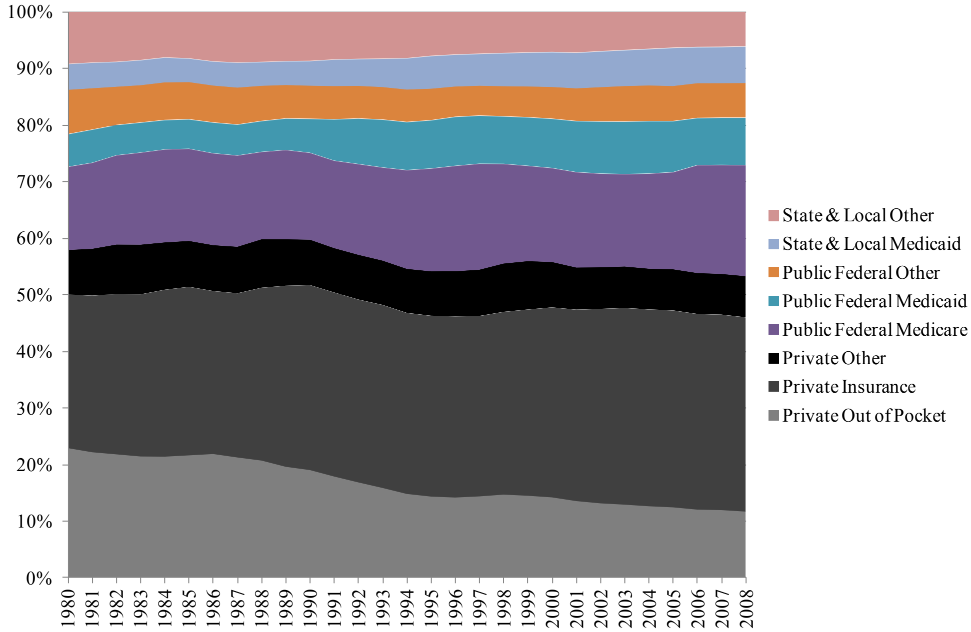
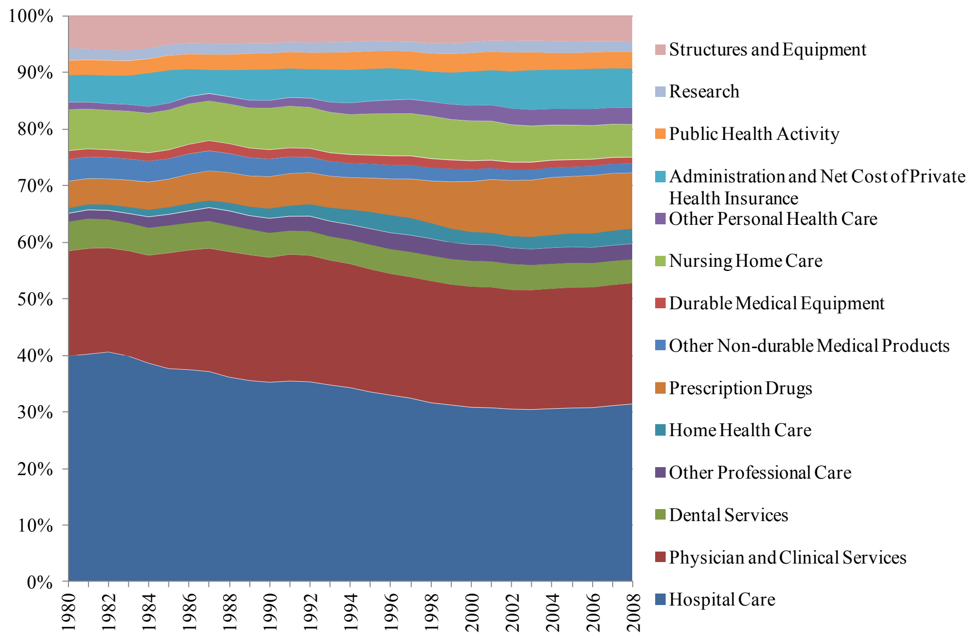
Figure 1.1: The Evolution of US Health Care Expenditures by Source 1980-2007



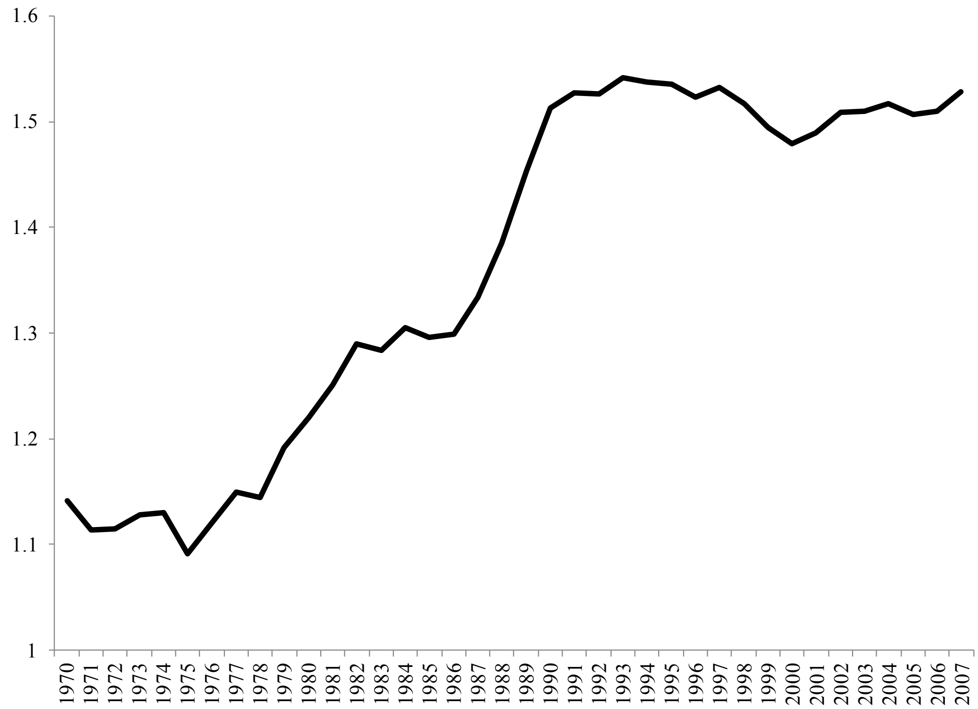
Source: US Department of Health and Human Services - Centers for Medicare and Medicaid Services.

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



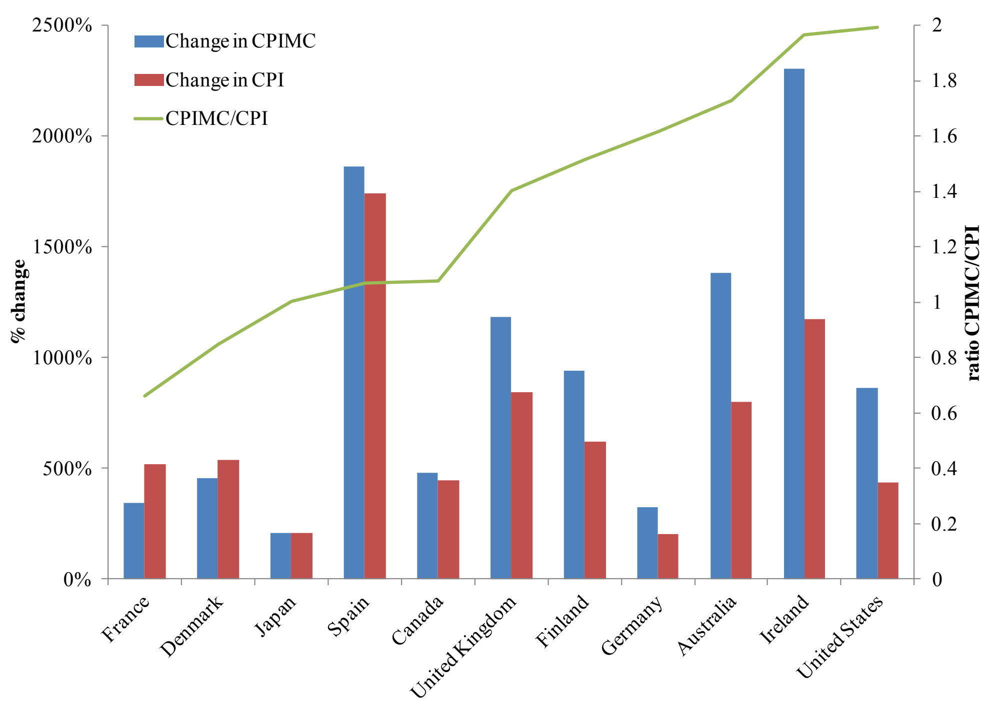
Source: US Department of Health and Human Services - Centers for Medicare and Medicaid Services.

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



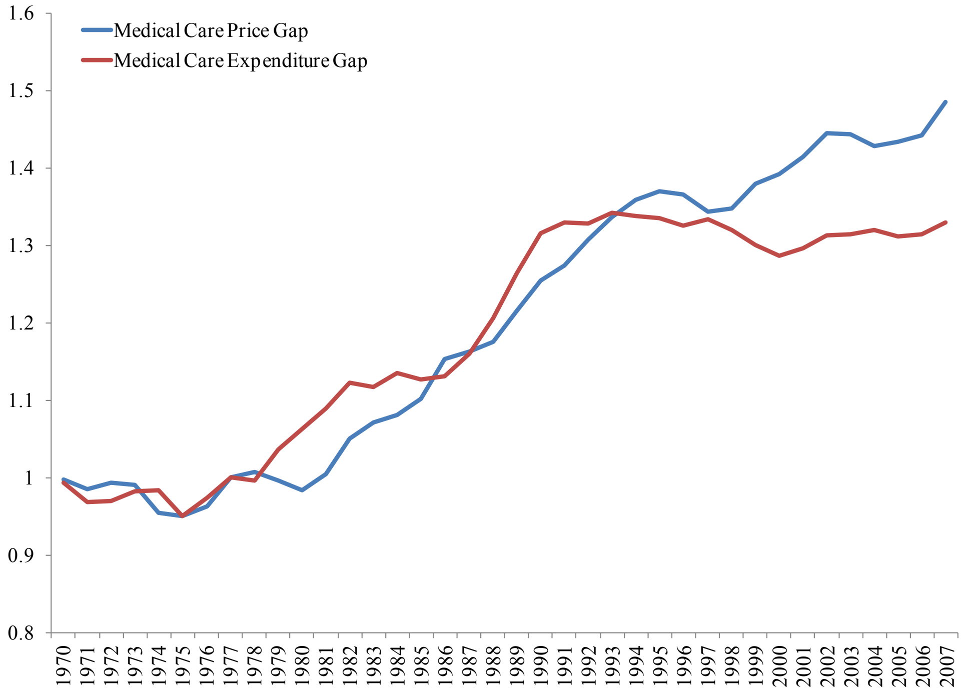
Source: OECD Health Data (June 2014)

Figure 2.2: The Medical Care Price Gap 1970-2007



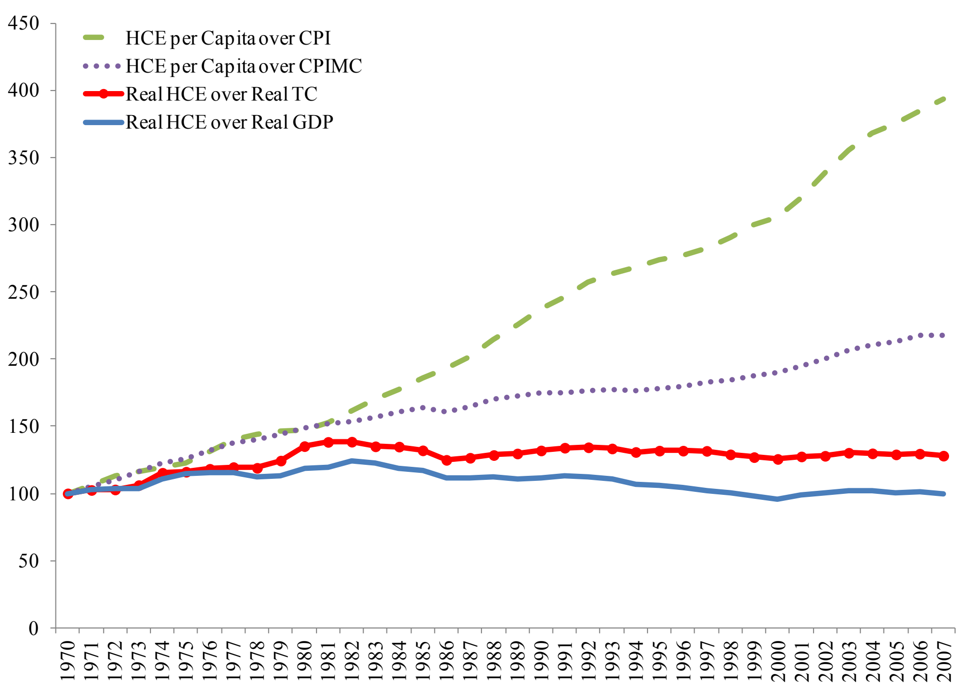
Source: Official statistics of each country and authors' computations.

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



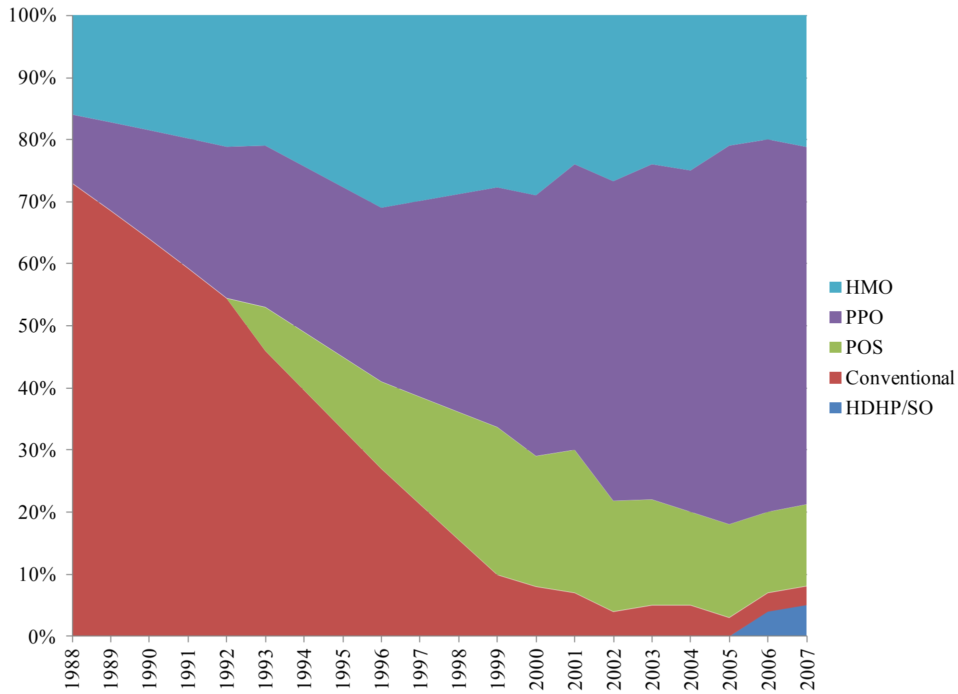
Source: Health Care Expenditures are from the OECD Health Data (June 2014). Health Care Price data are taken from each country's official statistics and authors' computations.

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.

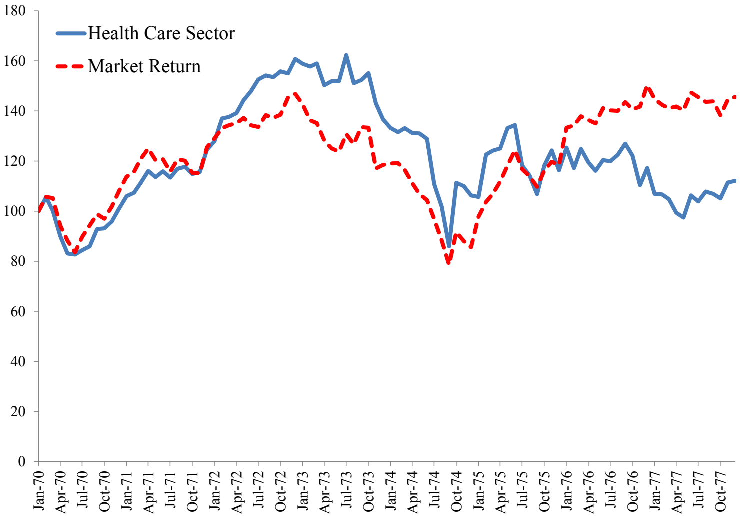
Figure 2.5: The Structure of the Insurance Market



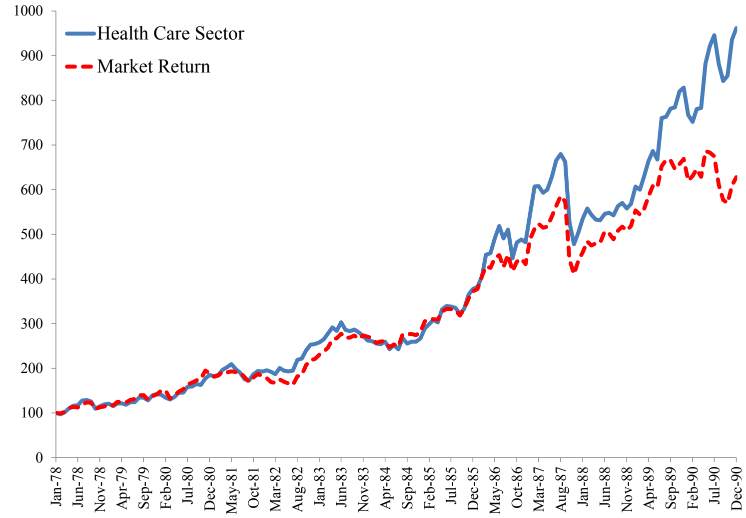
Source: Kaiser Family Foundation

Figure 2.6: Market Returns vs Health Care Sector Returns

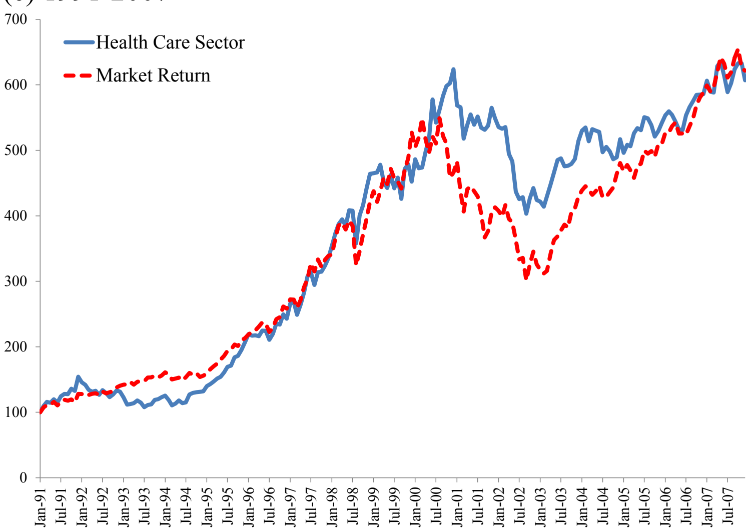
(a) 1970-1978



(b) 1978-1990



(c) 1991-2007



(d) 2007-2014

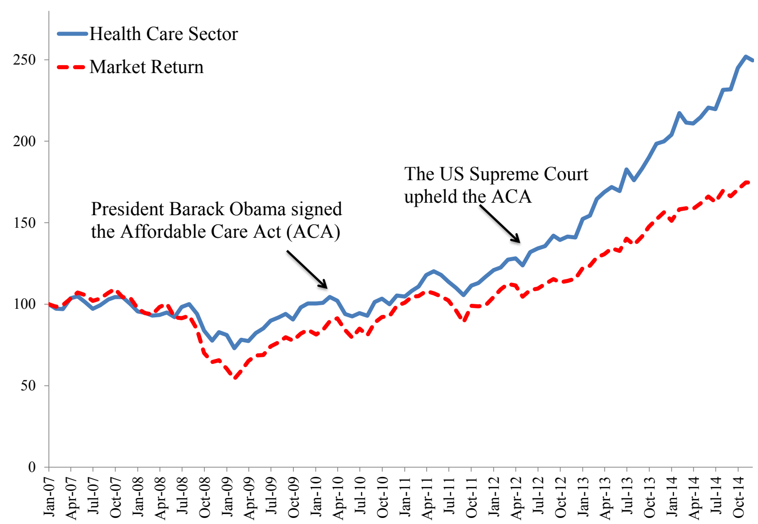
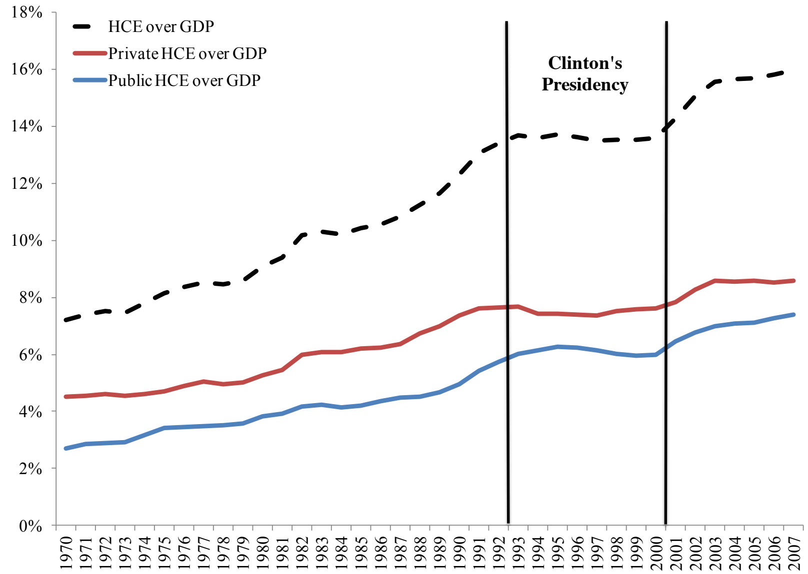
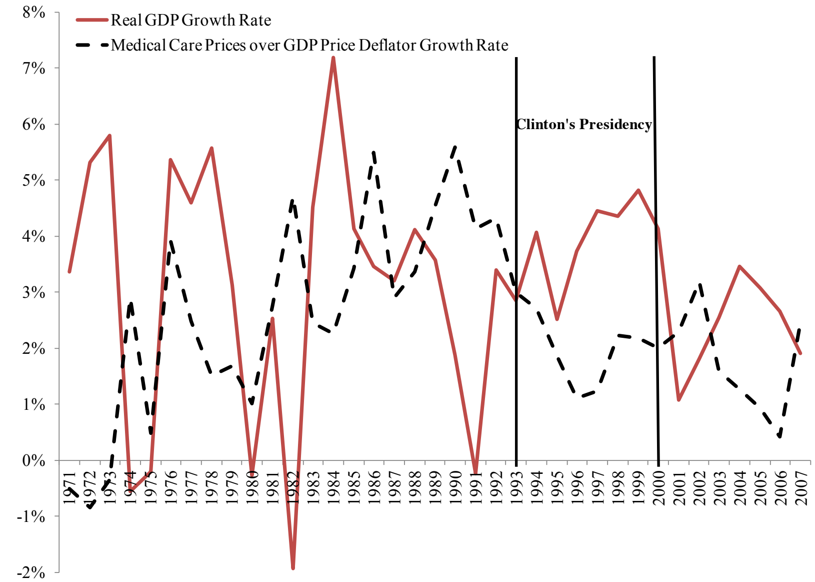


Figure 2.7: US Health Care Expenditures over GDP, Real GDP Growth, and the Relative Medical Care Price

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

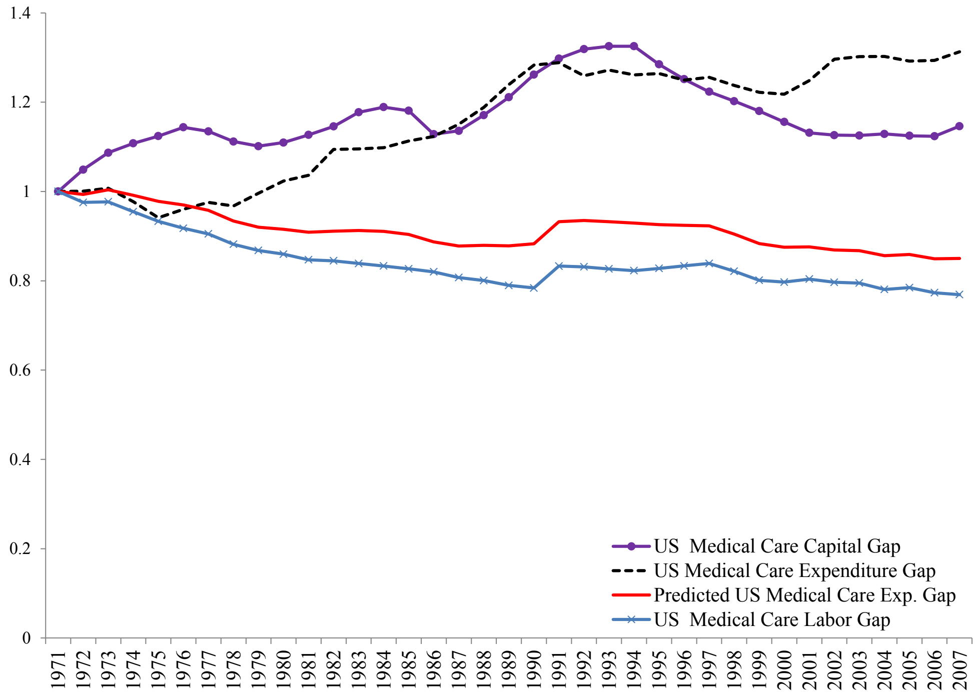


(b) Annual Real GDP Growth and Excess Inflation in the Relative Medical Care Sector



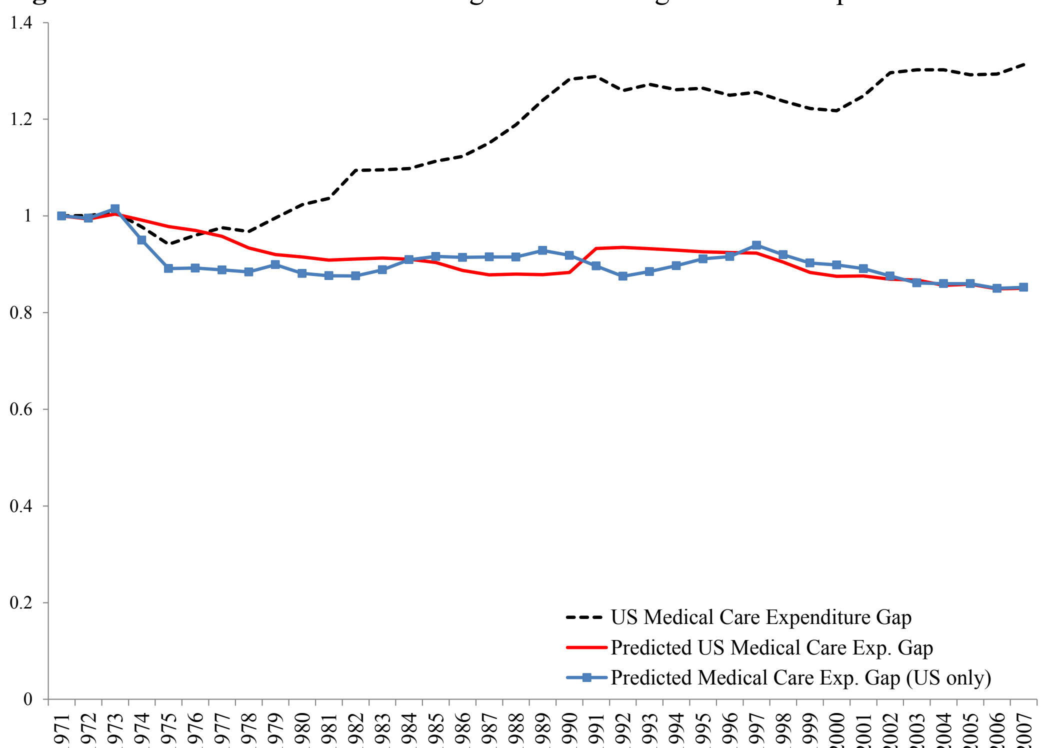
Source: US Census Bureau and US Department of Health & Human Services - Centers for Medicare and Medicaid Services

Figure 3.1: A Basic Growth Accounting Exercise Using Labor and Capital Data from the US and OECD



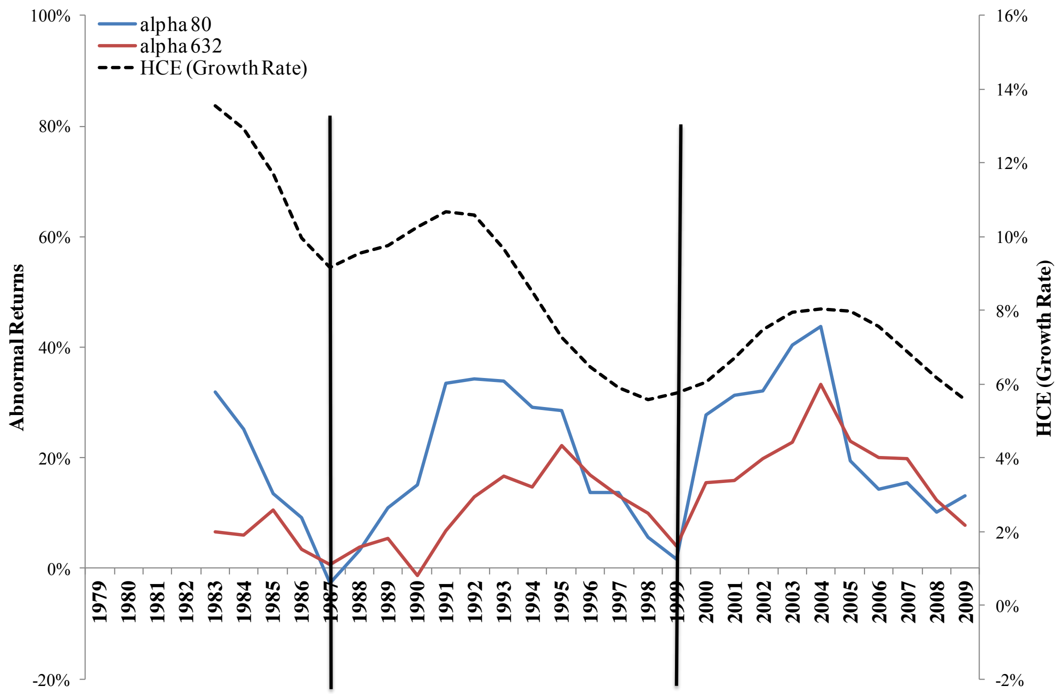
Source: OECD Health Data (June 2014).

Figure 3.2: A Basic Growth Accounting Exercise Using Labor and Capital Data from the US only



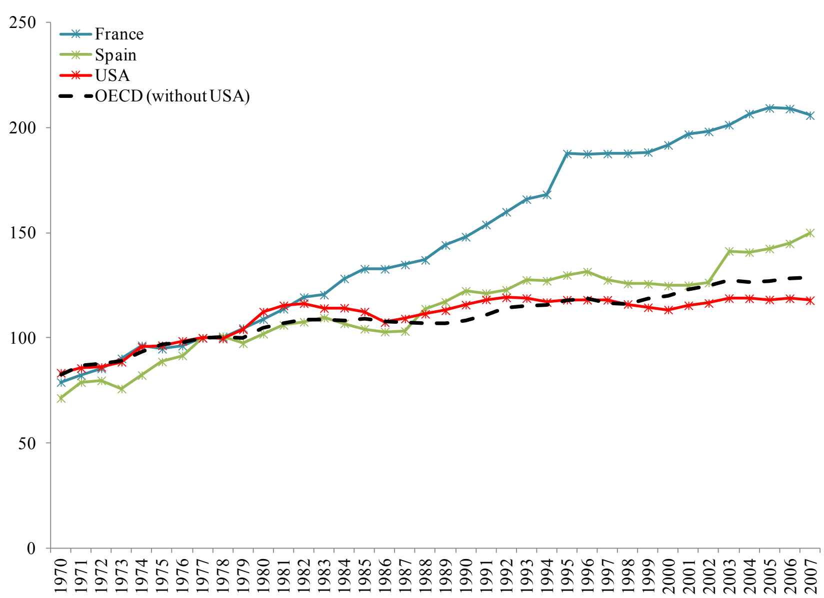
Source: OECD Health Data (June 2014).

Figure 3.3: Abnormal Returns and Health Care Expenditures 1979-2009



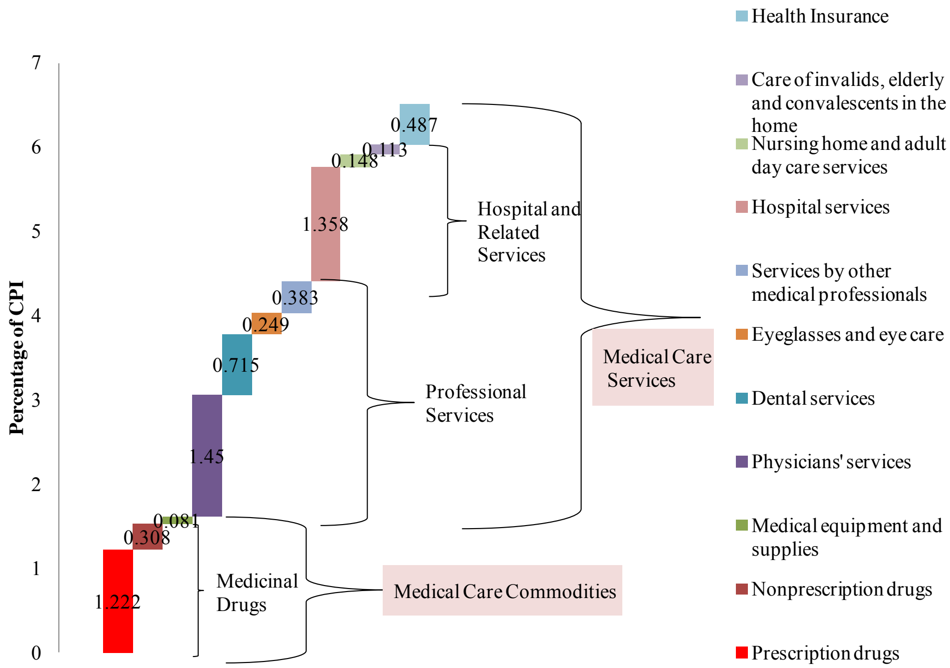
Source: CRSP, Bureau of Economic Analysis, US Department of Health & Human Services - Centers for Medicare and Medicaid Services, and Kenneth French webpage.

Figure 4.1: The Quality Residual for France, Spain, the US, and the OECD average



Source: Health Care Expenditure data are from the OECD Health Data (June 2014). Health Care Price data are taken from each country's official statistics and authors' computations.

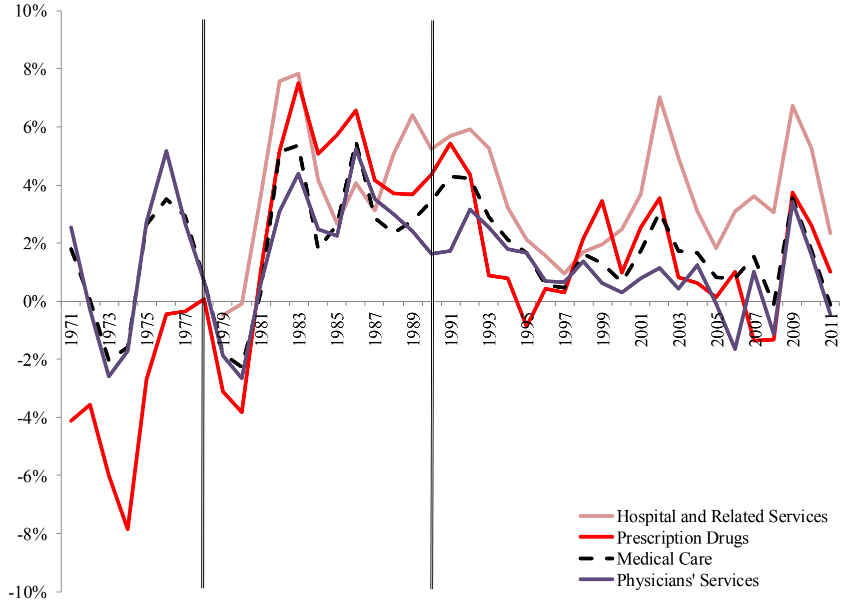
Figure 5.1: CPI--Medical Care Basket



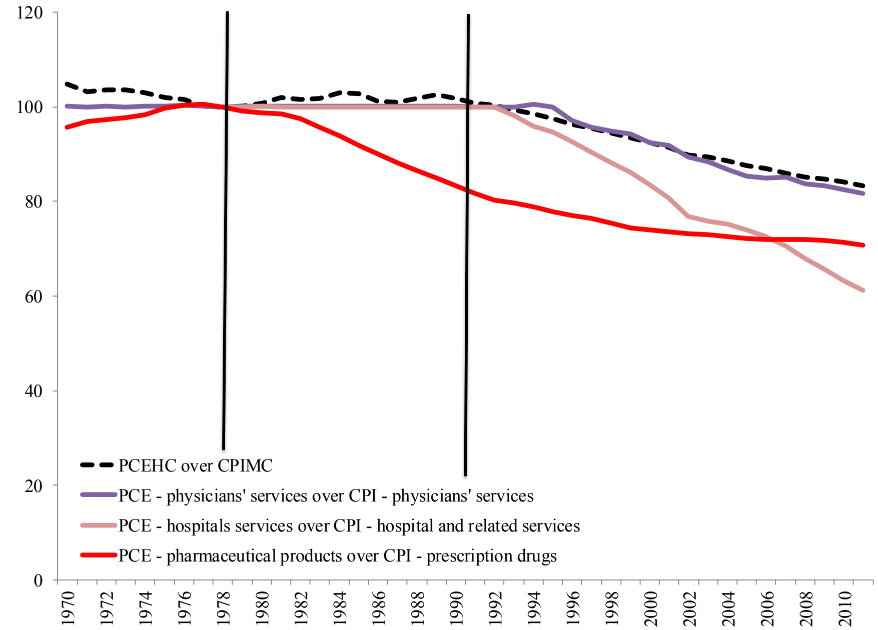
Source: US Bureau of Labor Statistics

Figure 5.2: The Evolution of the CPI--Medical Care and PCE--Health Care

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

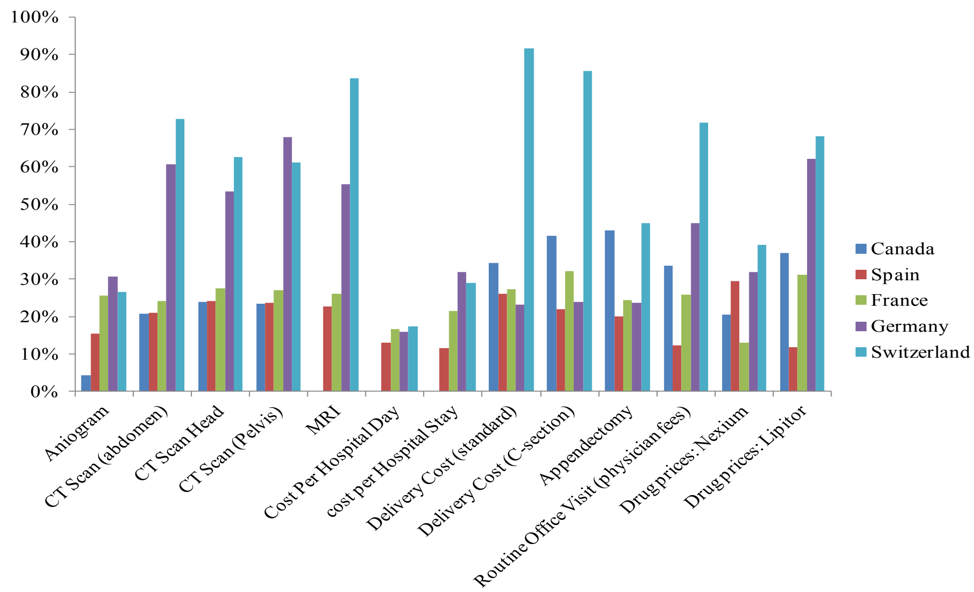


(b) PCE--Health Care over CPI--Medical Care



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

Figure 5.3: 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.

Table 3.1: Labor and Capital Statistics

a) Labor Productivity and Compensation in the US

	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%

b) International Comparisons of Labor and Capital

	1970	1980	1990	2000
(v) US Physicians per 1000 Workers	3.46	3.79	4.25	4.80
(vi) OECD Physicians per 1000 Workers	3.05	4.03	4.96	5.36
(vii) US Health Care Investment over HCE§	7.04%	5.57%	4.85%	4.35%
(viii) OECD Health Care Investment over HCE§	5.52%	4.33%	4.25%	4.07%
(ix) US Aggregate Investment over GDP§	22.02%	22.97%	20.98%	21.76%
(x) OECD Aggregate Investment over GDP§	26.46%	24.34%	23.15%	22.92%

* Data from year 1982.

§ Average over the subsequent 10 years

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

Table 3.2: Sensitivity Analysis

(a) 1970-2007 Period

Observed Change in US Medical Expenditure Gap: 30%			
δ	α	α_H	Predicted Change in Gap
0.08	0.25	0.25	-15.0%
0.06	0.25	0.25	-15.0%
0.08	0.4	0.25	-13.3%
0.06	0.4	0.25	-13.3%
0.08	0.4	0.4	-9.6%
0.06	0.4	0.4	-10.0%

(b) 1978-1990 Transition Period

Observed Change in US Medical Expenditure Gap: 32%			
δ	α	α_H	Predicted Change in Gap
0.08	0.25	0.25	-5.4%
0.06	0.25	0.25	5.9%
0.08	0.4	0.25	-4.7%
0.06	0.4	0.25	-5.2%
0.08	0.4	0.4	-17.0%
0.06	0.4	0.4	-2.5%

Table 3.3: 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.

Table 4.1: 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 5.1: 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).