A CROSS COUNTRY ANALYSIS OF HEALTH CARE EXPENDITURES

Understanding the US Gap

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Abstract

In this paper we analyze the evolution of the US health care expenditures over total consumption; as is well known, this share has been trending upwards in the last 40 years. We consider a representative sample of OECD countries, and lay out a growth accounting exercise that decomposes the effects of relative health care prices, income, regulations, and technology. Our quantitative analysis demonstrates that relative prices and health care reforms can trace down the differential increase in US health care expenditures over various time sub-samples. There is ample international evidence to support relatively higher health care prices in the US. Some other explanatory variables --- life expectancy, physicians' compensation, and trends in aging population --- would seem unable to explain the evolution of US health care expenditures over our sample of OECD countries and time periods.

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Key words: health care expenditures, health care prices, health care reforms, growth accounting, price elasticity, technological progress.
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1. Introduction

Over the last 40 years, the share of US health care expenditures in total consumption has displayed a pronounced upward trend.[1] According to OECD data, health care expenditures accounted for less than 1/12 of total consumption in 1970, while it is now over 1/5. Mounting US health care expenditures have become an issue of national concern and a major challenge faced by US policy makers (e. g. Clinton's *Health Care Plan of 1993* and more recently the "*Obamacare*"). Our purpose here is to study and identify the main macroeconomic forces underlying these well-known patterns of US health care expenditures.

One major difficulty to uncover increasing trends in US health care expenditures is the high degree of uniformity presented by these expenditures in the subcategories of sources and uses. These regular patterns are even preserved in periods of high expenditure growth. Figure 1.1 illustrates the evolution of US health care expenditures by source. Even though some public programs such as Medicare and Medicaid have gained more prominence at the expense of private funding and out-of-pocket expenditures, these deviations are just second-order differences that cannot account for the general evolution of health care expenditures.

[Figure 1.1: Evolution of US Health Care Expenditures by Source]

Figure 1.2 presents the evolution of health care expenditures by use. Again, we see a substantial increase in other personal health care, and prescription drugs, and a slight decline in physical and clinical services, and hospital care. But these changes are just small departures from general trends in US health care expenditures.

[Figure 1.2: Evolution of US Health Care Expenditures by Use]

In conclusion, one would need to identify a group of variables that must be driving together the various subcategories of US health care expenditures. To impose further discipline in our quantitative exercise, we include a sample of 11 OECD countries considered to have high quality data: Australia, Canada, Denmark, Finland, France, Germany, Ireland, Japan, Spain, United Kingdom and United States. Our goal is then to identify deviations in US health care expenditures from common forces. This should be informative for policy purposes.

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[1] Our framework below requires using the ratio of health care expenditures over other kinds of consumption. We will use total consumption because the consumption price index (CPI) is readily available for all countries. Most researchers use health care expenditures as a percentage of GDP (see Chernew and Newhouse 2012). The graphs reported below do not change substantially when considering other consumption goods, total consumption, or GDP (see figure 2.5).

We would like to emphasize that the structure imposed in our analysis makes that our findings are not easily comparable to other related studies picking up common trends. Indeed, these studies are not intended to account for the evolution of US health care expenditures over various time sub-periods. For instance, Hall and Jones (2007) propose a model relating increases in US health care expenditures to both income and life expectancy. As is well known, there has been some catching-up of income levels by European countries. Moreover, US life expectancy has always been around average among OECD countries.[2] Hence, we understand that this model is not meant to illustrate the observed differences in health care expenditures at the cross-country level.

To further complicate the problem, some researchers [cf. Anderson and Frogner (2008)] argue that even though the US has the highest ratio of health care spending over GDP 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 as compared to the rest of the OECD countries. For our cross-country study, one would have to show that the US inefficiency gap, or the gap in defensive medicine, has grown over time. Our results do not pick a higher residual for the US, and do not seem to leave room for significant increasing gaps in many other directions.

The spread of health insurance has been suggested as an explanatory variable for the growth in health care expenditures in the US. Finkelstein (2007) estimated that the introduction of Medicare between 1965 and 1970 produced an increment in hospital spending six times larger than an individual's insurance cost would have produced during the same period of time. At about the same dates, however, many OECD countries implemented a system of universal health care (e.g., Japan in 1961, Spain in 1986, and Denmark in 1973). Thus, changes in insurance markets would not be able to completely explain the differences observed in the growth rate of health care expenditures between the US and the rest of the OECD countries. Of course, some of these health care reforms will become evident in our quantitative study.

A large literature has related the rapid increase in health care expenditures in the US to technological change. For example, Di Matteo (2005) finds that technological change accounts for 2/3 of health care spending growth in the US over the 1975-2000 period. A good review of this literature is presented in Chernew and Newhouse (2012). Here, we control for the effect of technological change by studying a cross-section of developed countries with similar technology.

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

As a matter of fact, our identifying assumption is that the gap in technological progress with respect to the US remains constant over the sample period. Smith, Newhouse and Freeland (2009) point out that early diffusion of new technologies is frequently linked to real per capita GDP [Moise (2003)].

Our quantitative analysis attests that the explosive behavior of US health expenditures can be mimicked by similar responses of health care relative prices. Therefore, what we will call the *US expenditure gap* will be replicated by the *US price gap* under standard price elasticities. It is important to understand that these gaps essentially combine real quantities for both health care expenditures and total consumption, while most of the literature has considered nominal expenditures. Our analysis also underscores the role of some health care reforms that may produce sharp deviations from past trends.

We support these findings with a further evaluation of US time series for real output and relative health care prices, and provide additional evidence of international health care prices at the micro level. It seems that increases in health care prices have greatly benefitted companies in the health care industry sector. The labor income share has remained roughly constant over the period. Doctors' earnings do not appear to be responsible for increases in health care prices and expenditures.

The paper is organized as follows. In section 2 we highlight some basic empirical facts regarding health care expenditures and relative prices. These facts will be central to our study. In section 3 we set out our framework of analysis, and derive our main quantitative results. In section 4 we support these findings with further evidence on the evolution of US health care expenditures; we also discuss some evidence on international price comparisons, and investigate what production factors may have benefitted from the US health care price increases. We conclude in section 5.

2. Basic Empirical Regularities

As already pointed out, we have selected a sample of representative OECD countries that are considered to have high quality data: Australia, Canada, Denmark, Finland, France, Germany, Ireland, Japan, Spain, United Kingdom and United States. Yearly health care expenditures for France are only available after 1990. From 1970 to 1990, French data are only available every 5 years. Missing years have been interpolated. We were able to obtain health care prices data for the period 1970-2007 for most these countries; for a few countries, price data interpolations were made whenever necessary.

2.1 The US Health Care Expenditure Gap

As compared to our sample of OECD countries, the US was already among the top spenders in health care in 1970 but far for being an outlier. In fact, the ratio of US health care expenditure (HCE) to total consumption (TC) over the corresponding OECD average ratio went from 1.1 in 1975 to 1.5 in 1990. Then, the gap trended downwards during the eight-year period of the Clinton presidency, and it has slightly gone up during the last decade.

[Figure 2.1: The HCE Gap]

Hence, we define the US health care expenditure (HCE) gap over total consumption (TC) as the ratio HCE/TC in the US over the ratio HCE/TC in our OECD sample. There are actually three well differentiated periods [Figure 2.1]: (i) *The 1970-1978 period* in which the gap hovered around 1.1, (ii) *The 1978-1992 period* in which the gap increased steadily to 1.55, and (iii) *The 1993-2007 period* in which the gap has roughly settled down to 1.5. Therefore, the 1980-1992 period stands up as a transitional period with a high variability in the gap. This variability is certainly puzzling, and becomes a challenge for theories intended to account for the evolution of US health care expenditures. As already remarked, during the transitional period 1980-1992 there are no noticeable changes in HCE by source and use [e.g., see Figures 1.1. and 1.2].

2.2 *The US Health Care Price Gap*

The US health care price gap will pick up the evolution of the health care price[3] index (HCPI) over the consumer price index (CPI). That is, we refer to the US health care price gap as the ratio of HCPI/CPI in the US over the average ratio HCPI/CPI in the sample of OECD countries.

Figure 2.2 considers the evolution of the HCPI and CPI for our sample of countries over the 1978-1990 transition periods. Figure 2.3 amplifies these trends to the whole sample period 1970-2007. Some countries in the sample experience similar rates of inflation in both health care and total consumption, and so the ratio HCPI/CPI has remained constant. In the US, however, the ratio HCPI/CPI has tripled over the sample period and in Japan has gone up to 4.5 times. Hence, the US has been second to Japan to undergo an excess acute inflation in the health care sector over the total consumption sector. Therefore, these two figures for the price gap confirm similar patterns over the

[3] In general, price indexes do not take into account changes in quality. According to the Boskin report (1996) the US consumer price index must be adjusted by a 2.76% yearly increase in the quality of health care goods. Hence, lack of adjustment leads to an overestimation of health care prices. Unfortunately, we were not able to find data on quality changes for other OECD countries as measured in the Boskin report. Hall and Jones (2007) assume a 1% faster increase in the technical change of the US health care sector over the economy's average. Their estimate is based on various papers that show improvements in the adjusted-price of several medical treatments. Although this issue is very important, the effect of change in quality across OECD countries should be lessened because state-of-the-art techniques are also available in these other countries.

transition period 1978-1990, and over the whole sample period 1970-2007. It should be stressed that health care inflation in the US is not higher than in many other countries. What it seems high is the change in the relative price of health care in terms of other consumption goods.

[Figure 2.2: The Price Gap 1978-1990]

[Figure 2.3: The Price Gap 1970-2007]

2.3 The US Health Care Expenditure Gap vs. The Price Gap

Figure 2.4 plots the HCE gap against the price gap (with the normalization that both ratios equal to 1 in the year 1977). The figure makes clearly the case that the price gap has been the driving force in the period 1979-1992 in which increased by 30%. Then, there is a mild US disconnect: Health care prices have increased more than HCE. More precisely, from 1993 to 2007 the Price gap increases from 1.3 to 1.4 only and the HCE gap cease to increase. This suggests that real health care consumption has declined in the US in the last part of the sample period. Indeed, when the HCE gap grows less than the price gap over our sample of OECD countries, this means that real health care consumption over real total consumption is going down in the US over the other countries. See the Appendix.

[Figure 2.4: The HCE Gap vs. the Price Gap]

2.4 The Stability of Real HCE over Real GDP

HCE per capita at constant CPI prices in the US has increased 300% between 1970 and 2007. HCE per capita at constant health care prices (real HCE) has increased less than 100% in the same period. As already pointed out, the US has experienced one of the lowest increases in real HCE among the set of analyzed OECD countries. We attain further stability for health care expenditures when we adjust real HCE by real Total Consumption growth or real GDP growth. During the period 1970-2007 real quantities have remained almost constant: Real HCE over real Total Consumption increased by 28% and Real HCE over real GDP did not increased at all.[4] Hence, Figure 2.5 reports: (i) HCE per capita at constant GDP prices; (ii) HCE per capita at constant health care prices---what we call real HCE; (iii) Real HCE over real Total Consumption and (iv) Real HCE over real GDP.

[4] The difference between Real HCE over real Total Consumption and Real HCE over real GDP is mainly due to differences between the CPI and the GDP price deflator. During the period 1970-2007 the ratio CPI/GDP deflator increased by 22.5%. The ratio Total Consumption as % of GDP remained very stable, decreasing 4.5% from 1970 to 2007.

[Figure 2.5: Evolution of US Health Care Expenditures]

Real HCE can be considered a proxy for the quantity of health care provided, and real GDP is considered a proxy for income. Figure 2.5 illustrates that 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, McClellan and Newhouse (2000)], which was mainly accomplished in the 90´s. This is reflected in the relative decline of physical and clinical services, and hospital care, in expenditures by use (Figure 1.2), and the shift from private indemnity plans or conventional insurance to more incentive-compatible mechanisms for private insurance such as HMO's, PPO's, and POS's [Figure 2.6.a]. At the same time, the insurance distribution among the population remained very stable [Figure 2.6.b]. Then, among other things, in the 2000's the Bush reforms appear to increase pharmaceutical expenditures (see Figure 1.2).

[Figure 2.6: Insurance Market]

Of course, there are a few underlying forces behind the stability of US real HCE over real GDP. There is price elasticity for health care expenditures, there is income elasticity for health care expenditures, and there are the effects of technological progress. By just considering real HCE to real GDP we may be implicitly assuming that the price elasticity is equal to zero, the income elasticity is equal to 1, and there are no other differential effects of technological progress. Our model below is intended to make further progress on these issues.

Figure 2.7 displays the evolution of real HCE over real GDP for all countries in the sample. Figure 2.8 shows that these trends remain roughly the same when we report real HCE over real TC. The countries in which quantities provided of health care have increased the most in the period 1970-2007 are Spain, France, and Australia. Spain shows a steep increase in the years 1986 and 2003. These two observations agree with the dates in which two major health care laws were enacted: The General Health Law (1986) which recognized the right to health care services to all citizens and foreign residents in Spain, and the Law of Cohesion and Quality (2003) which modernized and broadened the scope of the previous law. 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 in several stages, and it became universal for all its citizens and residents in the year 2000 in which coverage was expanded to 8% of the poorest population (Rodwin 2003).[5] Australia implemented universal health care for all its citizens and residents in 1984 (called Medicare). Thus, some sizable increases in real HCE are driven by changes in regulation leading to demand expansions.

In summary, the ratio real HCE to real GDP has been fairly constant in the US over the last 40 years. Certain deviations from these trends can be traced down to health care reforms and regulations. Reforms also affected some other countries in our sample such as France and Spain, and broadened the mass of population protected by public insurance. Health care reforms and regulations in our sample of countries may explain why the HCE gap did not grow after 1992 when the Price gap still grew a little. We now consider a simple growth model to quantify all these effects.

[Figure 2.7: Real Health Care Expenditures over Real GDP]

[Figure 2.8: Real Health Care Expenditures over Real Total Consumption]

[5] We are unable to capture jumps for France between 1970 and 1990, since during that period data on health care expenditures is available only every 5 years. The missing years have been filled in by interpolation.

3. A Simple Model of Health Care Expenditures

This section presents our main quantitative results. Underlying those results there are key parameter values such as the income elasticity for health care expenditures (assumed to be equal to unity), the price elasticity, and the growth rate of technological progress. We impose the identifying assumption that the rate of growth of technological progress in the US should equal the sample average.

3.1 Model Setup

We consider an endowment economy with a representative agent. There are two goods in this economy: a health care good *m* and a composite of all other remaining goods *c*. Preferences are represented by a CES utility in which the health care consumption share is driven by the number of available of technologies.

More specifically, the representative agent solves the following budget-constrained maximization problem:

$$\text{Maximize} \sum_{t=0}^{\infty} \beta^t \left[\lambda c_t^{\rho} + (1-\lambda) \left(\phi(a_t)^{\frac{1}{\rho}} \left[\int_0^{\sigma(a_t)} m_{st}^{\gamma} ds \right]^{\frac{1}{\gamma}} \right)^{\rho} \right]^{\frac{1}{\rho}}$$

subject to

$$c_t + q_t h_t = y_t$$

$$\int_0^{\sigma(a_t)} m_{st} ds = a_t h_t$$

$$0 < \gamma < 1$$

Here, $q_t h_t$ represents nominal health care expenditures, and h_t is real expenditures. Parameter a_t is an index of technological progress, and defines the level of efficiency to transform real expenditure h_t into consumption m_t through the expansion of $\sigma(a_t)$. At the same time, the parameter $\phi(a)$ captures the shift in consumption towards new treatments or cures due to an increase in technology. The parameter γ denotes the degree of substitution. Therefore, in this simple setting an increase in a_t has three effects: *(i) The Price Effect:* It lowers the effective price q_t/a_t of consumption good m_t. *(ii) The Productivity Effect*: It decreases the required level of consumption of good m_t for a given level of utility through the expansion of $\sigma(a_t)$. *(iii) The Quantity Effect*: It may expand the demand for good m_t by increasing $\phi(a_t)$. For an inelastic demand for health care expenditures, the price effect means that an increase in a_t will lower nominal health care expenditures, $q_t h_t$. Hence, the literature usually considers a quantity effect [Chernew and Newhouse (2012)] to replicate the observed rise in medical expenditures.

Note that the model imposes a unit income elasticity. This seems to accord with trends discussed above and other extensive cross-country empirical evidence [e.g., Gerdtham and Johnson (2000)].

3.2 Optimality Conditions

The representative agent assumes that the relative price q_t has been exogenously given. Note than in an optimal solution $m_{st}=m_t$. Hence, the preferences at period t get reduced to

$$\left[\lambda c_t^{\rho} + (1-\lambda)\phi(a_t)\sigma(a_t)^{\frac{\rho}{\gamma}} m_t^{\rho}\right]^{\frac{1}{\rho}}$$

Then, from the first-order conditions of the consumer's optimization problem we obtain the optimal ratio of health care consumption to the composite consumption of all other goods:

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

Therefore,

$$\frac{m_t}{c_t} = \left(\frac{1}{q_t}\right)^{\frac{1}{1-\rho}} \left(\frac{1-\lambda}{\lambda}\right)^{\frac{1}{1-\rho}} \left(a_t\phi(a_t)\sigma(a_t)^{\frac{\rho-\gamma}{\gamma}}\right)^{\frac{1}{1-\rho}} \quad (2)$$

Finally, multiplying by relative price q_t, we can express the ratio of health care expenditures over total expenditures in non-health care goods as follows:

$$\frac{q_t h_t}{c_t} = q_t^{\frac{-\rho}{1-\rho}} \left(\frac{1-\lambda}{\lambda}\right)^{\frac{1}{1-\rho}} a_t^{\frac{\rho}{1-\rho}} \phi(a_t)^{\frac{1}{1-\rho}} \sigma(a_t)^{\frac{\rho(1-\gamma)}{\gamma(1-\rho)}} \quad (3)$$

Equation (3) provides an expression for the evolution of health care expenditures relative to non-health care expenditures as a function of the relative price between the two goods and a residual term $A_t = \left(\frac{1-\lambda}{\lambda}\right)^{\frac{1}{1-\rho}} a_t^{\frac{\rho}{1-\rho}} \phi(a_t)^{\frac{1}{1-\rho}} \sigma(a_t)^{\frac{\rho(1-\gamma)}{\gamma(1-\rho)}}$ driven by the level of technological progress a_t.

We allow residual term A_t^i to be different for each country *i*. But to evaluate the US differential effects, we will assume that *A* in the US displays the same average growth of our OECD sample.

3.3 Calibration Method

(1) Set the relative price index q_{1970}=1. Let $A_t = \left(\frac{1-\lambda}{\lambda}\right)^{\frac{1}{1-\rho}} a_t^{\frac{\rho}{1-\rho}} \phi(a_t)^{\frac{1}{1-\rho}} \sigma(a_t)^{\frac{\rho(1-\gamma)}{\gamma(1-\rho)}}$.[6]

(2) Estimate A_t for each OECD country in the sample as $A_t^i = \left(\frac{q_t^i h_t^i}{c_t^i}\right)\left(q_t^i\right)^{\frac{\rho}{1-\rho}}$. Let $\tilde{A}_t = N^{-1}\sum_{i=1}^{N} A_t^i$

To assess the effects of health care reforms of some countries, we compute $\tilde{A}_t$ in three ways:

- Raw $\tilde{A}_t$ estimated directly from step (2). Results are presented in figure 3.1.
- Regulated $\tilde{A}_t$. It consists in controlling for possible jumps due to changes in regulations in France and Spain with a simple rule. If the yearly change in absolute value in A_t^i for *i*=France or Spain is greater than 5% we cap the change at 5% (positive or negative).[7]
- An $\tilde{A}_t$ excluding France and Spain.

[Figure 3.1 Not sure if this figure is needed]

3.4 Results

The simulations are done in two simple steps.

[6] We use as proxy for q_t the health price index of a country divided by its CPI. This determines the growth rate of q_t.

[7] We set the cap at 5% because that is the maximum yearly change observed for the average A_t^i calculated using every country in the sample except France, Ireland, Spain and the United States.

(1) Set $\tilde{A}_{1970}$ to match $\frac{q_{1970}h_{1970}}{c_{1970}}$ in the US.

(2) The final step consist in simulating $\frac{q_t^{US}h_t^{US}}{c_t^{US}} = (q_t^{US})^{\frac{-\rho}{1-\rho}}\tilde{A}_t$

The only free parameter left in the model is ρ. In their review of the health literature, Ringel *et al.* (2000) report an average estimate for the elasticity of demand for health care equal to -0.17. This implies ρ = -5. That is, which leads to a price-elasticity of health care expenditures of 1/6. Results are nevertheless robust to the choice of the parameter ρ as we show in table 3.1 which also reports the Root Mean Square Error (RMSE) between the simulated and true data for ρ = -4 and ρ = -6.

[Table 3.1]

Therefore, the RMSE generated by the model with ρ ranging from -4 to -6 is in general less than 1%.

Figure 3.2 portrays the US share of health care expenditures for our baseline estimation ρ = -5 under three different $\tilde{A}_t$ scenarios. The model is able to mimic the shape and magnitudes of the observed US ratio of health care expenditures to total consumption. Therefore, excess acute inflation in the health care sector over the transition period 1978-1990 appears to be the main driving force behind the steep increase in health care expenditures over total consumption.

[Figure 3.2]

3.5 Extension

3.5.1 Malpractice, Out of Pocket Expenditures and the US Residual

Although real health care prices are the main variable that explains the evolution of HCE/TC, there could be other variables that are worth taking into account in order to control health care expenditures growth. In this section we focus on Malpractice and the ratio Health Care Expenditures to Out of Pocket Expenditures (HCE/OoP).

To assess the effect of malpractice costs we construct an index of Malpractice Insurance Premiums based on the cost of malpractice insurance for three specialties: General Medicine, Ob/Gyn and General Surgery. The index follows the mean price of these insurance across the US. Data has been retrieved from Danzon (1991) for the period 1975-1986, Harrington et al. (1998) for the period 1987-1990 and the Medical Liability Monitor Survey for 1991 onwards.

The evolution of our Malpractice Index divided by Health Care prices, HCE/OoP and HCE/TC is plotted in panel a) of Figure 3.3. As observed, Malpractice Insurance Costs increased relatively to health care prices during the mid 80s and early 2000s, which are periods in which HCE/TC also presents an explosive pattern. The behavior of HCE/OoP is very similar to HCE/TC throughout the whole period. Panel b) of figure 3.3 plots the Malparactice Index, HCE/OoP and the residual A_t of the US, all of them linearly detrended. The correlation coeffcieients of the detrended variables in first differences are presented in table 3.2.

[Figure 3.3]

[Table 3.2]

As observed from figure 3.3 and table 3.2, changes in HCE/OoP are positively related to changes in the US residual A_t while changes in Malpractice Index are negatively related to changes in the US residual A_t. This means that a relative decrease in Out of Pocket expenditures and a decrease in Malpractice costs can be associated with an expansion of the residual A_t. Of course these variables might affect prices too, so the final effect is still uncertain. We leave a more thorough research on how these and other variables affects prices for future research.

3.5.2 Defensive Medicine Intensity in the use of technology

Another source of difference in expenditures and/or quantities of health care provided between the US and the rest of the OECD countries could be the intensity in the use of expensive technology or expensive medical facilities. Wunsch et al. (2009) showed for example that in the US there is much more intensive care hospitalization among people 85 years old and older than in England: "…among decedents 85+ years, intensive care was used for 31.5% of medical deaths and 61.0% of surgical deaths in the United States versus 1.9 and 8.5% of deaths in England."

Since we do not have time series data for these types of variables, in this section we attempt to assess their effect at a cross-country level without taking into account any dynamics. In table 3.3 we show several statistics for the year 2007 about the quantity of Computed Tomography Scanners (CT) per 1 million population, Magnetic Resonance Imaging units (MRI) per 1 million population, PET scanners per 1 million population and Radiation Equipment per 1 million population for a sample of OECD countries. The table shows that the US is close to the max on every measure regarding the quantity of technological equipment and its values are around two or three times above the mean.

The second part of table 3.3 shows the intensity at which this technology is used. We provide statistics for the variables CT exams per 1,000 population, MRI exams per 1000 population, Mammography screening as % of females aged 50-69 and Cervical screening as % of females aged 50-69 screened. In this regard, it is clear that the US is the country that shows the highest intensity in the use of technology, being at the maximum level in three out of the four variables in the table. Although there might be other variables that proxy for the intensity in the use of technology that we are not using, these stylized facts clearly show how prone American physicians are to ordering expensive studies for their patients.

[Table 3.3]

In figure 3.4 we plot proxy variables for the intensity in the use of technology against variables related to health care expenditures. In figure 3.4.a.1 and 3.4.a.2 we use the quantity of Magnetic Resonance Imaging (MRI) and Computerized Tomography scans (CT) per 1,000 consultations as proxy for intensity in the use of technology. In figure 3.4.b.1 and 3.4.b.2 we use the quantity of transplants per 10,000 population as proxy for the intensity in the use of technology. The quantity of transplants corresponds to the sum of lung, kidney, liver and heart transplants. Panels a.1 and b.1 plot the proxies against total health expenditures as percentage of GDP while panels a.2 and b.2 plot the proxies for the intensity in the use of technology against expenditures per capita measured in US dollars. The black straight line in every figure corresponds to the linear trend estimated for the health expenditures variable. The first important fact is that the US is the country with the highest MRI+CT per consultation and also the one with the highest quantity of transplants per inhabitant. Panel a.1 clearly shows a positive relationship between MRI+CT and expenditures on health per capita. Panel a.2 shows an almost flat relationship for MRI+CT per consultation when compared to health expenditures as % of GDP. Panels b.1 and b.2 show a positive relationship between the proxy variable used for technology and health expenditures, although it is not as strong as in panel a.1. This suggests that one of the factors driving US health expenditures can be found in the intensity in which technology is used.

[Figure 3.4]

Why is it that US physicians expose their patients to so many more CTs and MRIs than their OECD counterparts? One possibility is the rationing of expensive services in OECD countries. Another possibility is that US physicians and private health institutions have more incentives to increase the use of sophisticated equipment since they charge a fee for service; therefore, increasing the use of technology increases their incomes. The problem with the last point is that what is income to physicians is a cost to insurance companies. Insurance companies have all the incentives to audit and reduce the quantity of unnecessary CTs and MRIs. Another explanation is the performance of defensive medicine by US physicians in order to avoid possible legal consequences by not performing all the necessary tests, sometimes even independently of how effective they might be (see for example Smith-Brindman et al 2011). We leave a more thorough analysis of the impact of malpractice litigation on health expenditures and prices for future research.

To finish this section we provide evidence that the outcomes of health care across OECD countries seem to be very similar despite the difference in the intensity in which technology is used. Table 3.4 shows the stylized facts for the year 2003 of the following measures that can be considered as proxies for quality: breast cancer five year observed and relative survival rates for females, cervical cancer five year observed and relative survival rates for females, colorectal cancer five year observed survival rates for females and colorectal cancer five year observed survival rates for males.

[Table 3.4]

The statistic Standard Deviation/Mean is around 0.1 or less which means that there is very little variability in the survival rates among the OECD countries.[8] The US has the maximum survival rates for breast cancer and is below the maximum for cervical and colorectal one. Thus, the intensity in the use of technology does not seem to provide significant improvement in outcomes.

[8] Survival rates are not the best proxy for the quality or outcome of a procedure. A better one would be the quality of life afterwards and how well the patience recover after the procedure is done. Unfortunately we do not have data for those variables.

4. Health Care Prices

Our previous analysis attests that relative health care prices and regulations can mimic quite well the health care expenditure gap over the three subperiods 1970-1978, 1978-1992, and 1992-2007. We now offer some supplementary evidence to support our findings.

4.1 A Time–Series Analysis of US Health Care Expenditures

Since our previous growth accounting exercise demonstrates that the technology residual *A* has moved quite smoothly over time, we may then ignore global trends and focus simply on a time-series analysis of HCE in the US. As previously discussed, the ratio of nominal HCE over GDP has not increased at the same pace throughout the last 40 years. Of course, the steep growth in health care expenditures over the period 1978-1990 is most notorious. Another salient feature is the 1993-2000 period under the Clinton Presidency in which nominal HCE over GDP remained flat.[9]

[Figure 4.1]

The actual evolution of HCE over GDP in the US between 1970 and 2008 is portrayed in Figure 4.1 [Panel (a)]. To recast our previous analysis, Panel (b) of this figure plots the rates of differential inflation in the health care sector and of real GDP growth. From Panel (a) we can observe that both US private and public health care expenditures move *in tandem.* Our main interest is to discuss the effects of excess inflation in the health care sector and real GDP growth as explanatory forces behind these expenditure patterns. According to some researchers [cf. Smith, Newhouse and Freeland (2009)], there could be lags in the response of these variables that may go up to five years. That is, the *short-run* price elasticity may be smaller than the *long-run* price elasticity. The same may hold for the elasticities of real GDP. These lags may lead to non-linear dynamic behavior in the ratio HCE/GDP.

As in section 2, we consider the following sub-periods: (i) *The 1970-1978 period* in which the health expenditure gap hovered around 1.1. From Figure 4.1 [Panel (b)] this time episode presents moderate increases in relative health care prices and high real GDP growth. (ii) *The 1978-1992 period* in which the gap increased steadily to 1.55. From Figure 4.1 [Panel (b)] this time episode presents the highest increases in relative health care prices and the lowest rates in real GDP growth. (iii) *The 1992-2007 period* in which the gap has roughly settled down to 1.5. This time episode presents the lowest average increases in health care prices. The 1993-2000 period of

[9] Real HCE relative to total consumption displays the same pattern as can be observed in Figure 3.2.

Clinton's presidency is the only one in which real GDP growth clearly dominates excess inflation in the health care sector. As a consequence, the ratio real HCE/GDP remained flat.

Of course, this does not mean that we should neglect the effects of health care reforms and other regulations over the last 40 years. As already discussed, the 90's witnessed a shift to *managed care,* which led to a relative decline of physical and clinical services, and hospital care [Figure 1.2], and to a decrease of private indemnity plans in favor of HMO's and PPO's [Figure 2.6]. Changes in the composition of the private health insurance market might have affected the evolution of US prices in the health care sector during the 1990s. Cutler *et al.* (2000) suggest that managed care organizations like HMO's may have cut down costs by about 30% or 40% as a result of declines in prices of medical services and treatment intensities.

4.2 Comparisons of International Health Care Prices

Several studies and international institution have reported notorious cross-country differences in health care prices. For instance, Figure 4.3 presents costs of several health care items in five OECD countries relative to the US for the year 2011. Switzerland exhibits the second highest costs: Around 65 percent of US dollar costs. For the remaining countries in the sample, the unitary prices observed are around one fifth of US costs.

[Figure 4.2]

There is a large international market for international prescription drugs. The cross-country variability in wholesale drug prices is all well known. For instance, 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 company. Some products were even three times cheaper than in the US.

Later research has expanded the range of sample products to provide more accurate price indexes. Danzon and Furukawa (2003) consider a sample of 249 leading US molecules for nine representative countries including the US. The sample represents 30 -- 60 percent of sales in these countries. Indexes for 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 more expensive. 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 higher prices of prescription drugs in the US:

(i) *Product Liability*: Manning (1995) argues that both the litigation experience of specific pharmaceutical products and measures of substantial risk may have substantial and strongly 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 liability reduces the predicted mean and median to 36 and 33 percent respectively. The virtual effect of product 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 above study of the US Department of Commerce (2004) the pharmaceutical sector in the US follows guidelines 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 those restrictions influence drug prescription prices (pp. 15-17), the number of launches of new active substances, and drug availability (*op. cit*., p. 47).

(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) and Santos (2000)], a cross-country difference of ten percent in income per capita may lead to a 3 percent increase in the relative price of non-tradable goods.

It is not the scope of this paper to quantify the US price gap in the health care sector across the different subcategories. However, this evidence seems to indicate that a US price gap of 70 percent does not seem all that implausible. Accordingly, a price elasticity of 0.17 entails that the US expenditure gap should be roughly around 60 percent, which is quite close to our given observations.

To further understand domestic sources of price increases, we now look at the evolution of US income shares in the health care sector.

4.3 Who Benefits from High Prices?

4.3.1 Physicians: Income, Relative Productivity and Quantities

Some authors (e.g. Laugesen and Glied 2011) have pointed out the relative high incomes US physicians earn when compared to other countries. However, an analysis of the evolution of US physicians' incomes rejects the possibility of this variable as a factor to explain the observed increase in health care expenditures as percentage of GDP. In table 4.1 we show several data related to this issue. Line i of table 4.1 shows that the share of total National Health Expenditures that go to physicians' compensation has reduced from almost 15% in 1982 to 13.1% in 2000. Although it is true that physicians' salaries have increased during that period, the same is true for the average worker in the economy. In fact, we have evidence that physicians' productivity has increased more than average worker productivity. Line ii of table 4.1 shows the evolution of a measure of physicians' productivity (total NHE per physician) divided by a measure of workers' productivity (GDP per worker). As observed, the ratio has increased from the years 1980 to 2000. To sum up, changes in physicians' compensation cannot be the variable driving up healthcare prices.

[Table 4.1]

During the period 1970-2000, the total number of active physicians as a percentage of total population increased from 15 per 10,000 population to 26 per 10,000 population. This is shown in line iii of the table above. During that same period, the structure of the health care labor force change. Line iv shows that the quantity of physicians as percentage of total health care workers has decreased from almost 11.7% in 1970 to 7.2% in 2000. The average compensation of a non-physician health care worker with respect to a physician as remained relatively stable as we can observe in line v of table 4.1. Is the increase in the quantity of non-physicians workers driving the increase in health care costs? To answer this question we estimated the relative income share of total health care workers calculated as Total Compensation for workers in the Health Services Industry divided by Total Health Care Expenditures. Results are presented in line vi. Although not shown in the table explicitly, it is worth mentioning that the labor income share of workers experienced a steep increment between 1966 and 1974. After 1974 it remained almost constant at around 30%. Then, the labor share does not seem to be able to explain the observed increase in health care expenditures, especially during the 1980's.

It is important to remember that Medicare was introduced in 1965, and with its introduction many changes occurred in the US health care sector (Finkelstein, 2007). According to our data, the introduction of Medicare seems to be accompanied by an increment in the income share of the labor factor. This increment is most probably due to a steep increase in the number of non-physician workers in the health care industry as shown in line iv and vi of table 4.1. The total number of health care workers with respect to total number of workers in the economy more than double from 1970 to 2000.

The relative average compensation between physicians and non-physicians in the health care sector has remained relatively stable, especially between 1982 and 2007. During the decade of the 80s the labor share remained flat while the Health Expenditures as percentage of GDP increased. During that decade physicians' share of Health Expenditures decreased but it seems that this decrease was compensated by an increase in the number of non-physician workers in the health care industry. At the same time, the relative salary of physicians to non-physicians in the health care sector has remained stable. To sum up, the steep increase in Health Care prices has not been translated in higher salaries for physicians or other health care workers. In the next section we study the behavior of publicly traded companies related to the health care sector.

4.3.2 Publicly traded companies and the market efficiency of the health care industry

Many papers have analyzed the competitiveness of the US medical care sector. For example, Dunn and Shapiro (2011) show that in markets where physicians possess market power they are able to bias medical care prices and utilization to their advantage. Skinner et al. (2005) show that Medicare spending seems to be highly inefficient, with 20% of Medicare expenditures not providing any increase on survival rates or quality of life for the elderly population.

In the previous section we showed that physicians have seen, in general, their wage income decrease with respect to the average US worker since the early 80s (Figure 4.5.b) while the relative productivity of physicians' has increased with respect to the relative productivity of the average worker (Figure 4.5.c). At the same time, we showed that the share of health expenditures that goes to physicians' payments diminished between the years 1982 and 2007 (Figure 4.5.a). Therefore, it seems that most of the increase in NHE has not been captured by the physicians. But what about the private companies in the health care sector? In this section we analyze the behavior of the returns of the publicly traded companies in the health care sector between 1979 and 2009. We use standard asset pricing techniques to assess if these companies generated higher or lower returns than those predicted by standard asset pricing models as normal or fair. A difference in the realized return with respect to the predicted by standard asset pricing models can be interpreted as the existence of an arbitrage opportunity and thus as evidence of market inefficiency. Our main goal is to determine whether the existence of an arbitrage opportunity is related to the evolution of health care spending related variables. In this sense, if companies produce higher returns than those predicted by the model in periods of high spending growth, shareholders are obtaining extra profits/returns than normal due to the higher spending growth.

To analyze the performance and efficiency of companies in the health care sector, we use standard empirical asset pricing techniques. For this purpose, we downloaded data on individual firms publicly traded in the US between January 1979 and December 2009 from the Center for Research in Security Prices (CRSP). We selected two groups of companies based on their Standard Industrial Classification (SIC) code:

a) 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 stock-holders, policy holders, or other carriers. Establishments primarily engaged in providing hospital, medical and other health services on a service basis or combination of service and indemnity bases are classified in Industry 6324.[10]
b) SIC 80: This major group includes 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 in Insurance, Major Group 63. Hospices are also included in this major group and are classified according to the primary service provided.[11]

The summary statistics of the data are provided on Table 4.2. Monthly data has been retrieved from the Center for Research in Security Prices (CRSP) and used to construct the yearly statistics. The data has been cleaned from firms with missing information. To be included in the analysis, a firm must have data on returns (including dividends), end of the month closing price and total number of shares outstanding.[12] The column Average Number of Firms corresponds to the average monthly number of firms for each SIC group, Mean Size corresponds the average size of

[10] Definitions from the United States Department of Labor available at http://www.osha.gov/pls/imis/sicsearch.html
[11] Ibid.
[12] The list of companies used to construct each index is available from the authors upon request.

the firm for a year, where size is defined as price times number of shares outstanding (market capitalization) at the end of June of each year. Max Size and Min Size correspond to the value of the firm with the largest and smallest market capitalization value calculated at the end of June of each year. Finally, the column of VWI Nominal Returns corresponds to the yearly rate of return of an index calculated with the companies within each SIC in which each company's weight in the index correspond to its market capitalization value divided by total market capitalization for the firms within the SIC (value-weighted index).

[Table 4.2]

In table 4.3 we present the average excess return over the risk free rate for the period 1979-2009 for each of the constructed value-weighted indices, and we compare them to the benchmark index, which is the value-weighted index calculated by CRSP for the entire US stock market.[13] We also report the standard deviation of each index and its Sharpe Ratio. The Sharpe Ratio is the average excess return over the risk free rate of the asset divided by its standard deviation and is also called the reward to volatility measure. It tell us how much excess return over the risk free asset a risky asset proportionate to his holder for each unit of risk that is faced, where the measure of risk is simply the standard deviation of the asset's returns. The table shows that the returns of the companies included in SIC 80 and SIC 632 have been larger on average than the average return of the rest of the stock market. Although the standard deviations of VWI SIC 632 and VWI SIC 80 are larger than that of the value-weighted portfolio of the whole market, the extra risk less than compensates for the higher returns leading to larger Sharpe Ratios than the benchmark (84% larger for SIC 80 and 71% larger for SIC 632).

[Table 4.3]

What table 4.3 shows is that publicly traded companies in the health care industry sector have done better than the average company in the US, as opposed to what showed in the previous section between physicians and average workers in the US.

Nevertheless, when analyzing Sharpe Ratios we are not controlling only for sources of systematic risk since the measure used as risk (standard deviation) includes the systematic and non-systematic components. As it is standard in the finance literature, in order to say that an asset has obtained abnormal returns, we have to control for its exposure to sources of systematic risk. Several models have been proposed for this purpose as is the case of the well known Capital Asset Pricing

[13] The rate of return of the value-weighted index for the whole US economy as well as the risk free rate has been retrieved from Kenneth French website: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french

Model (CAPM). 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 value-weighted portfolio of all the stocks in the economy is generally used as a proxy. The econometric version of the model that has been widely tested is

$$r_i - r_f = \alpha_i + \beta_i (r_m - r_f) + \varepsilon_i \tag{1}$$

where r_i is the vector of return of the asset we want to test (in our case i={SIC632,SIC80}), r_f is the vector of risk free returns, r_m is the vector of returns of the proxy used for the market portfolio and ε_i is the idiosyncratic risk that can be diversified by aggregating assets into portfolios. If asset i is properly priced given its quantity of systematic risk (β_i), then α_i should be statistically no different than zero, which implies the absence of abnormal returns.

Besides the CAPM we are going to use as benchmark two other models that are very popular in the empirical asset pricing literature. The Fama-French (FF) three factor model based on Ross's (1976) APT theory and the FF model augmented with the momentum factor also known as the Carhart model. The econometric version of the Fama-French three factor model is presented in equation (2), and the one with the momentum factor added is presented in equation (3):

$$r_i - r_f = \alpha_i + \beta_{i1} (r_m - r_f) + \beta_{i2} SMB + \beta_{i3} HML + \varepsilon_i \tag{2}$$

$$r_i - r_f = \alpha_i + \beta_{i1} (r_m - r_f) + \beta_{i2} SMB + \beta_{i3} HML + \beta_{i4} MOM + \varepsilon_i \tag{3}$$

where SMB is the factor capturing the so called Size effect, HML captures the Book to Market effect and MOM captures Momentum profits.[14]

Table 4.4 provides the results from using models (1), (2) and (3) to test whether VWI SIC 632 and VWI SIC 80 generate abnormal returns. Data on the factors was downloaded from Kenneth French website. In the table we report the values of the coefficients, p-values in parenthesis and the R^2 of each regression.

[Table 4.4]

[14] SMB, HML and MOM are generally considered to be sources of non-diversifiable risk in the empirical asset pricing literature. For a description on how these variables are constructed see Fama and French (1993) and Carhart (1997).

As shown in table 4.4, the abnormal returns (α) are positive and significant in every model for both indices, VWI SIC 632 and VWI SIC 80. In the case of the index constructed with the SIC 80 companies, the p-value of α is always less than 0.001 no matter which model is used. For the SIC 632 case the p-value for α is always less than 0.025. Not only are the α significant but their size is also economically relevant. For example, in the case of the SIC 80 when using the FF+Carhart four factor model we obtain a monthly α of 1.11%. This means that the yearly cumulative abnormal return generated by this portfolio is in the order of magnitude of 14.16%. These results are further evidence of the abnormal returns that publicly traded firms in the health care industry have obtained during the last 30 years, a period in which health expenditures have seen an explosive growth in the US when compared with the rest of the OECD countries.

Now we will link the abnormal returns previously calculated with health care expenditures. In figure 4.3 we plot yearly abnormal returns against the growth rate in Total National Health Expenditures. Yearly abnormal returns are simply the difference between the observed returns and those predicted by the CAPM.[15] Panel a) of the figure shows the yearly raw data. Since it is known that financial variables are much more volatile than macro variables, in panel b we plot a 5 year moving average of the abnormal returns and growth rates in order to have smoother variables. We have divided panel b into three periods: pre 1987, 1987-1999 and post 1999. As can be observed, during these three periods the trends among the variables behave similarly suggesting a link between the abnormal returns observed in the health care industry and the growth in total health expenditures. Panel c of figure 4.3 shows the moving average of the abnormal returns of the indices and the moving average of the growth rate of NHE/GDP. The similarity in this figure among the series' trends is striking.

[Figure 4.3]

We also correlated the abnormal returns (adjusted by inflation) with the real growth in the uses of health care expenditures for the period 1979-2009. Interestingly, the maximum correlation for the abnormal returns generated by the SIC80 index corresponds to the growth rate in Health Insurance (0.30). For the SIC632 index the correlation with growth rate in Health Insurance equals 0.14. For the specific case of the growth rate in Private Health Insurance the correlation values for the SIC80 and SIC632 abnormal returns are 0.18 and 0.10, respectively. We also correlated the

[15] The data in this figure is obtained by using a constant beta estimated using the entire sample. We also produced a figure with rolling betas estimated based on 60 consecutive monthly returns and collapsing alpha to zero whenever it is not significant. Results are qualitatively the same and are available from the authors upon request.

abnormal returns at period *t* with the growth rates of health expenditures at *t*-1. In this case we find similar results as when using contemporaneous correlations, in which the correlation of SIC80(*t*) and SIC632(*t*) with respect to total health insurance at *t*-1 is 0.24 and 0.22 respectively and for private health insurance is 0.32 and 0.14, respectively. To visually observe these correlations, we plotted 5 years moving average of the above variables in panel d of figure 4.7. Again, the similarities among the trends are striking.

To sum up, there is evidence that the companies that belong to the health care industry have obtained abnormal returns during the last 30 years when compared to the overall returns in the economy. At the same time, there is evidence that these abnormal returns are related to the uses of the health care expenditures in the US, especially the expenditures in Health Insurance, suggesting the lack of efficiency in the market and its further exploitation by companies belonging to the health care sector.

6. Concluding Remarks

In this paper we study the evolution of health care expenditures in the US comparing it to other OECD countries for the years 1970-2007. Given the model we propose we focus on the variable Health Expenditure relative to Total Consumption which behaves similarly to Health Expenditures as percentage of GDP, the variable generally used in the literature. During the period 1970-2007 there are three stages: the periods 1970-1978 and 1992-2007 in which the growth of the variable Health Care Expenditures to Total Consumption behaves similarly between the US and the average OECD country; and the period 1978-1992 in which the US shows an explosive behavior when compared to the rest of the OECD and the gap increases by 60%. Our main result is that inflation in health care prices and government regulations are the main forces behind the evolution of HCE to total consumption in the US. We provide a simple model that accounts for almost all of the increase in health expenditures by consumption during the period 1970-2007 by focusing on the evolution of real health care prices. We use OECD country data to calibrate it.

We also provide further evidence with regard which variables might be influencing the dynamic of health care expenditures and find that the market structure for private insurance, the reduction in out of pocket expenditures with respect to total expenditures, malpractice and the intensity in which technology is used in the US would be able to account for part of the real health care price behavior. We also provide evidence that the physicians' compensation, physicians' supply, and income levels would not explain why the US spends more than the rest of the OECD countries in health care, both as percentage of total consumption and as percentage of GDP. Finally, we show that the shareholders of the companies in the health care sector and not the labor input are the ones that benefit the most with the increase in health care spending.

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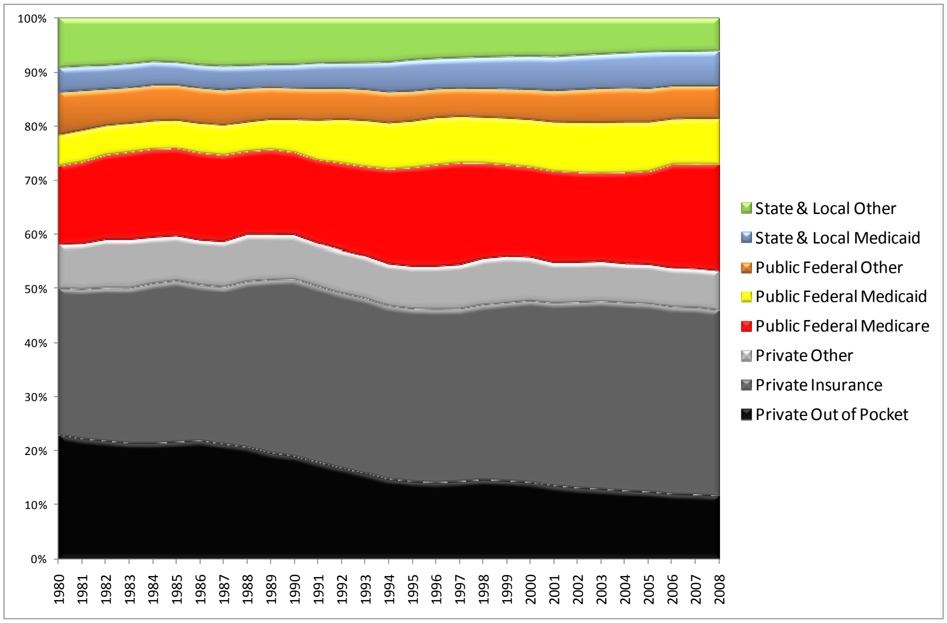
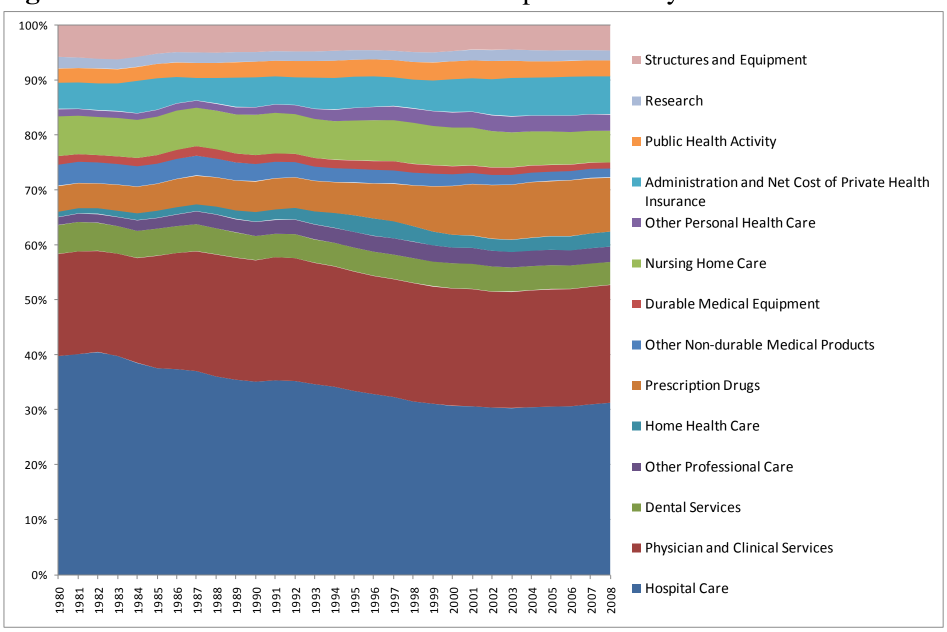
Figure 1.1: Evolution of US Health Care Expenditures by Source



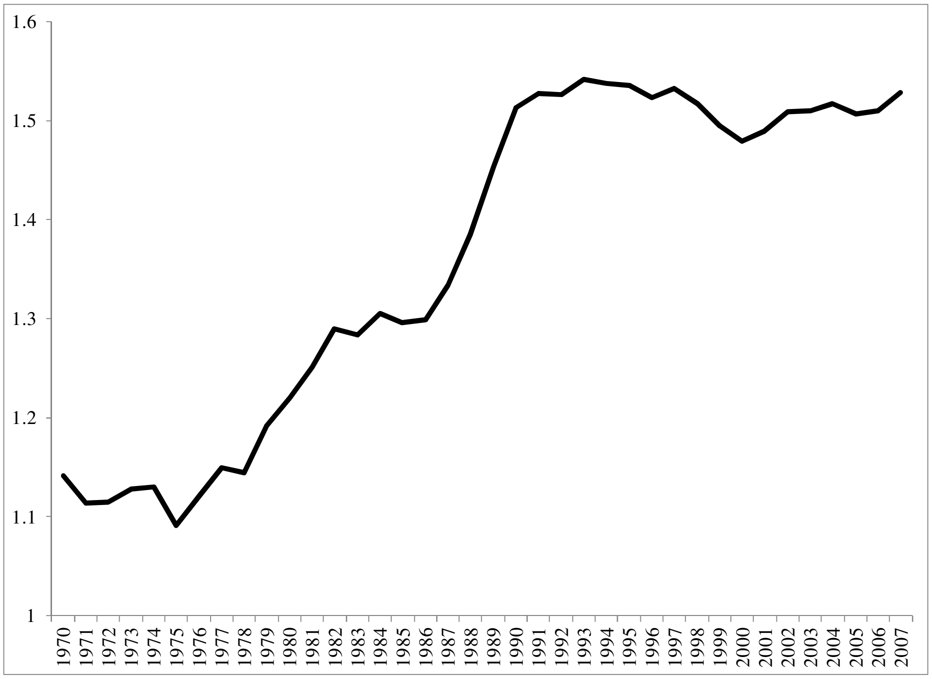
Source: US Department of Health and Human Services - Centers for Medicare and Medicaid Services.

Figure 1.2: Evolution of US Health Care Expenditures by Use



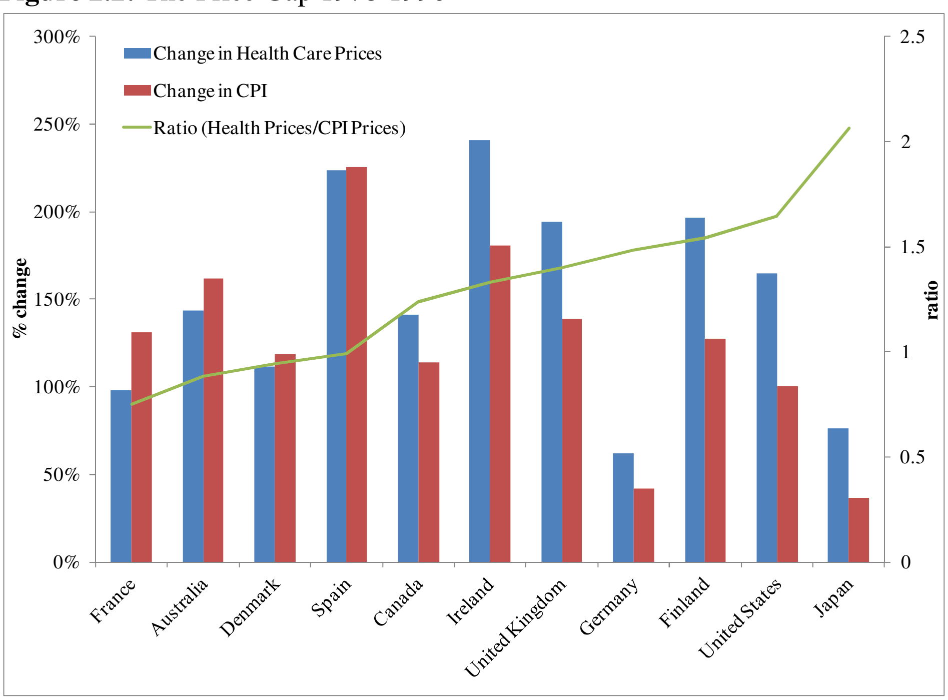
Source: US Department of Health and Human Services - Centers for Medicare and Medicaid Services.

Figure 2.1: The HCE Gap



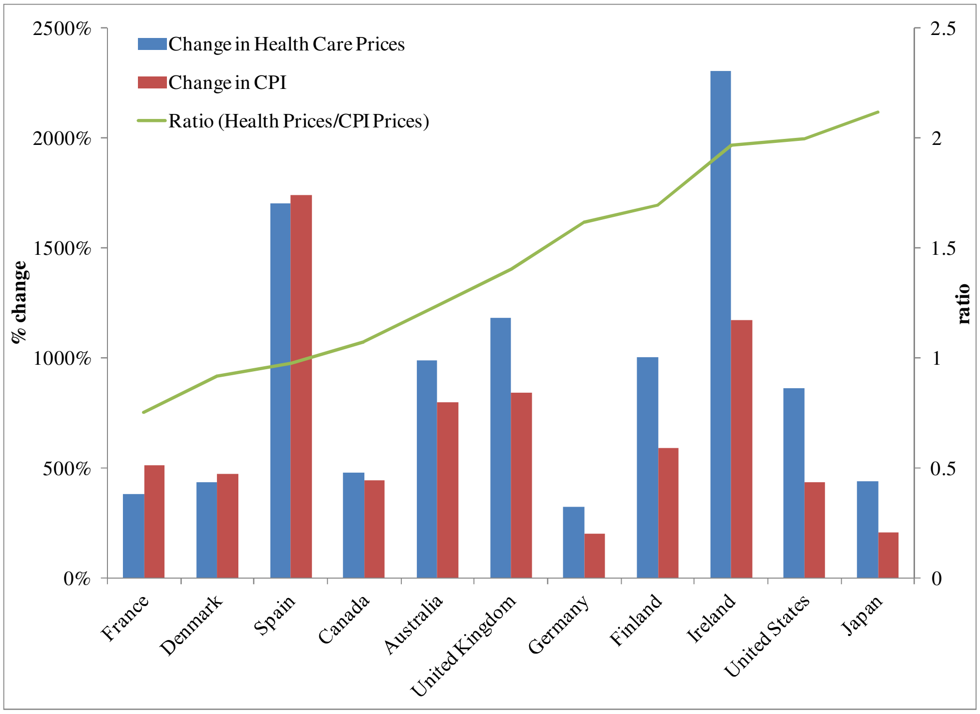
Source: OECD Health Data (June 2012)

Figure 2.2: The Price Gap 1978-1990



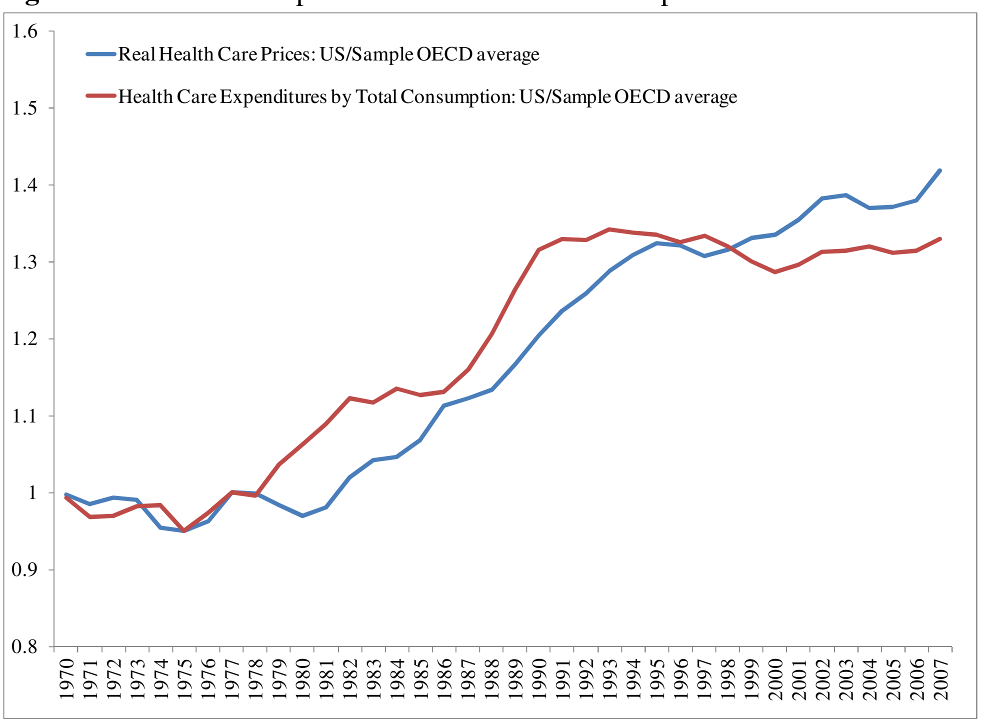
Source: Each country’s official statistics webpage and other sources.

Figure 2.3: The Price Gap 1970-2007



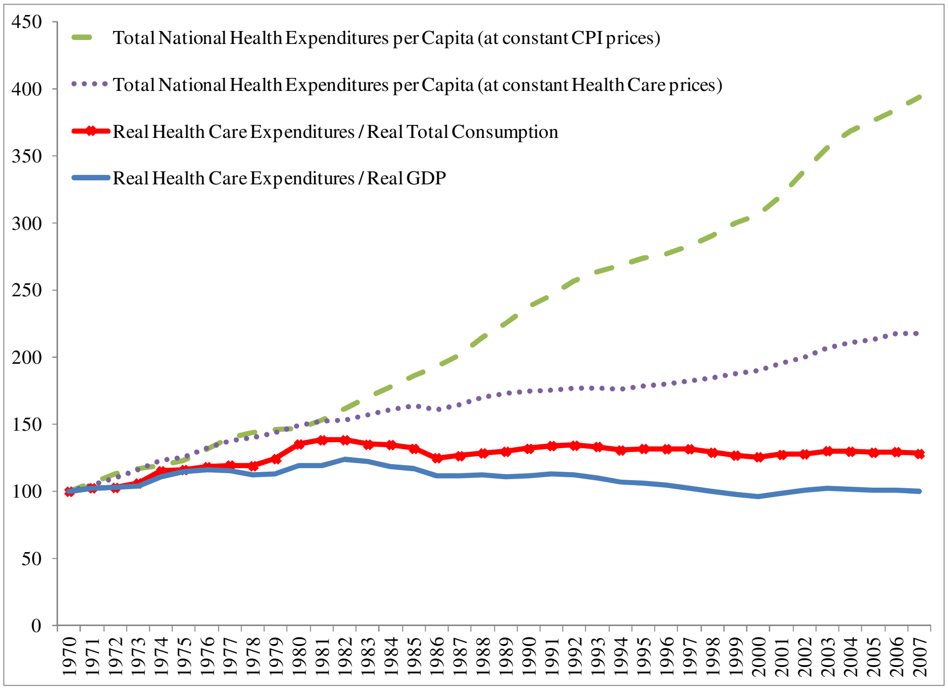
Source: Each country's official statistics webpage and other sources.

Figure 2.4: The HCE Gap and the Health Care Price Gap



Source: Health Expenditures are from the OECD Health Data (June 2012). Data on Health Care Prices are from each country's official statistics webpage and other sources.

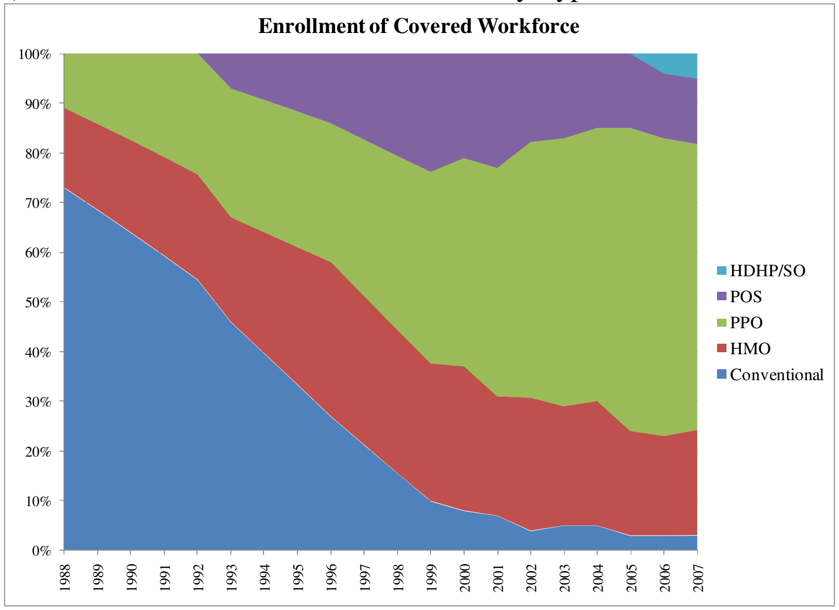
Figure 2.5: Evolution of US Health Care Expenditures



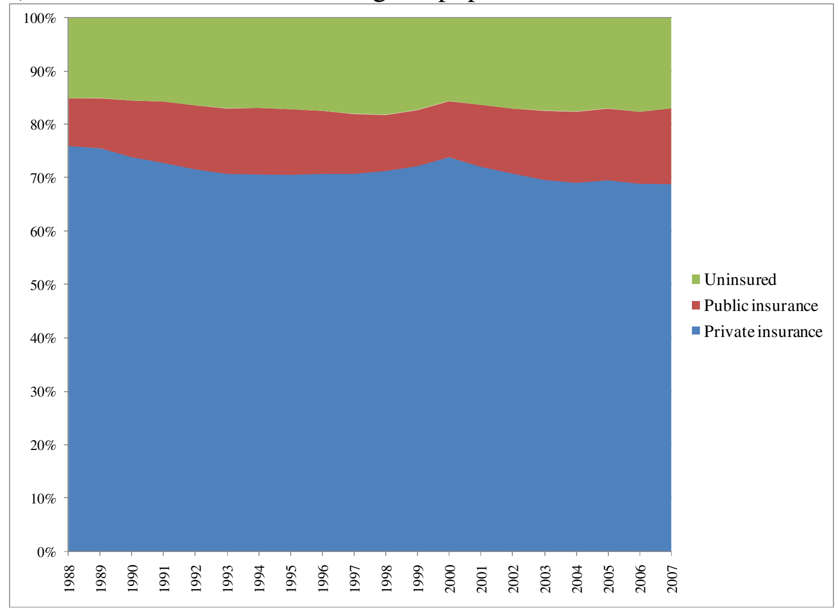
Source: Health Expenditures are from the OECD Health Data (June 2012). Data on Health Care Prices are from each country's official statistics webpage and other sources.

Figure 2.6: Health Insurance

a) Share of The Private Insurance Market by Type of Insurance

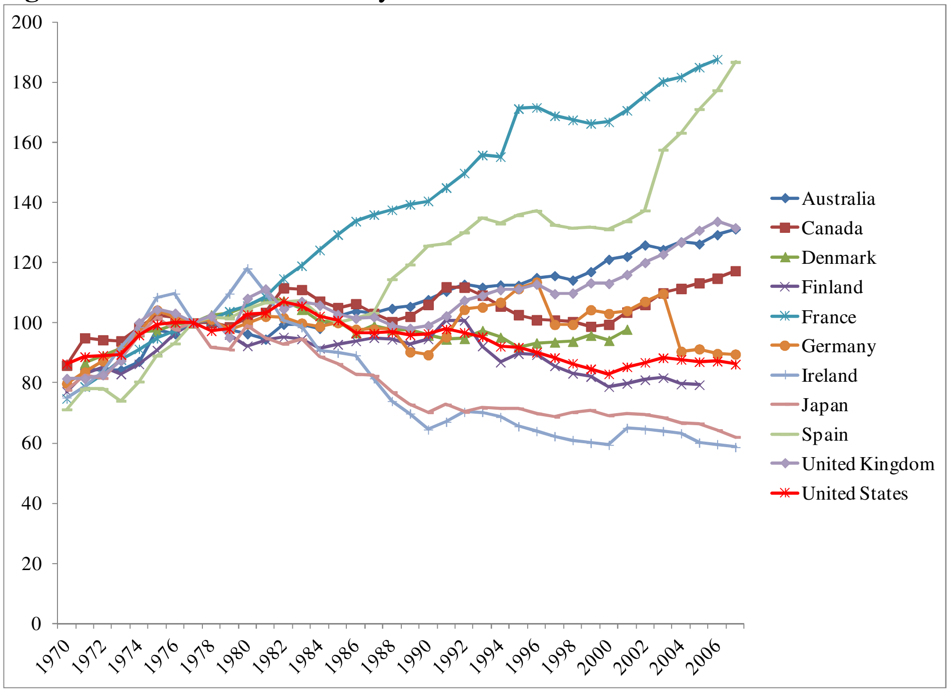


b) Insurance distribution among the population



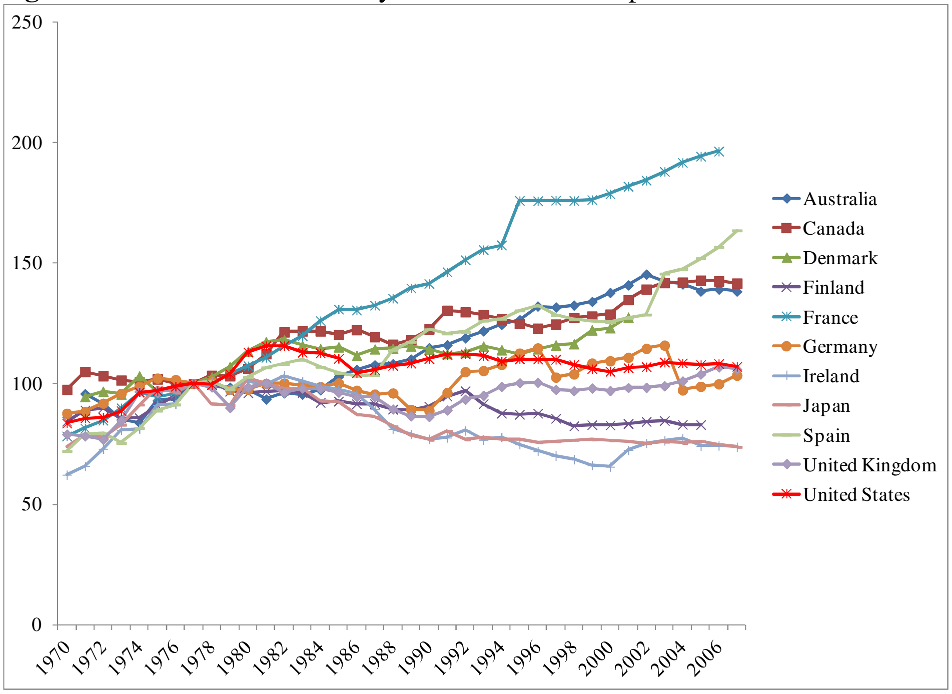
Source: Kaiser Family Foundation and Gruber & Levy (2009)

Figure 2.7: Real HCE divided by Real GDP



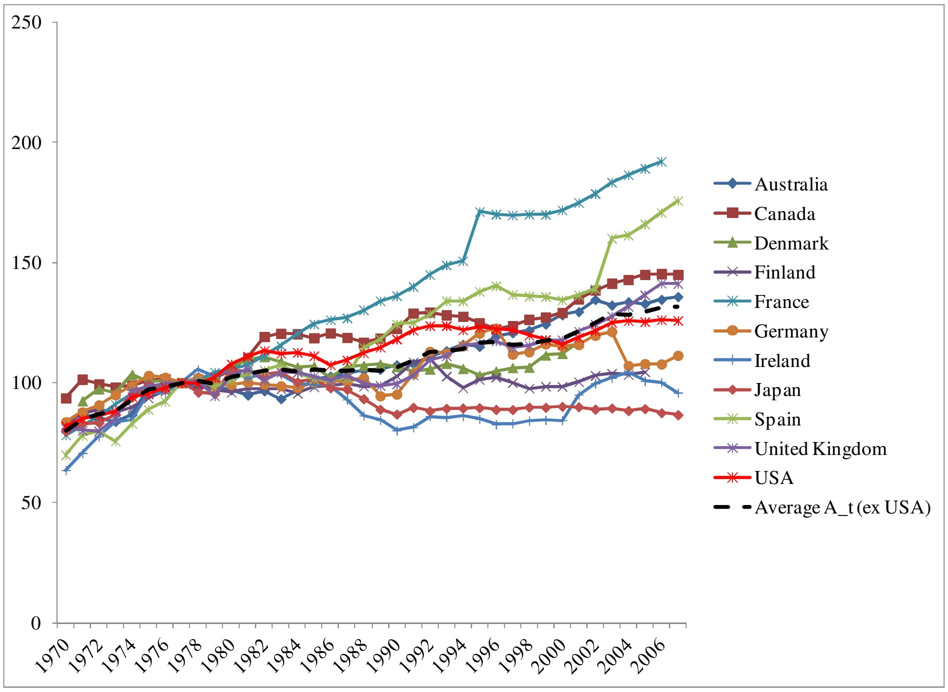
Source: Health Expenditures are from the OECD Health Data (June 2012). Data on Health Care Prices are from each country's official statistics webpage and other sources.

Figure 2.8: Real HCE divided by Real Total Consumption



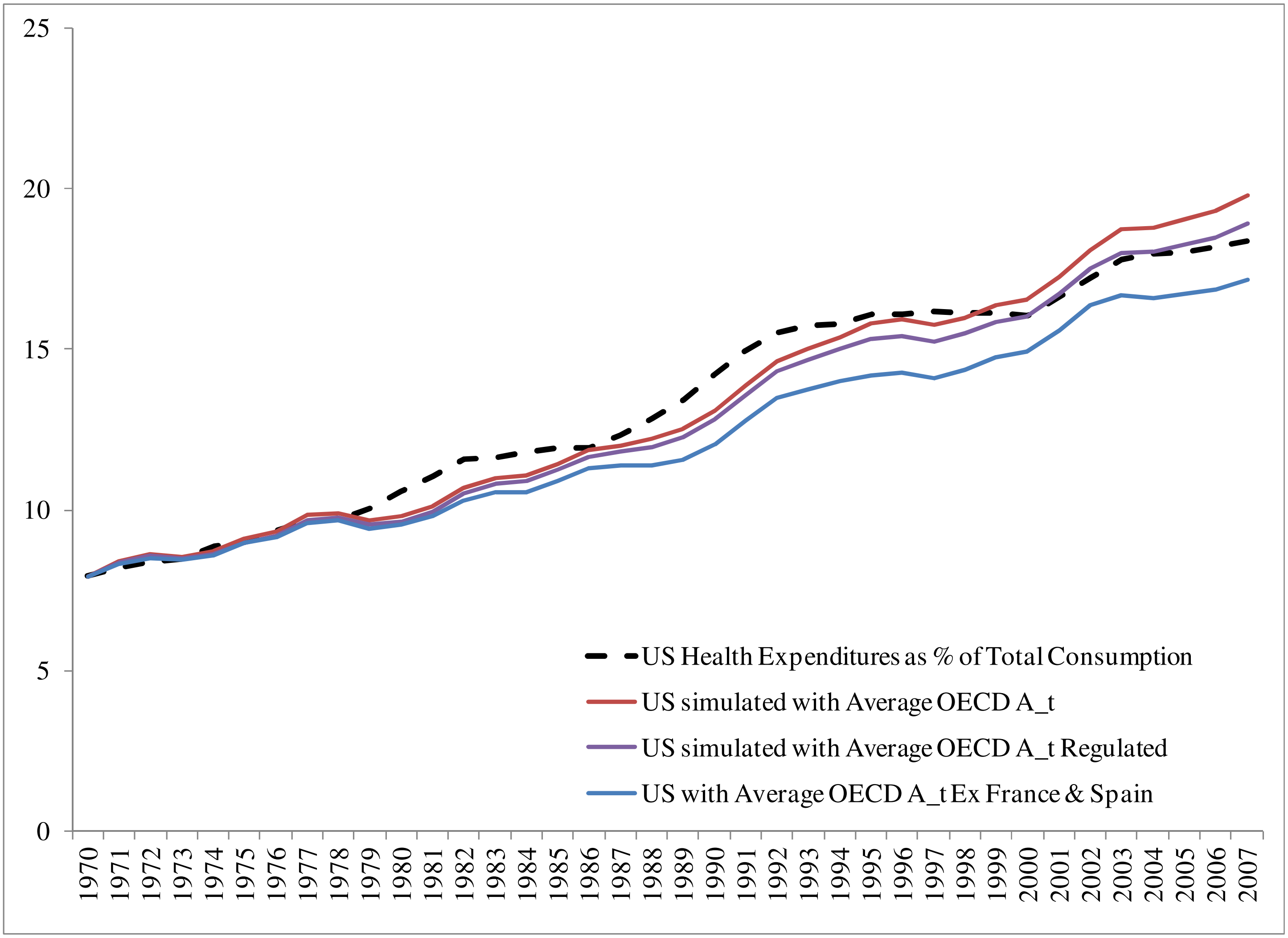
Source: Health Expenditures are from the OECD Health Data (June 2012). Data on Health Care Prices are from each country's official statistics webpage and other sources.

Figure 3.1: Raw $\tilde{A}_t$



Source: Health Expenditures are from the OECD Health Data (June 2012). Data on Health Care Prices are from each country's official statistics webpage and other sources.

Figure 3.2: Model Simulation

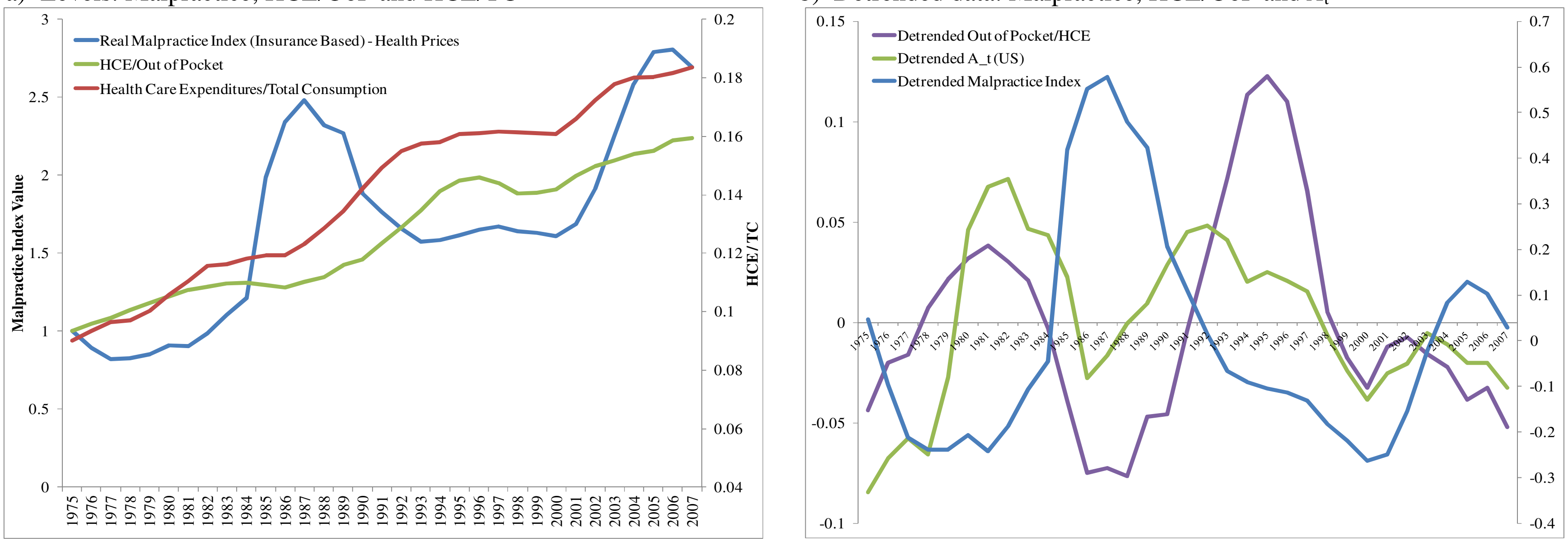


Source: Health Expenditures are from the OECD Health Data (October 2010). Data on Health Care Prices are from each country's official statistics webpage. The OECD included countries are Australia, Canada, Denmark, Finland, France, Germany, Ireland, Japan, Spain and the United Kingdom.

Figure 3.3: Malpractice, Out of Pocket expenditures and the US residual

a) Levels: Malpractice, HCE/OoP and HCE/TC

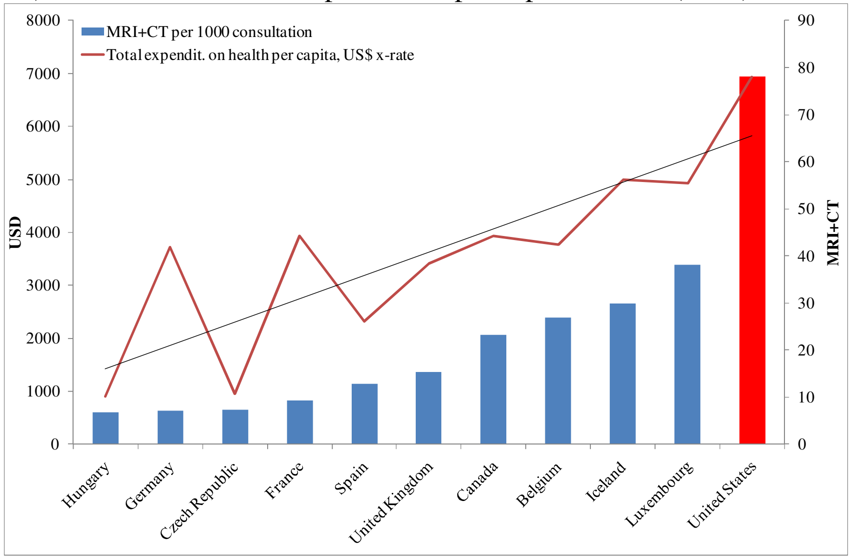
b) Detrended data: Malpractice, HCE/OoP and A_t



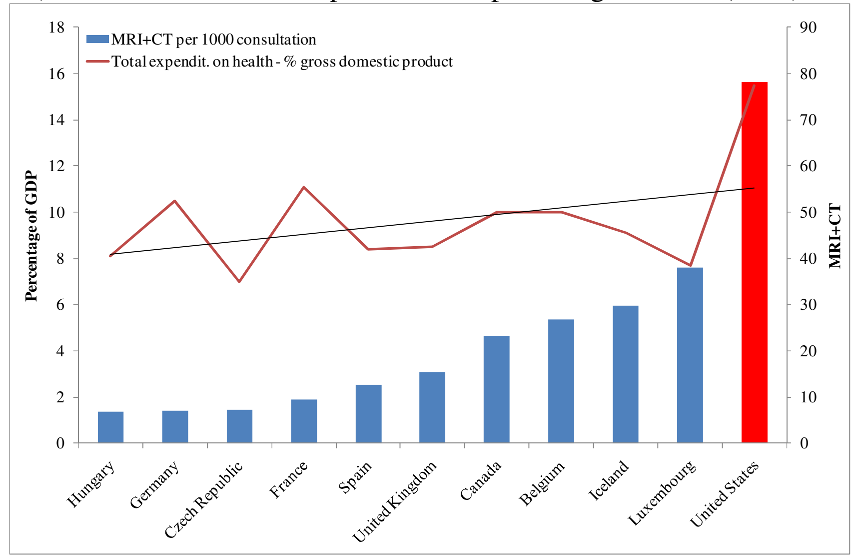
Source: Health Expenditures are from the OECD Health Data (June 2012), Danzon (1991), Harrington et al. (2008) and the Medical Liability Monitor Survey.

Figure 3.4: Intensity in the use of technology

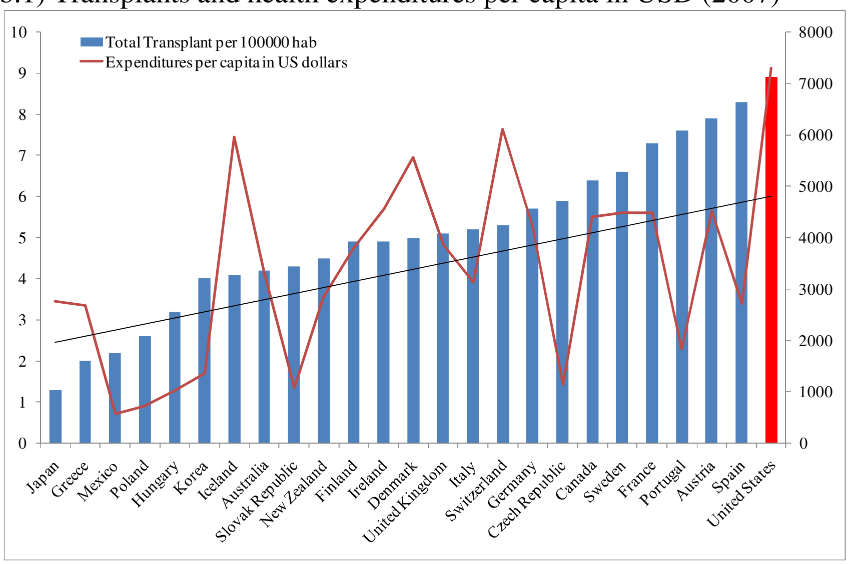
a.1) MRI+CT and health expenditures per capita in USD (2006)



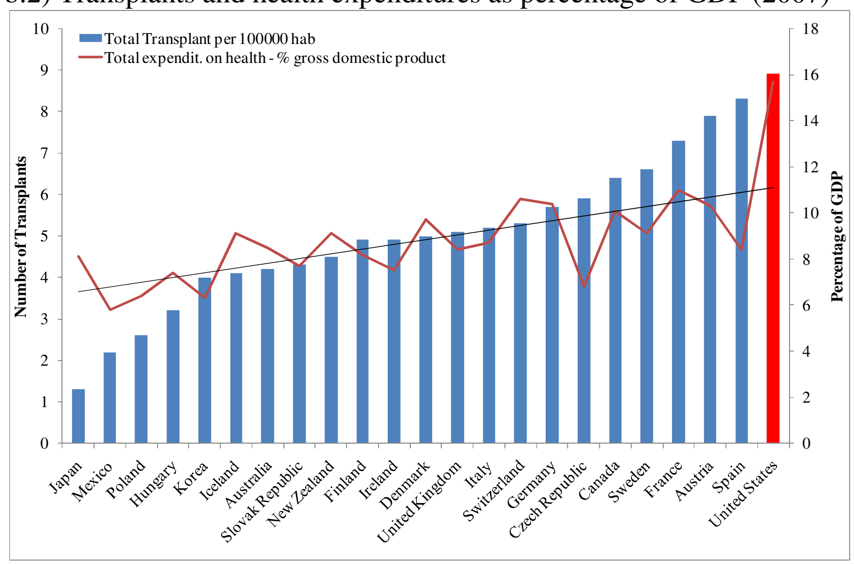
a.2) MRI+CT and health expenditures as percentage of GDP (2006)



b.1) Transplants and health expenditures per capita in USD (2007)



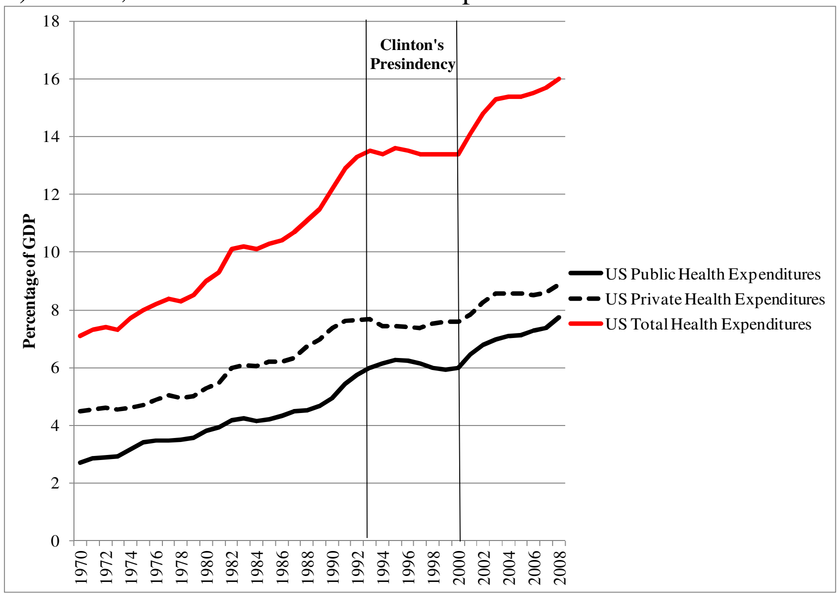
b.2) Transplants and health expenditures as percentage of GDP (2007)



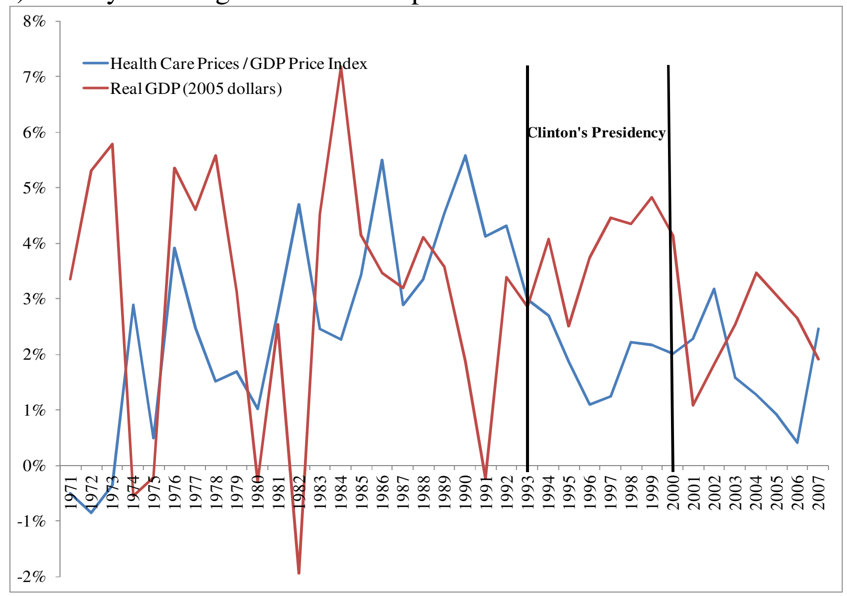
Source: OECD Health Data (October 2010)

Figure 4.1: Health Care prices and Health Care Expenditures as percentage of GDP

c) Public, Private and Total Health Expenditures as % of GDP

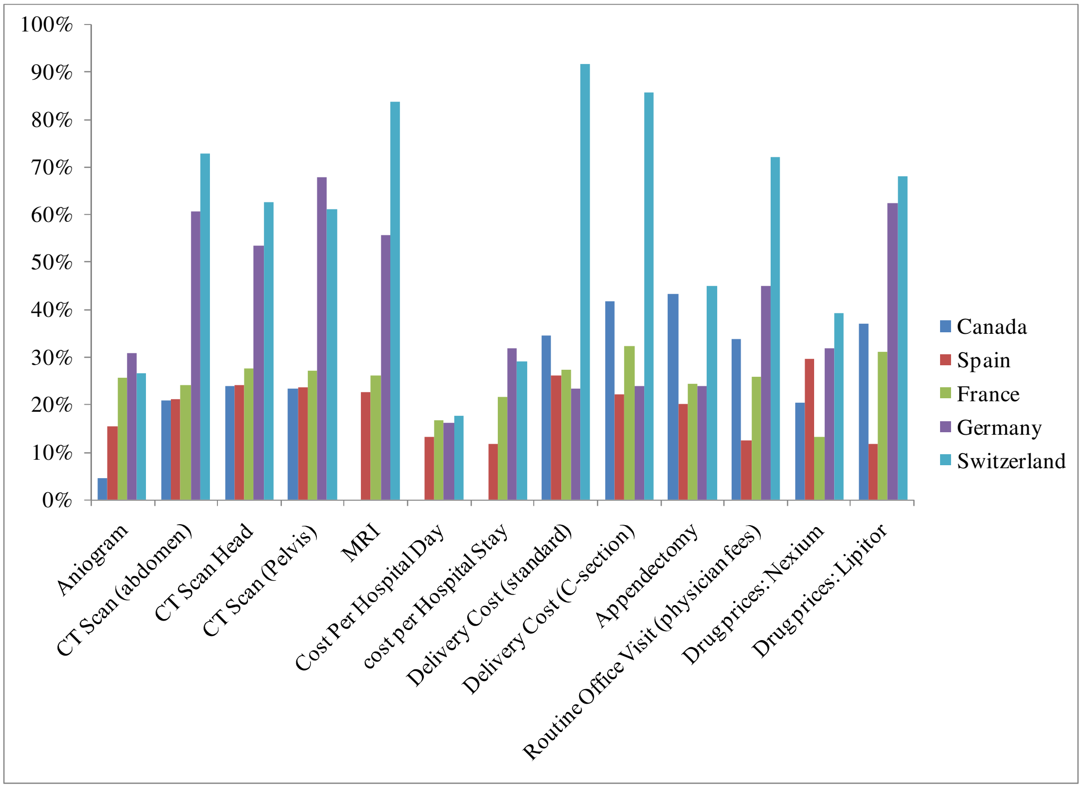


d) Yearly % change in HCP/GDP prices and Real GDP



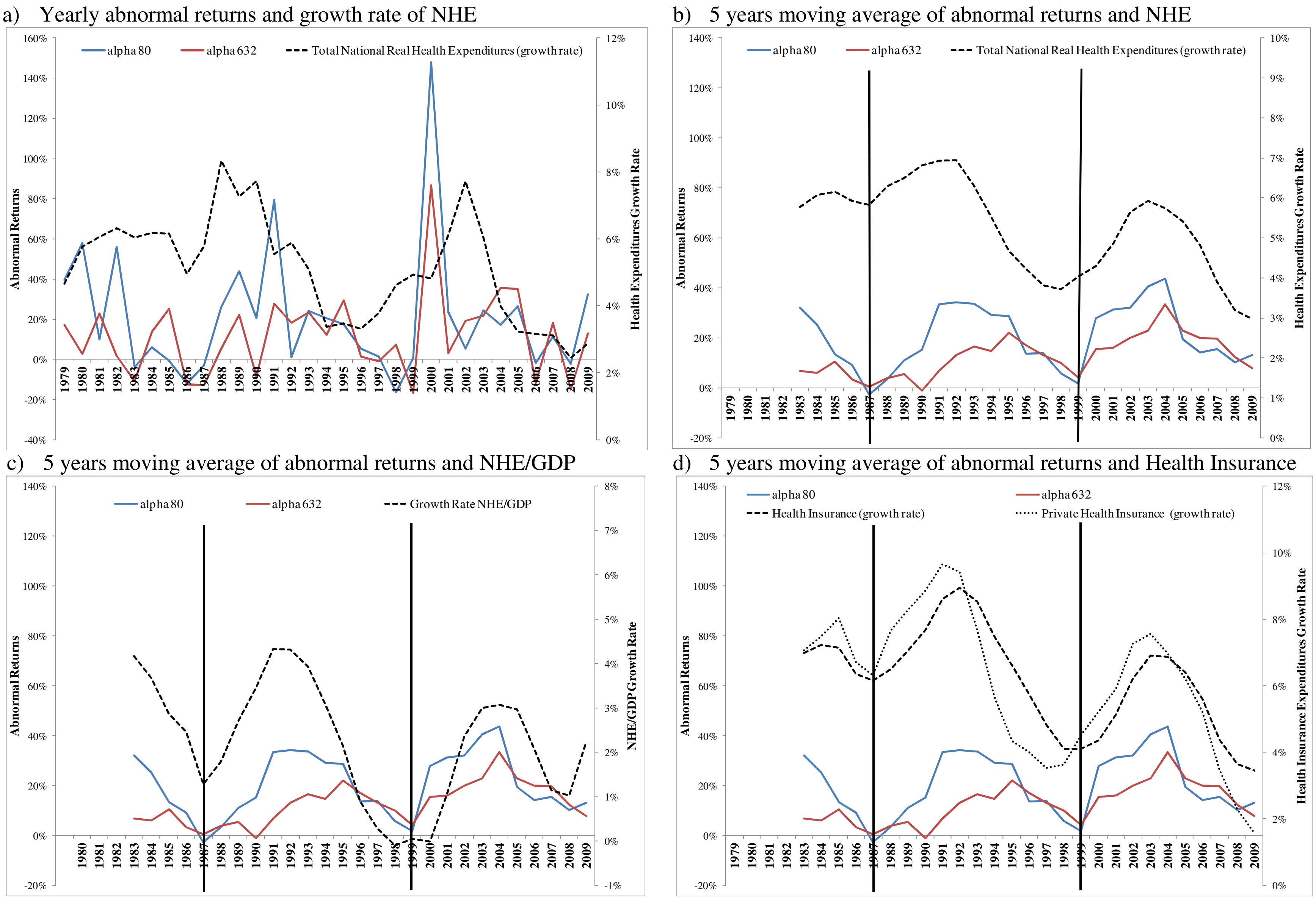
Source: US Census Bureau and US Department of Health & Human Services - CMS

Figure 4.2: Average Health Care prices as percentage of US Health Care prices 2011 (USS dollars)



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

Figure 4.3: Abnormal Returns and Health Expenditures



Source: CRSP, Bureau of Economic Analysis and Kenneth French webpage.

Table 3.1: Simulations' RMSE

	$\rho = -4$	$\rho = -5$	$\rho = -6$
Simulation with Raw A_t	0.63%	0.65%	0.69%
Simulation with Regulated A_t	0.74%	0.69%	0.66%
Sim. with A_t Ex Spain and France	1.38%	1.29%	1.23%

Table 3.2: Correlation table: Malpractice Index. HCE/OoP and the US residual A_t

	ΔA_t	Δ HCE/Out of Pocket	Δ Malpractice Index
ΔA_t	1		
Δ HCE/Out of Pocket	0.43	1	
Δ Malpractice Index	-0.28	-0.40	1

Table 3.3: Technology

Variable	Obs	Mean	US/Mean	US/Max	Std. Dev.	StdDev/Mean	Min	Max
				2007				
Computed Tomography Scanners (per 1 million pop)	26	17.80	**1.93**	**0.92**	10.27	*0.577*	3.99	37.13
Magnetic Resonance Imaging units (per 1 million pop)	25	9.24	**2.80**	**1.00**	6.60	*0.714*	1.52	25.91
PET scanners (per 1 million pop)	23	1.28	**2.40**	**0.79**	1.07	*0.836*	0.00	3.85
Mammographs (per 1 million pop)	21	22.05	**1.82**	**0.94**	12.20	*0.553*	1.69	42.80
Radiation Equipment * (per 1 million pop)	21	7.22	**1.57**	**0.69**	4.26	*0.591*	0.52	16.49
Computed Tomography exams (per 1000 pop)	17	108.21	**2.11**	**1.00**	52.23	*0.483*	17.20	227.90
Magnetic Resonance Imaging exams (per 1000 pop)	17	36.91	**2.47**	**1.00**	23.51	*0.637*	1.70	91.20
Mammography screening (% of females aged 50-69 screened)	13	58.55	**1.39**	**0.92**	21.18	*0.362*	22.10	88.10
Cervical cancer screening (% of females aged 50-69 screened)	14	64.26	**1.34**	**1.00**	18.34	*0.285*	24.50	85.90

Note: if there is no data for a country for a specific year but there is for an immediate previous or following year we use that number.
* Data corresponds to 2010

Table 3.4 Quality measures

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

Note: if there is no data for a country for a specific year but there is for an immediate previous or following year we use that number.

Table 4.1: Physicians' Income, Relative Productivity and Quantities

	1970	1980	1990	2000
i. Total Expenditures in Physicians divided total NHE	N/A	14.8%*	14.1%	13.1%
ii. Total NHE per physician divided GDP per worker (real terms)	N/A	20.5	23.8	22.1
iii. Active physicians as percentage of total population	0.15%	0.19%	0.22%	0.26%
iv. Physicians as percentage of total health care workers	11.7%	8.2%	7.1%	7.2%
v. Average Non-Phys. compensation divided average physician comp.	N/A	11.4%*	11.3%	12.0%
vi. Labor Income Share in the Health Care Industry	24.3%	32.6%	33.0%	31.1%
vi. Total health care workers as % of total workers	3.5%	5.5%	6.8%	7.4%

* Data corresponds to the year 1982

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

Table 4.2: Descriptive statistics for the firms coded as SIC 632 and SIC 80

	SIC 632					SIC 80				
Year	Average number of Firms	Mean Size (billions USD)	Max Size (billions USD)	Min Size (billions USD)	VWI Nominal Return	Average number of Firms	Mean Size (billions USD)	Max Size (billions USD)	Min Size (billions USD)	VWI Nominal Return
1979	12.92	$ 0.5026	$ 2.6087	$ 0.0014	36.7%	39.50	$ 0.0545	$ 0.5445	$ 0.0013	58.7%
1980	13.58	$ 0.5572	$ 3.0435	$ 0.0016	28.1%	41.50	$ 0.0861	$ 1.0599	$ 0.0010	82.9%
1981	14.17	$ 0.6518	$ 3.1976	$ 0.0033	25.5%	44.42	$ 0.1566	$ 1.9342	$ 0.0013	13.1%
1982	14.75	$ 0.6021	$ 2.8091	$ 0.0040	18.5%	52.67	$ 0.1070	$ 1.5710	$ 0.0005	72.8%
1983	15.33	$ 0.9591	$ 3.8673	$ 0.0069	6.9%	69.67	$ 0.2557	$ 4.4168	$ 0.0010	13.5%
1984	19.25	$ 0.5986	$ 2.9262	$ 0.0034	19.2%	97.58	$ 0.1470	$ 3.4420	$ 0.0015	11.6%
1985	22.00	$ 0.8486	$ 4.9935	$ 0.0045	48.2%	103.33	$ 0.1942	$ 4.3093	$ 0.0015	21.7%
1986	25.17	$ 0.8926	$ 6.6492	$ 0.0081	-0.2%	113.42	$ 0.1544	$ 3.1658	$ 0.0013	0.0%
1987	28.08	$ 0.8321	$ 6.7006	$ 0.0043	-9.6%	123.42	$ 0.1509	$ 3.7955	$ 0.0007	0.2%
1988	29.83	$ 0.6458	$ 5.1278	$ 0.0012	19.0%	118.92	$ 0.1214	$ 2.6328	$ 0.0010	39.5%
1989	29.08	$ 0.8285	$ 6.2148	$ 0.0049	43.4%	113.83	$ 0.1231	$ 2.2873	$ 0.0006	64.8%
1990	30.67	$ 0.8099	$ 5.8331	$ 0.0029	-9.5%	128.00	$ 0.1357	$ 3.0847	$ 0.0004	19.7%
1991	36.67	$ 0.6840	$ 5.0242	$ 0.0038	51.4%	145.67	$ 0.1827	$ 3.4549	$ 0.0004	102.4%
1992	40.83	$ 0.6956	$ 4.5544	$ 0.0031	25.4%	173.75	$ 0.2026	$ 3.2714	$ 0.0010	7.9%
1993	42.42	$ 0.8557	$ 6.1121	$ 0.0066	31.8%	185.00	$ 0.2173	$ 4.6205	$ 0.0007	32.5%
1994	46.33	$ 0.9293	$ 7.5037	$ 0.0097	13.2%	187.42	$ 0.3134	$ 12.6776	$ 0.0005	21.7%
1995	43.67	$ 1.0852	$ 7.1651	$ 0.0180	54.4%	187.92	$ 0.3590	$ 19.1294	$ 0.0015	41.9%
1996	45.08	$ 1.3745	$ 9.2056	$ 0.0129	16.9%	191.08	$ 0.5117	$ 24.0068	$ 0.0024	20.4%
1997	43.75	$ 2.0576	$ 15.3387	$ 0.0102	20.5%	186.83	$ 0.5182	$ 25.4269	$ 0.0027	22.1%
1998	41.33	$ 2.3661	$ 14.8593	$ 0.0025	23.4%	172.75	$ 0.5524	$ 18.1310	$ 0.0016	-0.8%
1999	38.33	$ 2.5640	$ 18.1080	$ 0.0106	1.3%	144.83	$ 0.4391	$ 12.4801	$ 0.0014	18.2%
2000	35.50	$ 2.5845	$ 15.2268	$ 0.0070	81.7%	121.67	$ 0.5451	$ 16.3004	$ 0.0023	143.4%
2001	35.00	$ 3.1728	$ 19.5861	$ 0.0071	-2.7%	111.92	$ 1.1332	$ 23.3416	$ 0.0013	17.9%
2002	34.33	$ 3.6826	$ 28.1927	$ 0.0007	6.3%	104.92	$ 1.3620	$ 23.4190	$ 0.0004	-7.1%
2003	31.50	$ 4.0877	$ 29.7779	$ 0.0262	43.5%	95.67	$ 1.1264	$ 15.7187	$ 0.0018	45.6%
2004	30.83	$ 5.3360	$ 38.3350	$ 0.0064	44.4%	94.17	$ 1.5220	$ 19.3239	$ 0.0040	25.7%
2005	28.75	$ 7.1207	$ 66.0176	$ 0.0108	40.9%	90.33	$ 2.1707	$ 42.6629	$ 0.0048	32.0%
2006	26.92	$ 7.3443	$ 60.3185	$ 0.0069	0.4%	88.25	$ 2.2874	$ 46.3857	$ 0.0022	9.9%
2007	26.08	$ 8.7672	$ 68.5301	$ 0.0165	24.4%	85.92	$ 1.8727	$ 48.9881	$ 0.0056	17.7%
2008	25.00	$ 6.4782	$ 32.2535	$ 0.0050	-39.4%	79.17	$ 1.4306	$ 25.0776	$ 0.0087	-25.3%
2009	22.08	$ 5.1290	$ 29.7140	$ 0.0165	33.4%	78.17	$ 1.3124	$ 24.6633	$ 0.0036	52.1%

Source: own elaboration with downloaded data from CRSP

Table 4.3: Excess returns, standard deviations and Sharpe Ratios of the indices

	VWI SIC 632	VWI SIC 80	VWI CRSP
Excess Return	16.8%	25.8%	7.3%
Standard Deviation	23.7%	33.8%	17.7%
Sharpe Ratio	0.71	0.76	0.41

Source: own elaboration with downloaded data from CRSP and Kenneth French website.

Table 4.4: Tests of abnormal returns

	SIC 632			SIC 80		
	CAPM	FF	FF+Carhart	CAPM	FF	FF+Carhart
α	0.00772	0.005394	0.00609	0.01306	0.012237	0.01111
	(0.00)	(0.02)	(0.01)	(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
		(0.84)	(0.97)		(0.00)	(0.00)
β_3		0.4183	0.3940		0.1658	0.2052
		(0.00)	(0.00)		(0.08)	(0.03)
β_4			-0.0744			0.1207
			(0.13)			(0.03)
R^2	0.45	0.48	0.49	0.41	0.44	0.45