High US health care spending is quite well explained by its high material standard of living

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rcafdm

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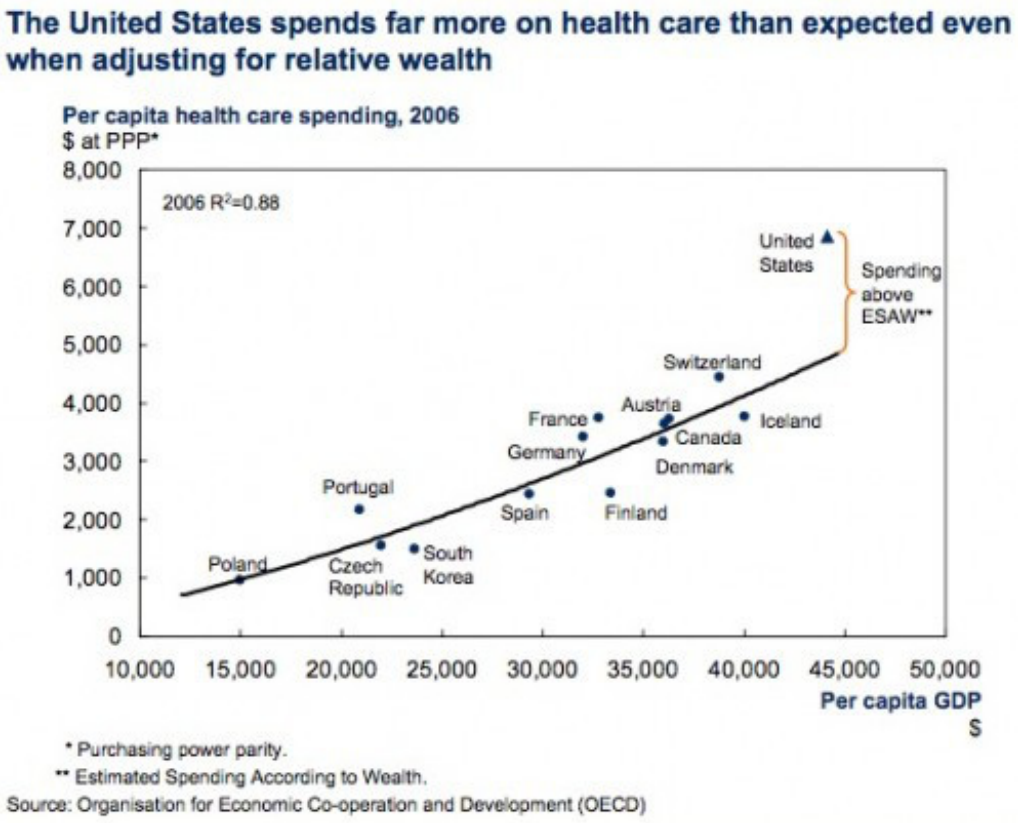
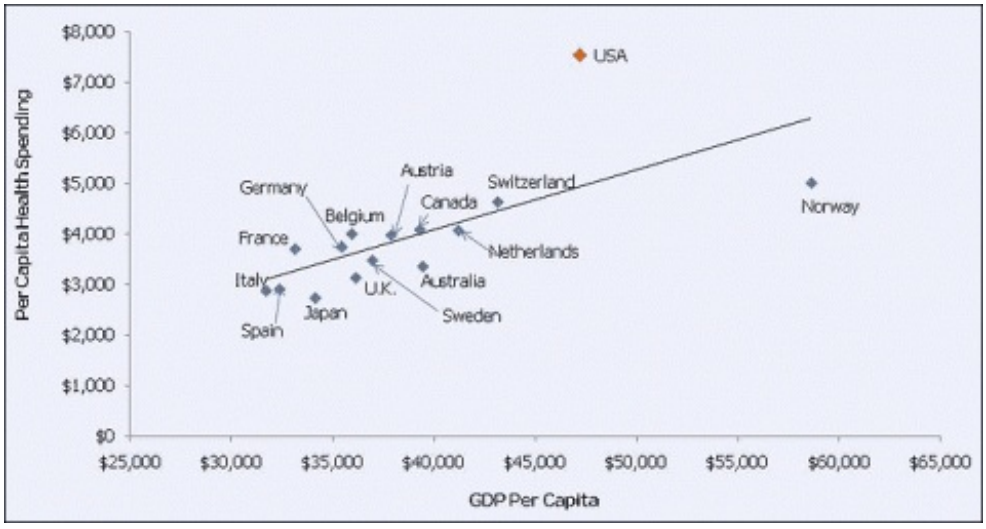
About two years ago I created a long blog post arguing that the United States is not an outlier in healthcare expenditures per capita. Following renewed interest from a link from Marginal Revolution recently and some criticism from a few people on various comment threads, I thought I'd take the time to update the evidence, address some areas of criticism, and muster yet more lines of evidence to support my argument. This post should largely make the earlier post obsolete, but I will keep the earlier post up for posterity and to retain data/information that won't necessarily be perfectly duplicated in this post.

There exist several popular plots like these that people use to make the argument that the United States spends vastly more than it should for its level of wealth.





These plots and the arguments that usually go with them give the strong impression that US spends about twice as much as it should. However, these are misleading for several reasons, namely:

1. GDP is a substantially weaker proxy for "wealth" *and* a substantially weaker predictor of health care expenditures than other available measures.
2. The US is much wealthier than other countries in these plots in reality.
3. The arbitrary selection of a handful of countries tends to hide the problems with GDP in this context and, oddly enough, simultaneously downplay the strength of the relationship between wealth and health care spending
4. Comparing these two quantities with a linear scale tends to substantially overstate the apparent magnitude of the residuals from trend amongst the richer economies when what we're implicitly concerned with is the percentage spent on healthcare.

When properly analyzed with better data and closer attention to detail, it becomes quite clear that US healthcare spending is not astronomically high for a country of its wealth. Below I will layout these arguments in much greater detail and provide data, plots, and some statistical analysis to prove my point.

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Healthcare is a superior good

First and foremost, it's important to understand that health care is a superior good, i.e., as *countries* get wealthier they spend an increasing share of their *consumption* (or income) on health care. I am certainly not the first person to point this out and, in fact, it has been well documented by others, but this tends to get swept under the rug or seriously downplayed when the issue of US healthcare spending comes up.

Academic economists have even pointed this out vis-a-vis GDP:

> **The GDP elasticity of health spending.**
>
> The slope of the estimated equation of logarithm GDP per capita versus logarithm health spending per capita can be viewed as a first, rough approximation of the so-called GDP elasticity of per capita health spending, defined as the percentage change in health spending per capita divided by the corresponding percentage change in GDP per capita. An elasticity above 1 implies that the percentage of GDP absorbed by health spending tends to rise with increases in GDP per capita.
>
> If one regresses the logarithm of health spending per capita on the logarithm of GDP per capita across the thirty countries in the OECD data set, one obtains an estimated per capita GDP elasticity of per capita health spending of 1.32 if the United States and Luxembourg (the outliers) are included in the sample, and 1.36 if they are not. Taken at face value, these estimates suggest that, other things being equal, an increase in GDP per capita of 10 percent tends to increase health spending per capita by 13–14 percent. In the jargon of economics, the estimate suggests that health care is a "superior" good—one on which spending tends to rise disproportionately faster than does disposable income or, here, GDP per capita.
>
> Earlier studies of the relationship simply between GDP per capita and health spending per capita have led to similar estimates of the GDP elasticity of health spending. **With a few exceptions, these estimates have fallen into the range of 1.2 to 1.6, although they do appear to vary with the degree of a nation's economic development, with poorer countries having lower elasticities.**
>
> Over the past two decades, however, health services researchers have performed more *sophisticated multivariate analyses* of this relationship, which control for factors other than income that may drive health spending...these more elaborate studies have led to...the "extremely robust" conclusion that **even after statistical control for many other factors, "the effect of per capita GDP (income) on expenditure is clearly positive and significant."**

source

These elasticity estimates mean that health care consumes an increasing *share* of GDP as GDP increases.

Or see long run consumption data in the US (long before our modern healthcare system evolved).

source

The point being that the relationship between wealth and healthcare spending is not something unique to my analysis or my data. **As countries get richer they tend to spend an increasing share of national income on health.**

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Table 2

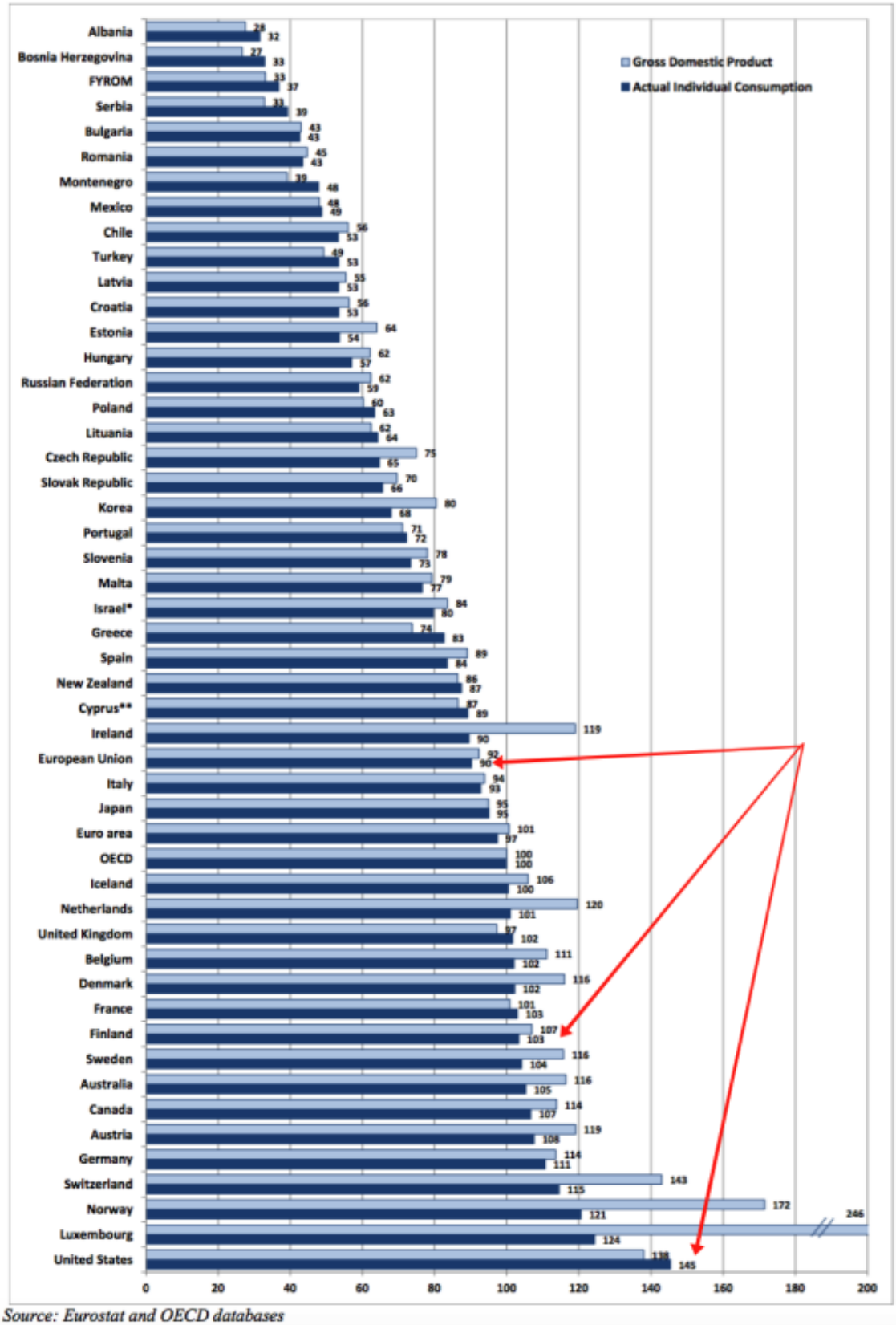
The Long-Term Trend in the Structure of Consumption and the Implied Income Elasticities of Several Consumption Categories

	Distribution of Consumption (%)		
Consumption Class	*1875*	*1995*	*Long-Term Income Elasticities*
Food	49	5	0.2
Clothing	12	2	0.3
Shelter	13	6	0.7
Health care	1	9	1.6
Education	1	5	1.5
Other	6	7	1.1
Leisure	18	68	1.5

Source: Fogel 2000.

USA has a much higher material standard of living

Figure 2. Per capita volume indices for GDP and Actual Individual Consumption, 2011
OECD=100



Source: Eurostat and OECD databases

Actual Individual Consumption (AIC) per capita is more than 50% higher in the US than in the European Union as a whole!

GDP per capita provides an average measure of economic activity …

GDP per capita is the most frequently used measure of the average level of macro-economic activity. Figure 2 shows that in 2011, GDP per capita measured on a PPP basis, ranged from 27 in Bosnia Herzegovina to 246 in Luxembourg[3], with GDP per capita for the OECD area set at 100. It is important to note however that, despite the large data collection covering 3000 products, there is still an inevitable margin of error in PPP conversions and, so, some care is needed when interpreting data for those countries with similar GDP per capita levels. For example, the precision of the data means that it is not possible to state that real GDP per capita for Australia (116), Denmark (116) or Sweden (116) is significantly different from real GDP per capita for Canada (114) or Germany (114).

It should also be kept in mind that GDP does not include international payments of income such as profits received from abroad or remittances sent abroad. Gross national income (GNI) takes such flows into account. For some countries, in particular Switzerland, Ireland and Luxembourg, moving from GDP to GNI can markedly change their relative position. However, for most other OECD countries, GNI and GDP rankings are very similar and, so, no separate table with GNI/GDP comparisons is provided in this note.

…but for comparisons of material well-being of households, actual individual consumption per capita is preferred

High levels of GDP per capita do not necessarily mean high levels of household consumption as high GDP may reflect high levels of investment, net exports or government consumption. The set of benchmark results for 2011 therefore also presents PPPs for household consumption expenditure. However, simple international comparisons of household expenditure on goods and services can be misleading if adjustments for government services such as health or education provided to households are not made, since the delivery of these services to households differs across countries. In some countries, the services are provided for 'free' and paid 'indirectly' via taxation, and so are not recorded as household final consumption (HHFC), while in others the services may be paid for by households at point-of-delivery, and are thus included in HHFC. Therefore, the levels of consumption shown in the table below include all types of consumption, notably the value of those services provided by government for free or at low cost. The data show what households actually consume ('*actual individual consumption*') as opposed to what they purchase. This constitutes a measure of average household material well-being.

The picture emerging from comparisons of real Actual Individual Consumption (AIC) per capita reveals that differences between countries are much smaller than when comparisons are made based on real GDP per capita (Figure 2, Table 2). With the value for the OECD average set at 100, the data show that real Actual Individual Consumption per capita ranges from 32 in Albania to 145 in the United States. Luxembourg, Switzerland, Norway, the Netherlands, Ireland, Denmark and Korea are among the countries where relative households' average material well-being is lower than real GDP per capita, while the opposite is true for Greece, the United States and the United Kingdom.

[3] One particular feature of Luxembourg's economy which to some extent explains very high GDP per capita is the fact that a large number of foreign residents are employed in the country and thus contributes to its GDP, while at the same time they are not included in the resident population.

source

While a handful of small countries have higher GDP per capita than the US, the US has a large lead in consumption per capita. Further, the great majority of the major EU countries are much more compressed in consumption terms than they are in GDP terms (which creates some range restriction). This is true even when this consumption measure includes government transfers, subsidies, etc, notably *including* the vast majority of healthcare and education spending, as Actual Individual Consumption (AIC) does.

Since some people earlier seemed to miss to this point, I'll repeat: **the only form of consumption excluded from AIC is that which cannot be attributed directly to individuals or households**, i.e, collective expenditures by government like military procurement and the like.

Box 4.1: Moving from final consumption expenditure to actual final consumption

Who pays	Final consumption expenditure	Actual final consumption	Who consumes
Households	Individual consumption expenditure by households	Actual individual consumption	Households individually
NPISHs	Individual consumption expenditure by NPISHs		
General government	Individual consumption expenditure by government		
	Collective consumption expenditure by government	Actual collective consumption	General government (households collectively)

- *Collective consumption expenditure by government:* The actual and imputed final consumption expenditure incurred by general government on collective services. It covers all government final consumption expenditure on general public services, defence, public order and safety, economic affairs, environment protection, and housing and community amenities. It includes as well government expenditure on the collective features of individual services mentioned in the previous bullet point.

source

Actual Individual Consumption (AIC):

(1) can usually be trivially derived from most developed country's national accounts data

(2) is explicitly published by OECD, Eurostat, WorldBank (ICP), and most developed countries as such (as in, "Actual Individual Consumption")

(3) is regarded by many leading economists to be a better measure of material living conditions than GDP.

Further, we have other evidence for high US consumption besides national accounts aggregates.

For example:

Table 3:3. Dwelling space. Various countries.

Country	Survey year	No. persons per home	Dwelling space, square feet	Dwelling space (square feet) per person
Austria	2000	2.4	974.9	406.2
Belgium	1991	2.5	928.6	371.4
Denmark	2001	2.1	1171.8	558.0
France	1996	2.5	946.9	378.8
Finland	2000	2.1	823.1	392.0
Germany	1998	2.2	932.9	424.0
Greece	1991	3.0	856.5	285.5
Ireland	2001	3.0	950.1	316.7
Italy	1991	2.1	971.6	462.7
Luxembourg	2001	2.6	1345.0	517.3
Netherlands	2000	3.4	1054.5	439.4
Portugal	1998	2.2	893.1	279.1
Spain	1991	3.3	917.8	278.1
Sweden	1997	2.1	966.2	460.1
UK	1996	2.4	914.6	381.1
Europe, average		2.5	976.5	395.7
USA, poor households	1993	2.8	1,228	438.6
USA, all households	1993	2.6	1,875	721.2

Table 2:2. Percentage of households in different countries owning various domestic appliances etc.

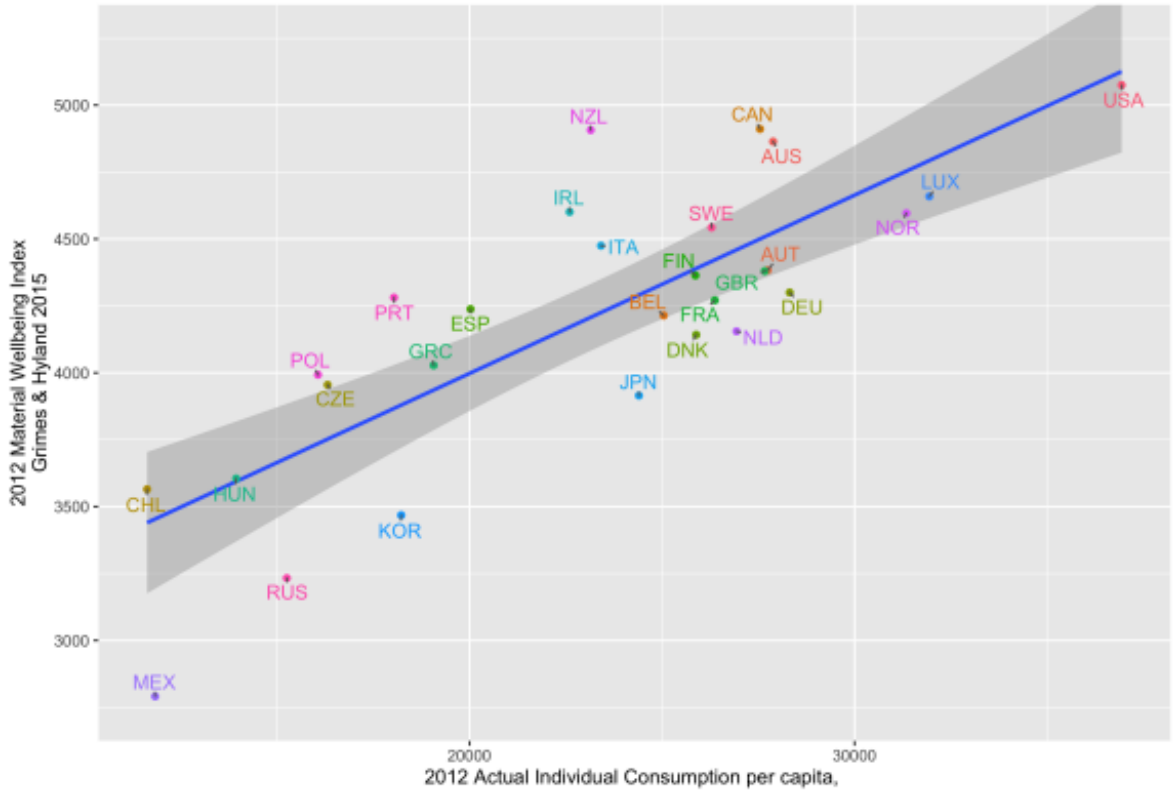
	USA	Belgium	Denmark	France	Germany	Italy	Netherlands	Spain	Sweden	Switzerland	U.K.
Clothes Washer	**90**	88	74	88	88	96	89	87	72	78	88
Dishwasher	**53**	26	36	32	34	18	11	11	31	32	11
Microwave	**86**	21	31	19	36	6	22	9	37	15	48
Radio	**99**	90	98	98	84	92	99	95	93	99	90
Television	**98**	97	**98**	95	97	**98**	95	**98**	97	93	**98**
Clothes Dryer	**82**	39	30	12	17	10	27	5	18	27	32
Vacuum Cleaner	**99**	92	96	89	96	56	98	29	97	93	98
VCR	**83**	42	63	35	42	25	50	40	48	41	69
Personal Computer	**40**	22	30	20	20	14	25	11	29	23	25
Phones per 100 people	63	46	61	56	49	43	53	39	**68**	61	50
Cell phones per 1000	12.4	23.2	157.3	23.8	42.8	67.4	33.2	24.1	**229.9**	63.5	98.0
TVs per 1000	**776**	464	536	579	550	436	495	490	476	461	612
Autos per 100	**57**	41	31	42	49	51	38	Na	41	44	3

Note: Figures in bold type indicate that the country has the highest percentage of households owning the product in question.

Source: Cox & Alm (1999, table 5.2, p. 97).

The specific tables above are a little old, but the patterns are much the same today.

Here is a comparison between a measure drawn from a study based on PISA household inventory questionnaires to measure material well-being and AIC.



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Note: These questions are pretty basic (e.g., desk: Y/N; own room: Y/N; etc), likely subject to some range restriction, and unlikely to be skewed greatly by a few high income families at top. However, the US still comes out #1 in the 3 years reported and is further from the mass of other highly EU developed countries (Germany, France, Great Britain, etc) than they are from, say, Greece, Spain, Poland, etc. These are not trivial differences in real consumption only found with this national accounts measure!

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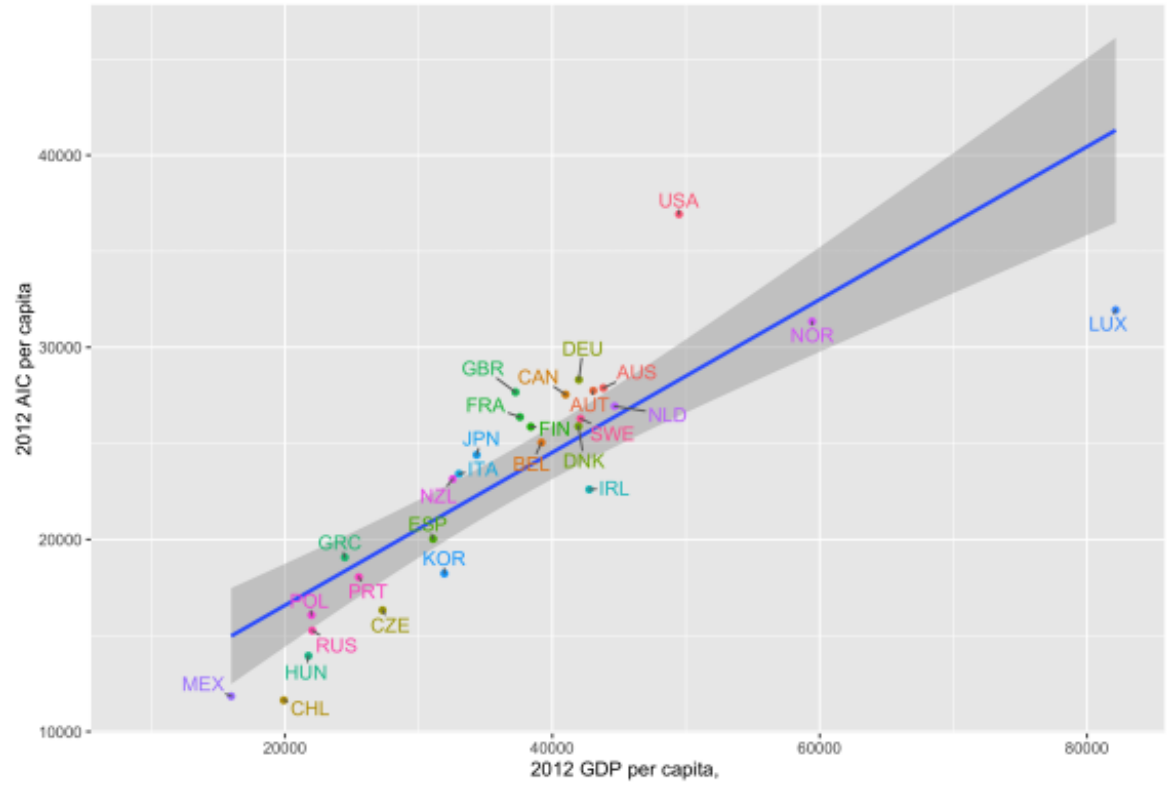
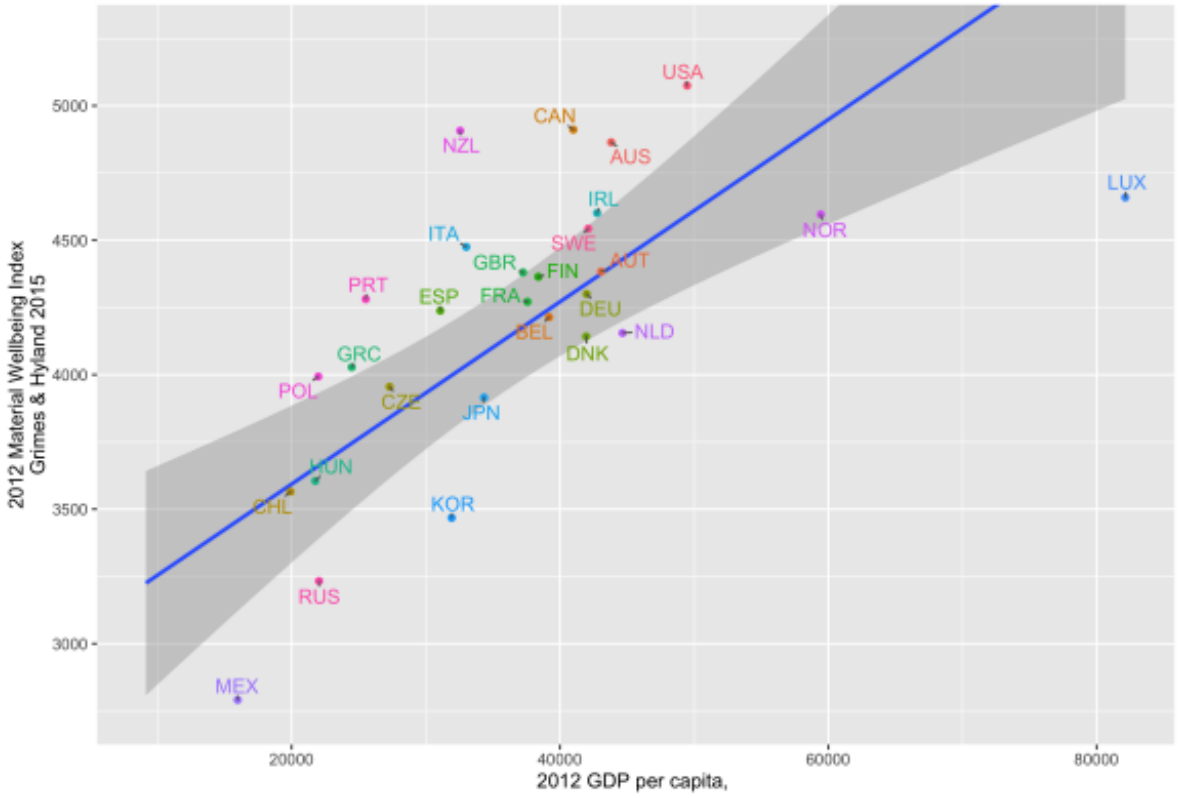
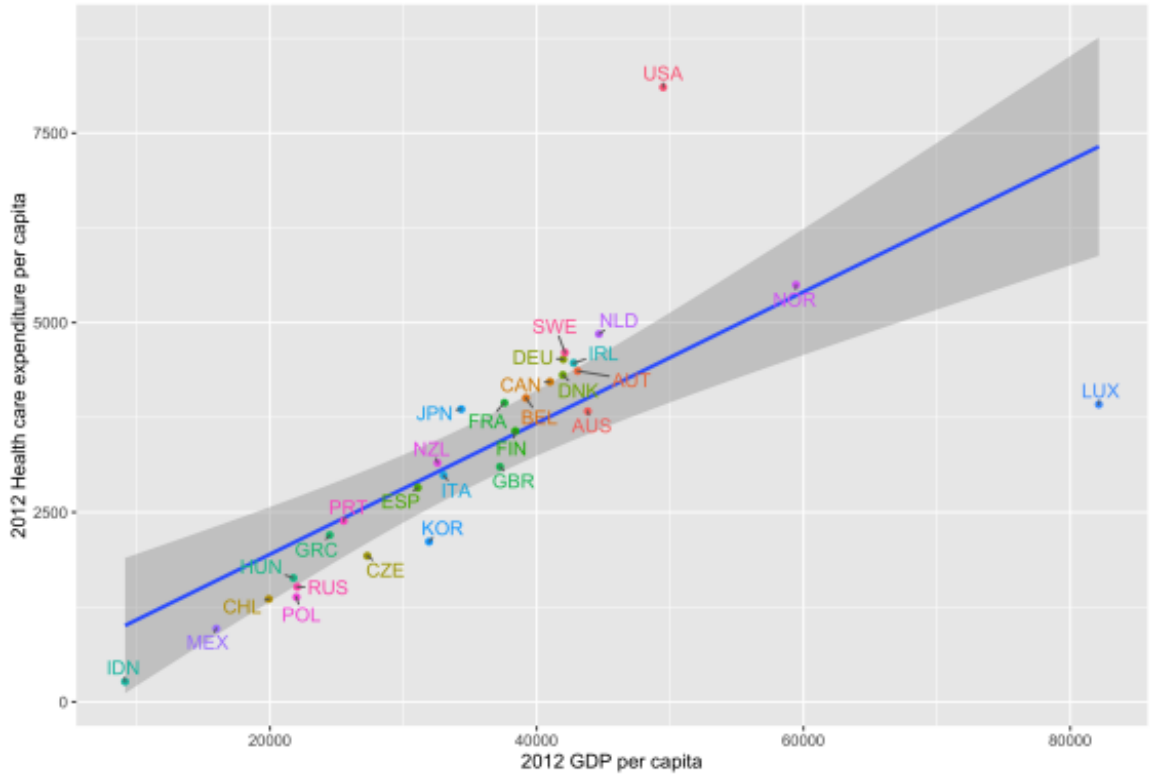
There is a similar pattern of divergence between consumption measures and GDP as we find with HCE and GDP


2012 AIC per capita
40000
30000
20000
10000
USA
LUX
NOR
DEU
GBR
CAN
AUS
AUT
NLD
FRA
FIN
SWE
JPN
BEL
DNK
ITA
IRL
NZL
ESP
GRC
KOR
POL
PRT
CZE
RUS
HUN
MEX
CHL
20000
40000
60000
80000
2012 GDP per capita,


2012 Material Wellbeing Index
Grimes & Hyland 2015
5000
4500
4000
3500
3000
USA
CAN
NZL
AUS
LUX
IRL
NOR
ITA
SWE
GBR
FIN
AUT
PRT
ESP
FRA
DEU
BEL
NLD
DNK
GRC
POL
CZE
JPN
HUN
CHL
KOR
RUS
MEX
20000
40000
60000
80000
2012 GDP per capita,



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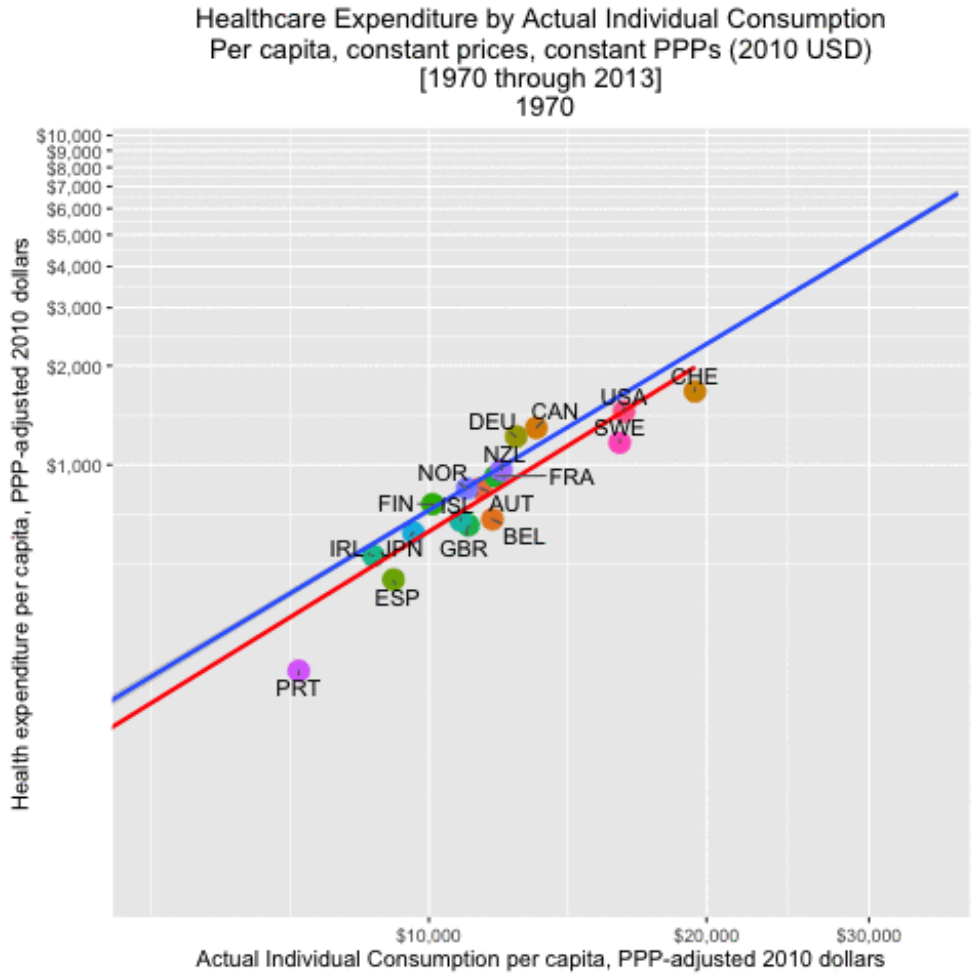
Consumption is a strong predictor of HCE

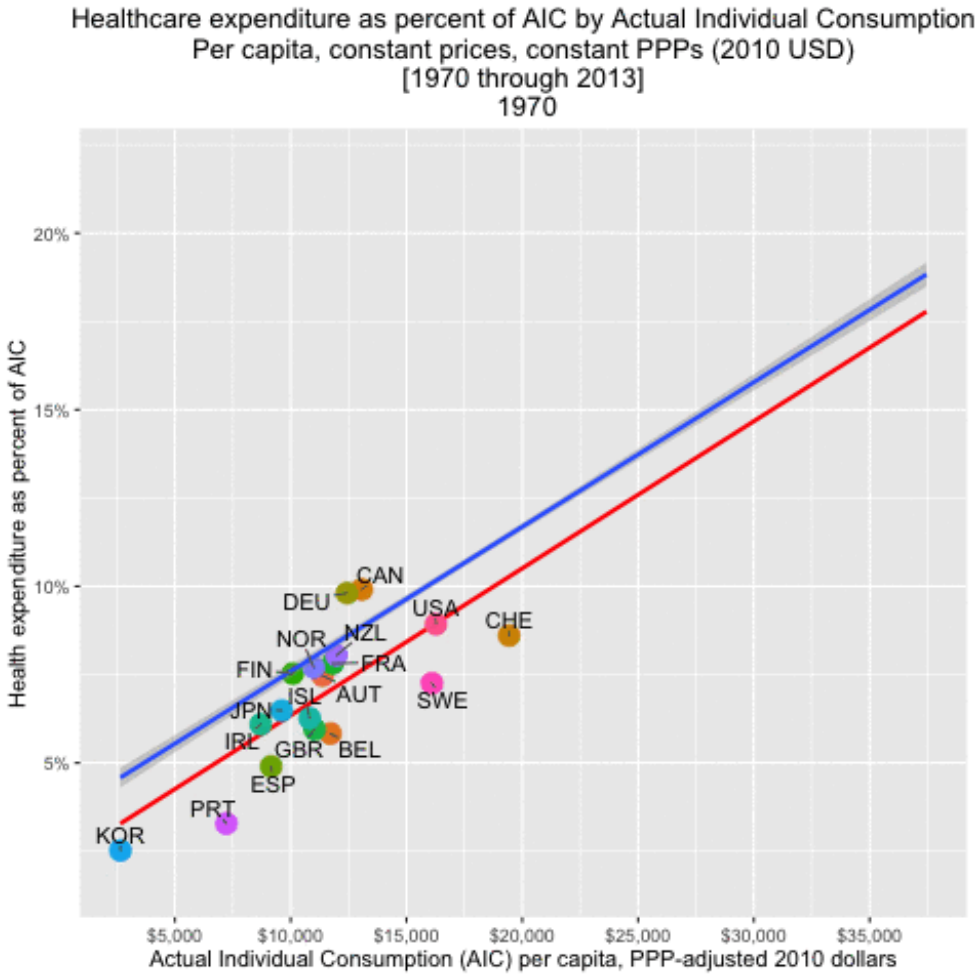
Using Actual Individual Consumption (AIC) we can explain the vast majority of healthcare expenditure differences between countries in any given year and the evolution of healthcare expenditure increases across more than 40 years!



Although there is a small secular trend in the intercept by year, likely due in part to technological change, that influence appears to be quite modest. Clearly healthcare expenditures have increased dramatically virtually everywhere, but health care spending is generally well explained by differences in consumption between countries and across time, i.e., as countries have grown richer their HCE tracks closely with it. **Countries that are where the US was decades earlier in constant PPP-adjusted consumption per capita terms (roughly the same material standard of living) tend to spend quite similar amounts adjusting for inflation and spending power.**

Note: I am intentionally plotting both axes with log scaling. This lets us much more easily compare the growth rates in percentage terms and see the relative magnitude of the residuals (a country spending $1000 more than predicted at a base of $5,000 is much different than same at $25,000). It also lets us fit more data in a relatively small plot.

Likewise, we can observe a similar trend if we plot health care expenditures as a percentage of AIC.



The data appear noisier in percentage terms, but you can clearly see healthcare is commanding an increasing share of consumption across the board and that there is a pretty stable long run trend (some noise year to year due to economic cycles, introduction of new countries, etc)

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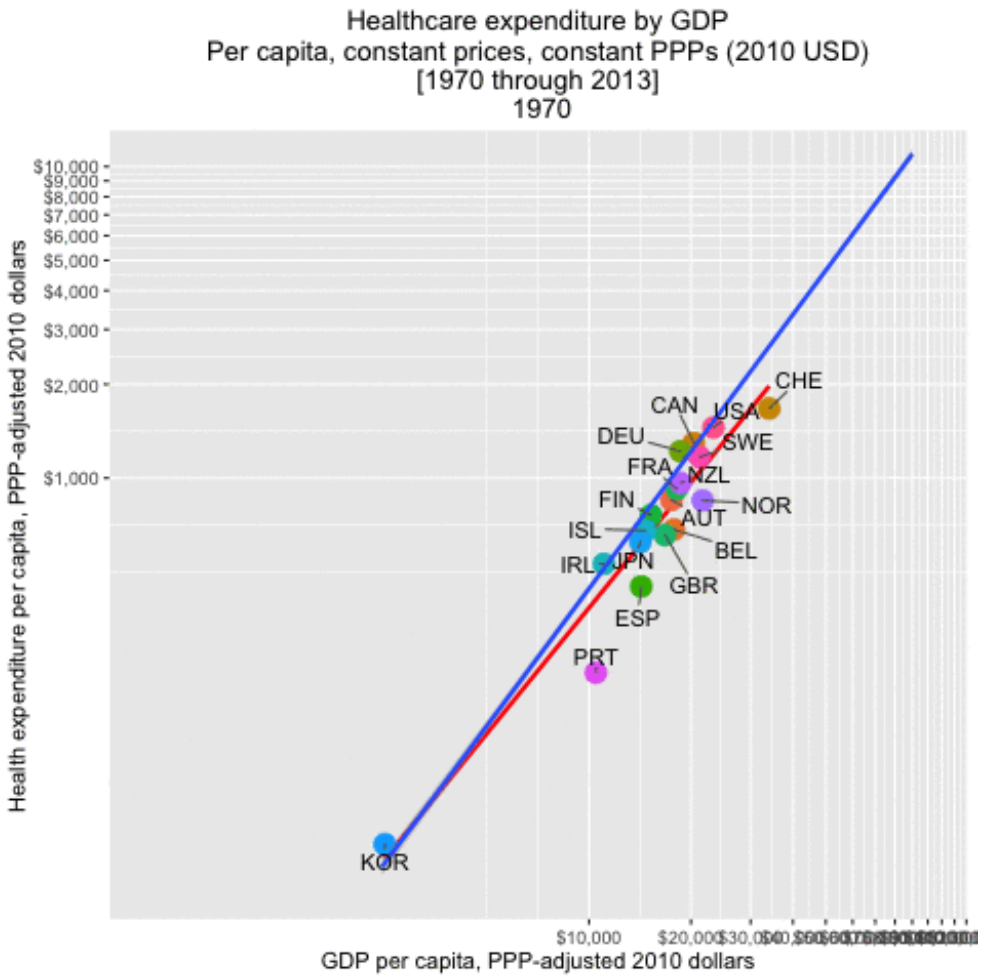
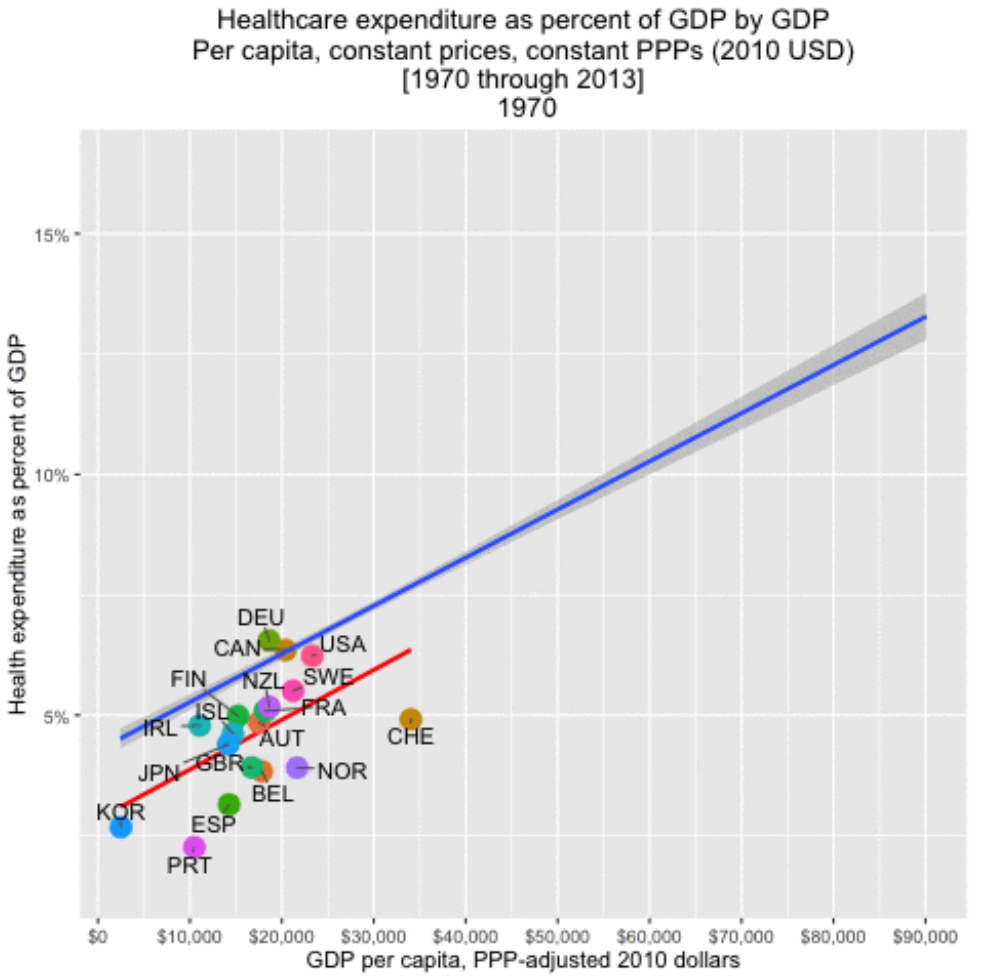
HCE increases with GDP too (even if less well correlated)

If we look at this with GDP instead of AIC on the x-axis we can pretty clearly see a strong trend. As countries grow richer they spend more on health care.

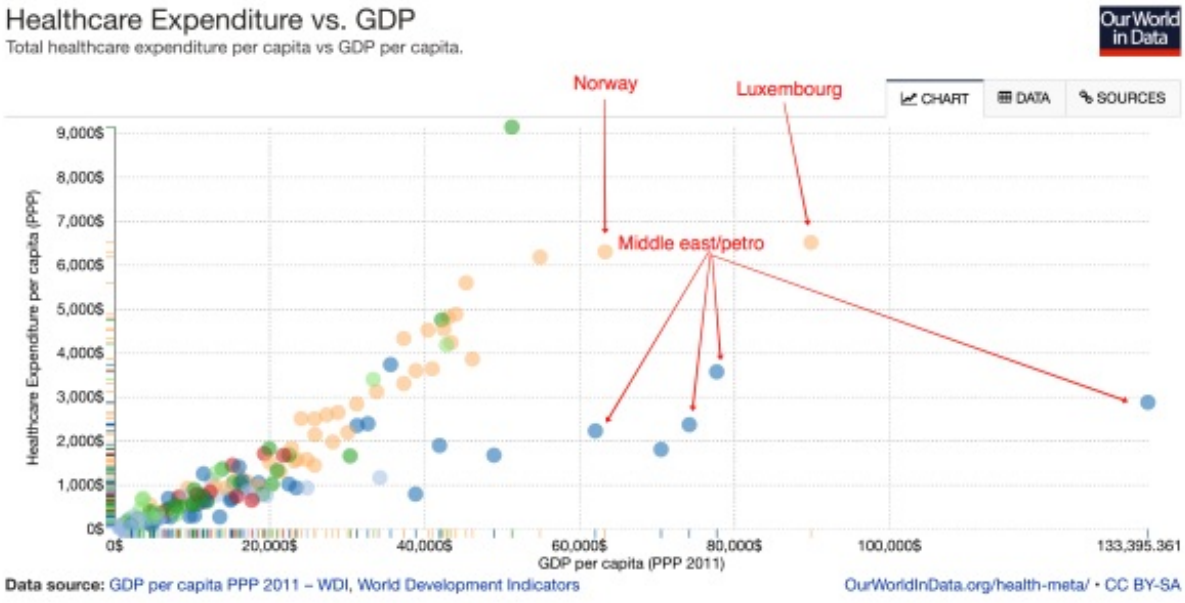


And as a percentage of GDP…



Healthcare costs have been rising as a percentage of GDP and AIC pretty consistently everywhere and the reason is pretty obvious: they've been getting wealthier too.

If you eyeball the AIC and GDP plots you can see that there's a lot more going on with GDP amongst the countries that OECD provides data on. Though I exclude data outside of the OECD data set from this analysis (did more in the earlier blog post), these flaws become even more apparent if you look at a broader array of countries with more diverse economies (e.g., high proportion export/capital equipment, large cross border/foreign worker sector, tourism, etc).



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AIC holds up to these more extreme outliers much better. All of these extreme outliers actually have *much lower consumption* than their GDP per capita would suggest (see earlier post on this topic if interested in specifics).
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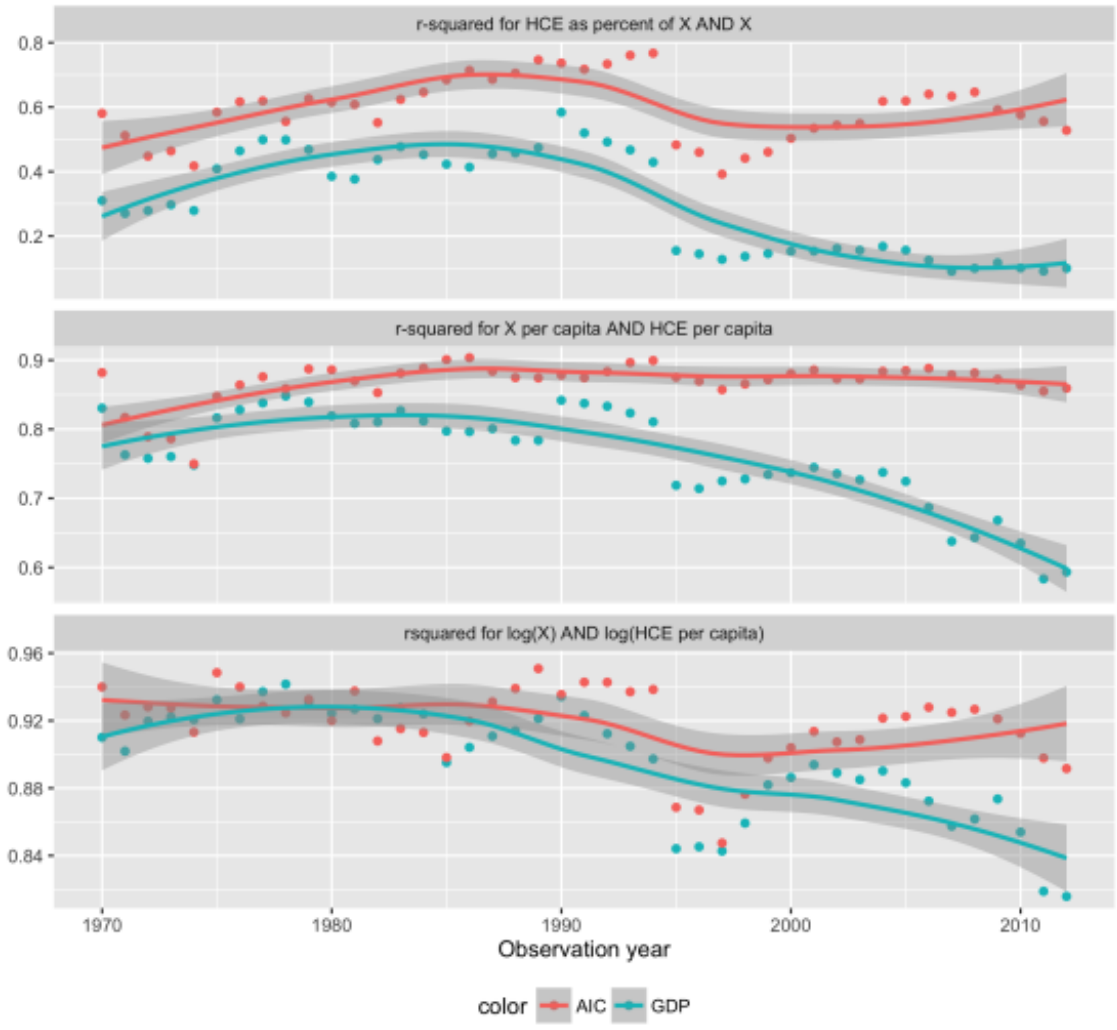
AIC fits HCE substantially better than GDP

Even with the more limited data available in the OECD stats data set, there are obvious differences in the relationships here.



The plot above simply compares the r-squared values for AIC and GDP with HCE in per capita terms (all PPP-adjusted, 2010 dollars, etc) on a yearly basis. Whether the dependent variable is defined as a fraction of the relevant predictor (AIC vs GDP) or per capita HCE, log-10 or not, AIC holds up appreciably better and quite consistently across years (increasingly more now with more economies in the OECD data and more economic differences between countries). **Clearly the stronger predictor here is AIC.**
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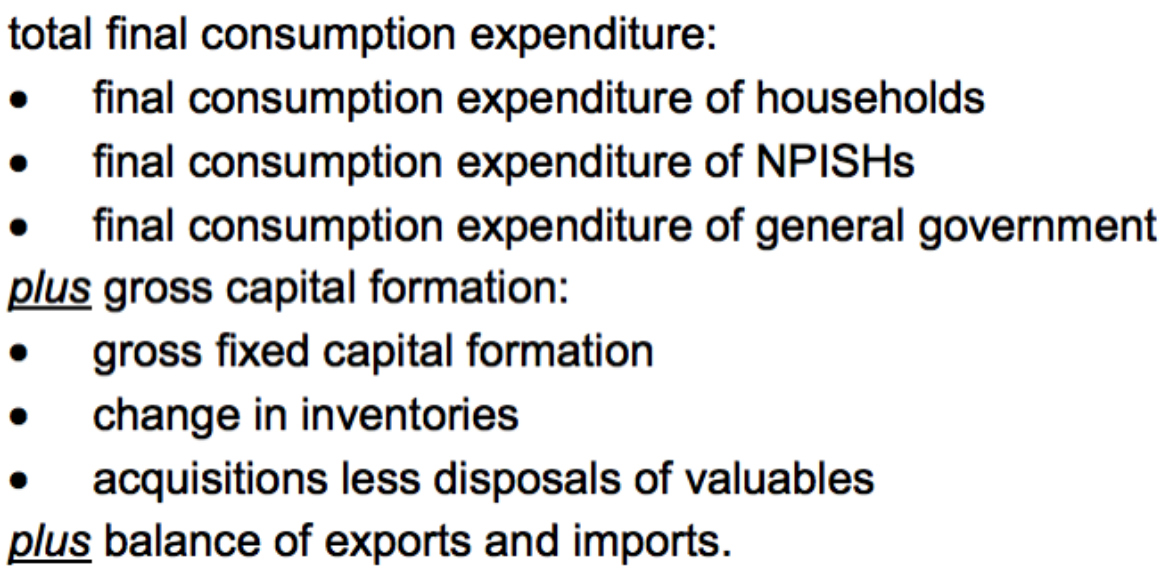
It matters how a country generates its GDP

Some people might think that a dollar of GDP is a dollar of GDP, no matter whether that economic value-add is derived from exports, consumption, or what have you for these purposes, but this is obviously wrong. Consider two countries of the same GDP where one derives fifty percent of its GDP (expenditure method) from net exports and the other zero percent. The latter will have much higher material standards of living almost by definition (most of that difference is apt to be found in consumption, not, say, capital formation).

Yes, export activity generally contributes to the material well-being of its citizens (profits, wages, taxes, etc), but we are already capturing that pretty well in other GDP expenditure categories (*especially* consumption). Similar issues apply to capital formation activity. Ultimately the consumption component of GDP tells us much more about how much

money a country truly has for consumption and other more discretionary uses of its resources and thus how much much we can expect them to spend on healthcare.

The expenditure approach to GDP is defined like so:



I take the OECD figures for these components of GDP (expenditure approach) in OLS to estimate the predictive value of each component in various specifications below.

In model (1) you can see that the slope of log(AICPC) and log(HCEPC) is pretty tightly defined at 1.6 controlling for nothing but year fixed effects (i.e., allowing the intercept for each year to vary independently). Controlling for Final Consumption expenditures less AIC (collective expenditures in other words) as in model (2) reduces the AIC slope marginally, but clearly it's still substantially positive and much larger than the estimate for collective consumption expenditures. Even if we remove HCE from AIC, to preemptively address complaints that the vast majority of HCE is allocated to AIC (and thus mechanically contributing to this relationship), we find much the same result!

	Dependent variable:		
	log(Health Care Expenditure (HCE) per capita)		
	(1)	(2)	(3)
log(AIC per capita)	1.609***	1.486***	
	(1.578, 1.639)	(1.441, 1.531)	
log(AIC less HCE per capita)			1.482***
			(1.429, 1.536)
log(Final Consumption less AIC per capita)		0.095***	0.142***
		(0.069, 0.121)	(0.113, 0.171)
Year FE?	Yes	Yes	Yes
Observations	1,235	1,235	1,235
R^2	0.924	0.927	0.905
Adjusted R^2	0.921	0.924	0.901
Residual Std. Error	0.207 (df = 1189)	0.202 (df = 1188)	0.231 (df = 1188)
F Statistic	319.359*** (df = 45; 1189)	326.686*** (df = 46; 1188)	244.882*** (df = 46; 1188)
Note:			*p<0.1; **p<0.05; ***p<0.01
			Underlying variables previously PPP-adjusted in constant 2010 USD

In model 3 below we compare AIC and GDP excluding AIC (basically collective consumption + net exports + fixed capital formation), we find vastly different slopes. If we go even further, as in model (4), and remove HCE from AIC we still find AIC beats out these other components of GDP by a mile.

	Dependent variable:			
	log(Health Care Expenditure (HCE) per capita)			
	(1)	(2)	(3)	(4)
log(AIC per capita)	1.601*** (1.571, 1.632)		1.311*** (1.261, 1.361)	
log(GDP per capita)		1.409*** (1.379, 1.439)		
log(AIC less HCE per capita)				1.270*** (1.212, 1.328)
log(GDP less AIC per capita)			0.231*** (0.198, 0.263)	0.300*** (0.264, 0.335)
Year FE?	Yes	Yes	Yes	Yes
Observations	1,232	1,232	1,232	1,232
R^2	0.920	0.905	0.931	0.913
Adjusted R^2	0.917	0.901	0.929	0.909
Residual Std. Error	0.206 (df = 1186)	0.225 (df = 1186)	0.191 (df = 1185)	0.216 (df = 1185)
F Statistic	303.514*** (df = 45; 1186)	250.663*** (df = 45; 1186)	349.859*** (df = 46; 1185)	269.269*** (df = 46; 1185)
Note:				*p<0.1; **p<0.05; ***p<0.01
				Underlying variables previously PPP-adjusted in constant 2010 USD

If I go a step further and break the GDP expenditure approach down into its major categories, albeit subtracting HCE from AIC, you can pretty clearly see that these different components have different implications for the amount of healthcare expenditure you can expect. In fact, this reduced subset of AIC appears to substantially mediate the predictive value of net exports.

	Dependent variable:			
	log(Health Care Expenditure (HCE) per capita)			
	(1)	(2)	(3)	(4)
log(AIC less HCE per capita)		1.660*** (1.622, 1.698)	1.421*** (1.348, 1.494)	1.265*** (1.186, 1.344)
log(net exports per capita)	0.219*** (0.110, 0.328)	0.089*** (0.048, 0.130)	0.075*** (0.035, 0.115)	0.045** (0.006, 0.084)
log(fixed capital formation per capita)			0.199*** (0.147, 0.252)	0.187*** (0.136, 0.238)
log(collective consumption per capita)				0.128*** (0.099, 0.157)
Year FE?	Yes	Yes	Yes	Yes
Observations	1,229	1,229	1,229	1,229
R^2	0.232	0.894	0.899	0.905
Adjusted R^2	0.203	0.890	0.895	0.901
Residual Std. Error	0.639 (df = 1183)	0.238 (df = 1182)	0.232 (df = 1181)	0.225 (df = 1180)
F Statistic	7.950*** (df = 45; 1183)	216.745*** (df = 46; 1182)	223.117*** (df = 47; 1181)	233.679*** (df = 48; 1180)
Note:				*p<0.1; **p<0.05; ***p<0.01
				Underlying variables previously PPP-adjusted in constant 2010 USD

If we break this to all the GDP expenditure components (mostly excluding the statistical adjustments to square the expenditure approach with the other approaches), *without* subtracting HCE from AIC, so that these should variables sum almost exactly with the GDP official numbers, we get something like this:

	Dependent variable:			
	log(Health Care Expenditure (HCE) per capita)			
	(1)	(2)	(3)	(4)
log(net exports per capita)	0.219***	0.039	−0.028	0.044**
	(0.110, 0.328)	(−0.020, 0.099)	(−0.081, 0.025)	(0.009, 0.079)
log(fixed capital formation per capita)		1.079***	0.794***	0.104***
		(1.039, 1.118)	(0.748, 0.840)	(0.059, 0.150)
log(collective consumption per capita)			0.336***	0.087***
			(0.301, 0.371)	(0.061, 0.113)
log(AIC per capita)				1.368***
				(1.301, 1.436)
Year FE?	Yes	Yes	Yes	Yes
Observations	1,229	1,229	1,229	1,229
R^2	0.232	0.774	0.825	0.925
Adjusted R^2	0.203	0.765	0.818	0.922
Residual Std. Error	0.639 (df = 1183)	0.347 (df = 1182)	0.305 (df = 1181)	0.200 (df = 1180)
F Statistic	7.950*** (df = 45; 1183)	87.774*** (df = 46; 1182)	118.714*** (df = 47; 1181)	303.461*** (df = 48; 1180)
Note:				*p<0.1; **p<0.05; ***p<0.01
				Underlying variables previously PPP-adjusted in constant 2010 USD

Even if I go a step further and introduce the United States as a flag variable (USA=1), you might observe (1) the other variables hardly budge (2) the model fit doesn't much improve and (3) the USA hardly sticks out dramatically.

	Dependent variable:	
	log(Health Care Expenditure (HCE) per capita)	
	(1)	(2)
log(net exports per capita)	0.044**	0.052***
	(0.009, 0.079)	(0.017, 0.086)
log(fixed capital formation per capita)	0.104***	0.136***
	(0.059, 0.150)	(0.090, 0.182)
log(collective consumption per capita)	0.087***	0.087***
	(0.061, 0.113)	(0.061, 0.113)
log(AIC per capita)	1.368***	1.307***
	(1.301, 1.436)	(1.237, 1.376)
Is USA		0.197***
		(0.134, 0.261)
Year FE?	Yes	Yes
Observations	1,229	1,229
R^2	0.925	0.927
Adjusted R^2	0.922	0.924
Residual Std. Error	0.200 (df = 1180)	0.197 (df = 1179)
F Statistic	303.461*** (df = 48; 1180)	307.247*** (df = 49; 1179)
Note:		*p<0.1; **p<0.05; ***p<0.01
		Underlying variables previously PPP-adjusted in constant 2010 USD

This implies the United States is somewhat above what you might expect controlling for these GDP components and year fixed effects over the time period in question, hardly "outlier" territory though.

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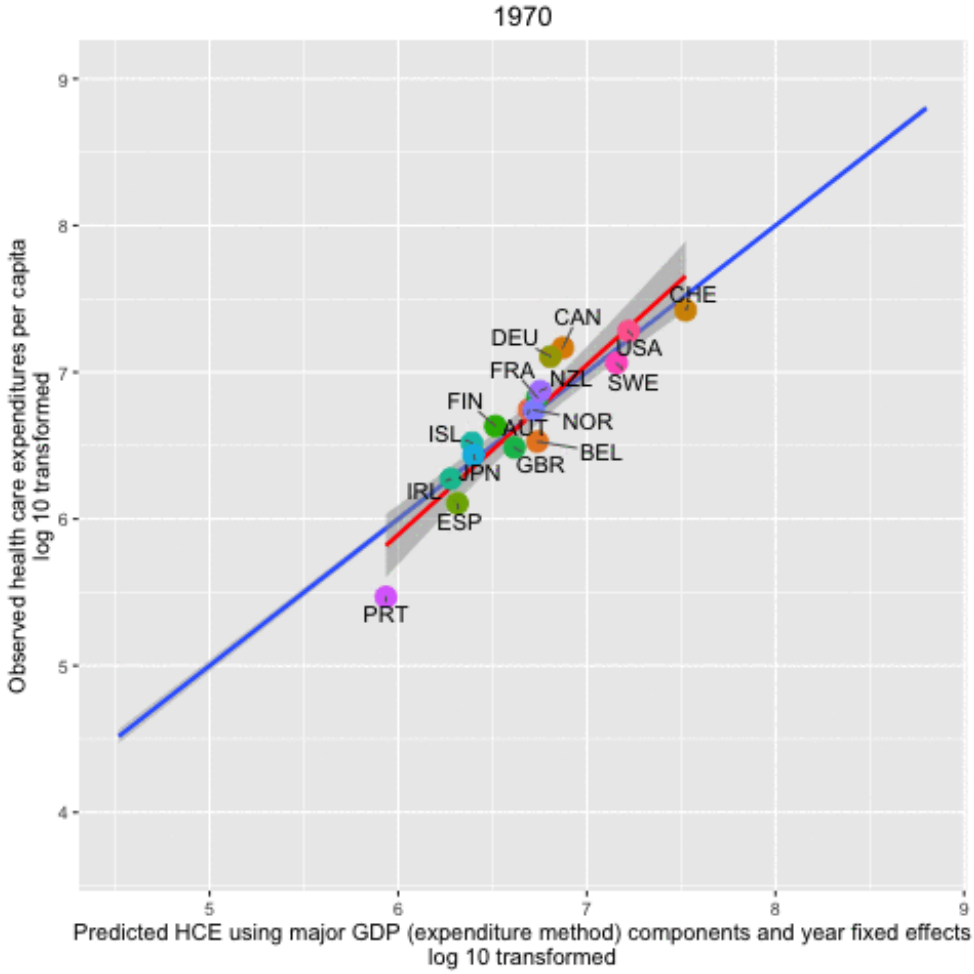
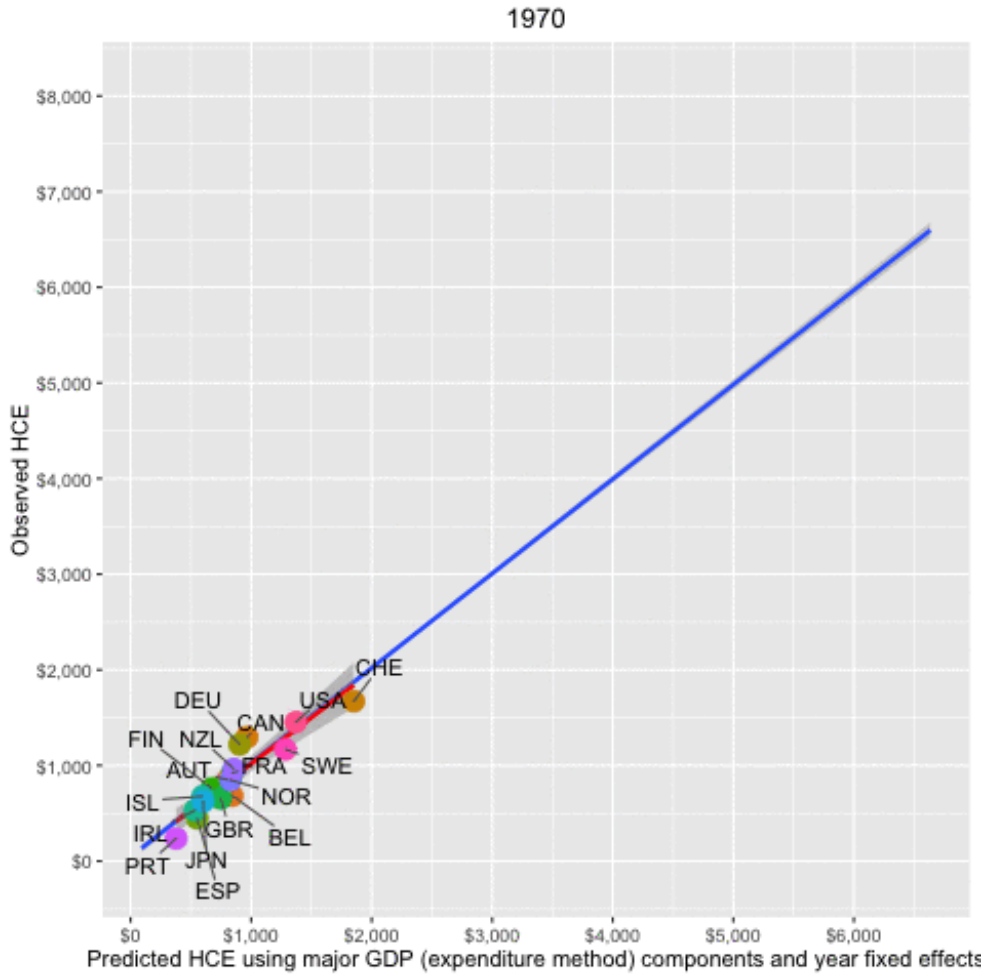
Comparing model predictions to observations

Using the model described above, the one with major GDP (expenditure method) components with year fixed effects, I can visually compare how this simple model fares over time.

With a log scale on both dimensions:

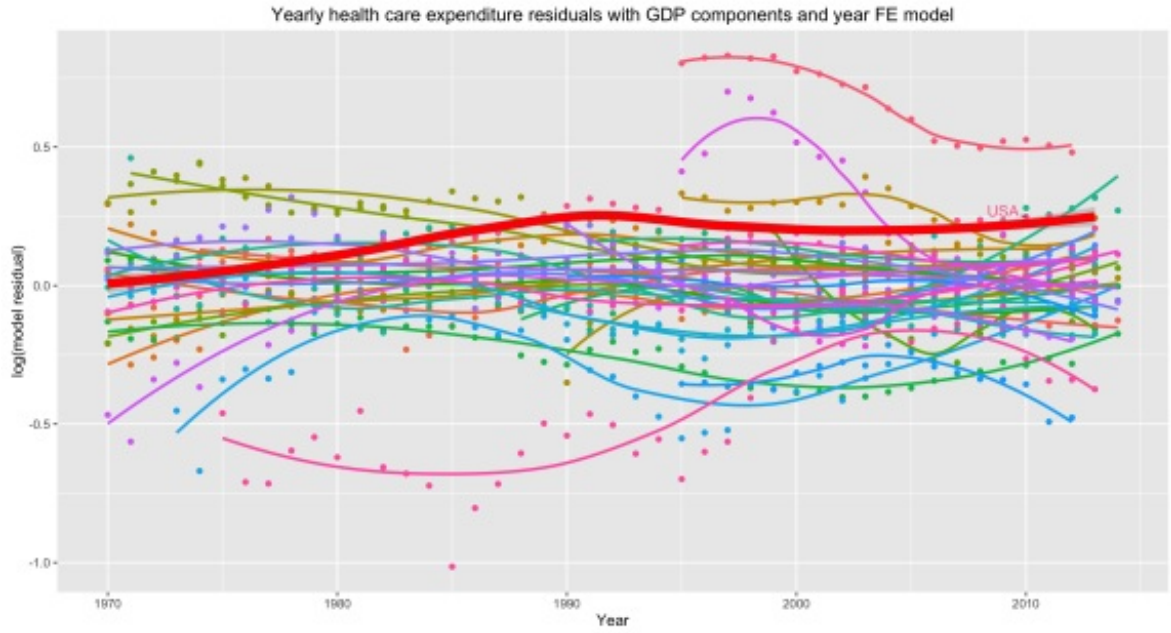


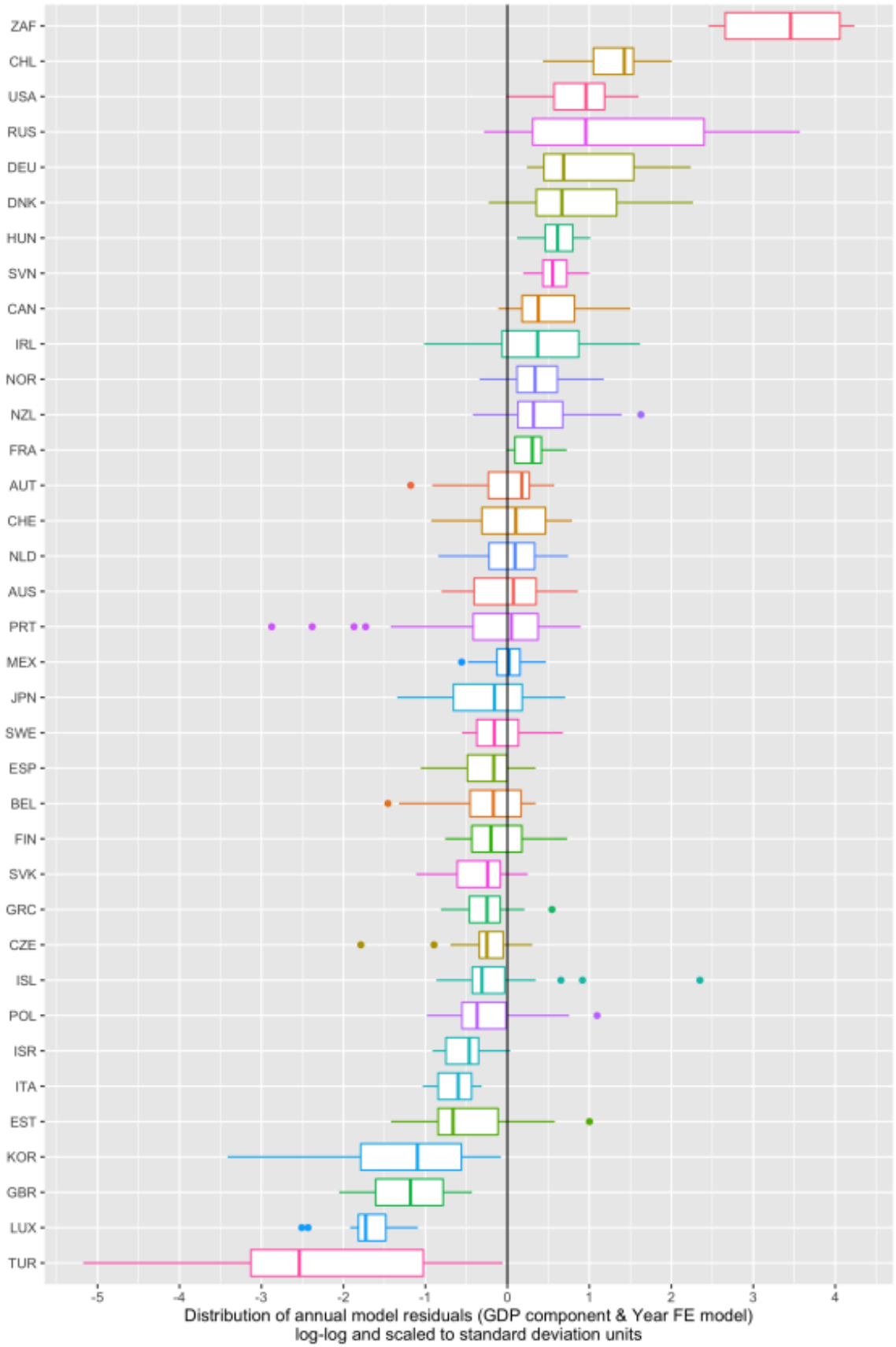
With a linear scale:



Note: The US and Luxembourg appear to tear away from the rest of the pack in ***both*** *dimensions on the linear plot starting around 1990. The linear scales tends to create an exaggerated sense of the relative magnitude of these residuals amongst richer countries.*

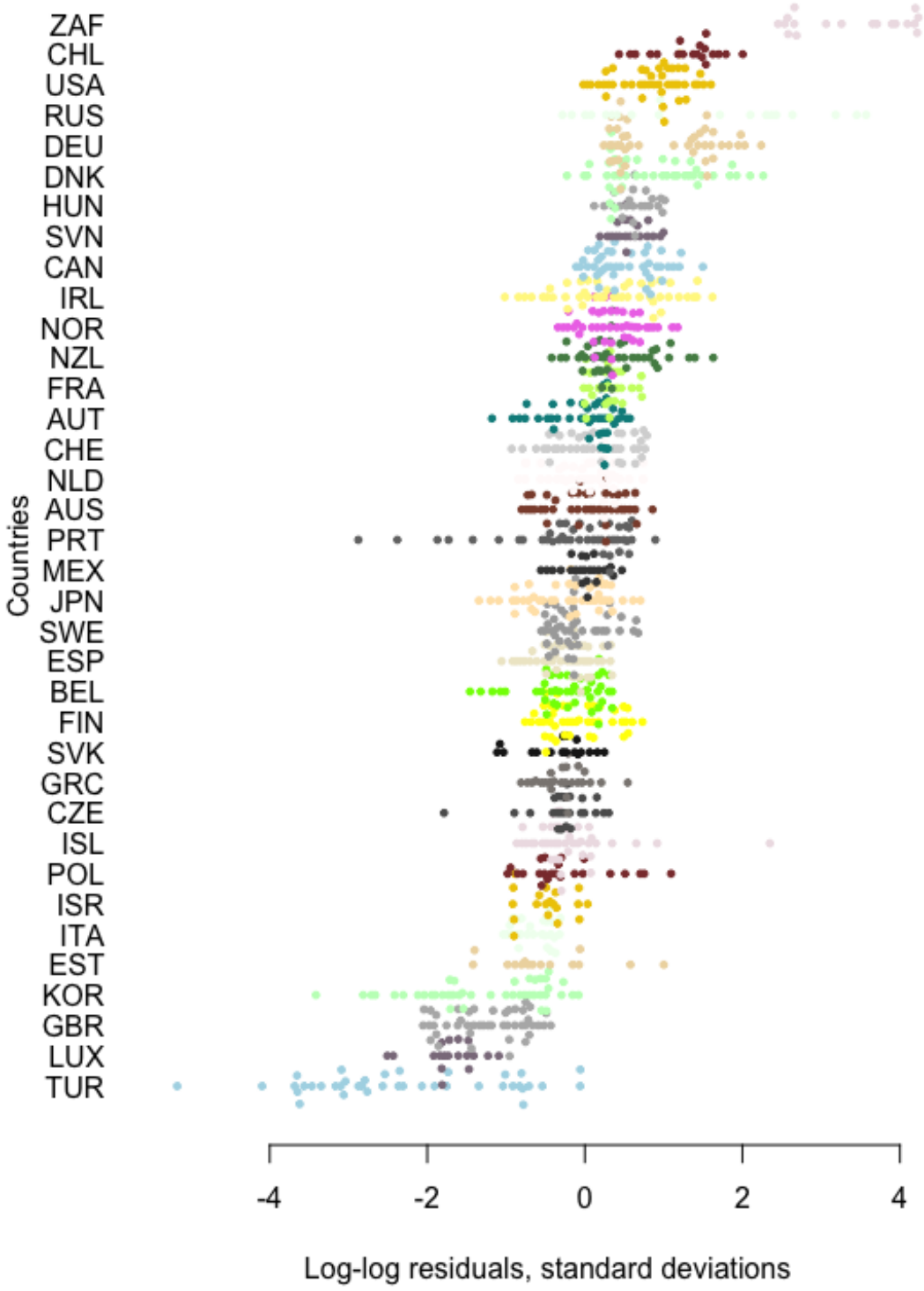
If I plot these log-log residuals, you can see how the US (the fat red line) compares to rest more systematically.





Note: the median US residual here is a bit less than 1 SD above the mean whereas, say, Great Britain is about 1 SD below the mean. You might also observe that several other highly developed countries are also above expectations and not that much lower than the US.

Another way to see the same data….



The US appears to be a bit on the high side (+1 SD) with this relatively crude, albeit reasonably well performing, model but it's not like these residuals are several standard deviations above the mean. There is also considerable overlap with other more comparable countries. **I suspect a substantial fraction of this residual can be explained by other factors, never mind the inclusion of some questionable countries in the OECD data set and forcing linear methods here, but it's a bit beyond of the original scope of this blog post** (my contention is that the US is not an outlier in a

reasonably well specified model, not that there is no positive residual between the US and the model)
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Modeling health expenditures as a percentage of GDP

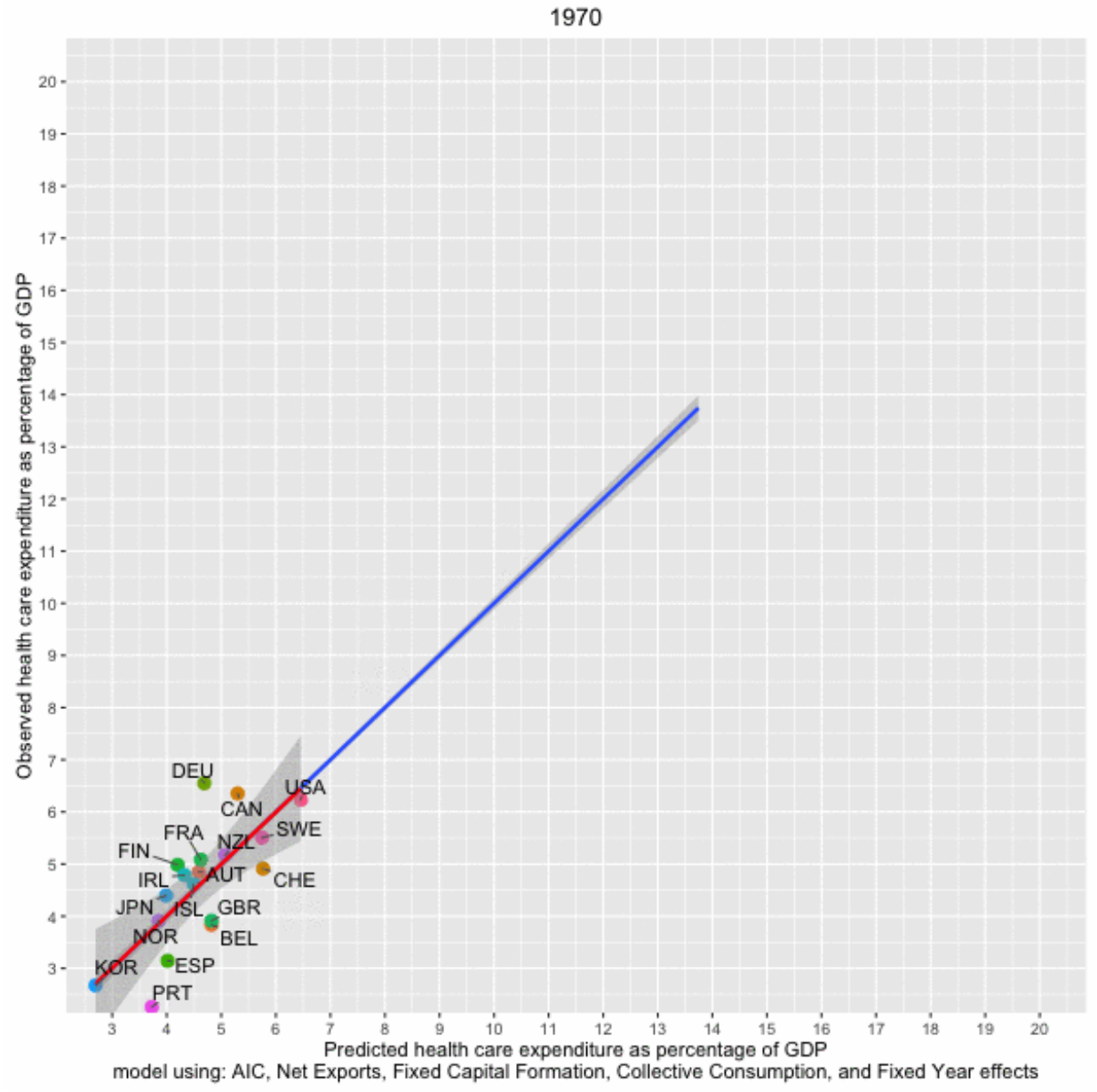
Since some people might object to or may not quite understand the significance of the log-log modeling/residuals so let's try this as a percentage of GDP instead. Since the focus seems to be on framing HCE relative to GDP (it *ought* be on consumption), the question we really want to answer here is: **approximately how many percentage points from its expected value is the US HCE spending as a percentage of GDP?** To do this we are going use the composition of GDP and year fixed effects to help answer the question using the OECD data set.

Both theory and the earlier regression analysis tells us that we can very expect different coefficients from different GDP components because all act on the denominator equally by definition whereas only some actually predict sizable increases in health care expenditures (the numerator). Ergo, even without having run this particular analysis, I'd fully expect that net exports and fixed capital to have s*ignificant negative effects* on HCE/GDP for this reason. And this is precisely what I find:

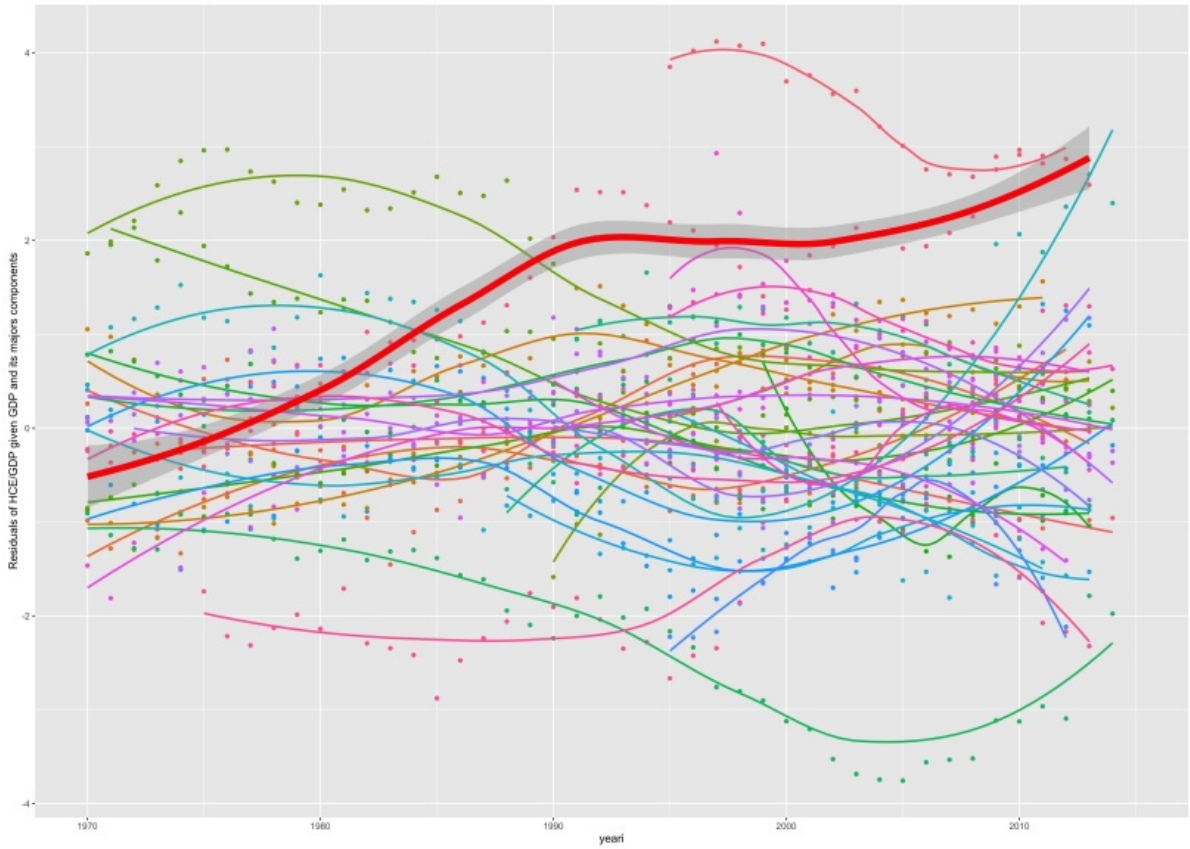
	Dependent variable:					
	Health care expenditures as percentage of GDP					
	(1)	(2)	(3)	(4)	(5)	(6)
Collective Consumption per Capita (10k)	1.014** (0.156, 1.872)	0.722* (−0.109, 1.552)	1.038** (0.234, 1.841)	2.409*** (1.478, 3.341)	2.001*** (1.148, 2.853)	2.001*** (1.148, 2.853)
Net Exports per capita (10k)	−1.609*** (−1.877, −1.341)	−1.476*** (−1.737, −1.216)	−0.511*** (−0.832, −0.190)	−1.929*** (−2.224, −1.635)	−0.534*** (−0.883, −0.184)	−0.534*** (−0.883, −0.184)
Fixed Capital formation per capita (10k)	−2.396*** (−2.850, −1.943)	−1.870*** (−2.321, −1.419)	−1.923*** (−2.358, −1.488)	−1.662*** (−2.159, −1.165)	−1.277*** (−1.738, −0.815)	−1.277*** (−1.738, −0.815)
Actual Individual Consumption per capita (10k)	3.092*** (2.870, 3.314)	2.751*** (2.525, 2.976)	2.724*** (2.506, 2.942)			
Is USA		1.745*** (1.381, 2.108)	1.857*** (1.506, 2.208)		2.381*** (2.013, 2.749)	2.381*** (2.013, 2.749)
Is Lux			−3.689*** (−4.451, −2.926)		−4.292*** (−5.111, −3.474)	−4.292*** (−5.111, −3.474)
AIC-HCE per capita (10k)				3.007*** (2.717, 3.297)	2.663*** (2.391, 2.935)	2.663*** (2.391, 2.935)
Constant	1.946*** (1.411, 2.481)	2.062*** (1.545, 2.579)	2.063*** (1.564, 2.561)	1.719*** (1.127, 2.311)	1.871*** (1.333, 2.409)	1.871*** (1.333, 2.409)
Year FE?	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,232	1,232	1,232	1,232	1,232	1,232
R^2	0.724	0.743	0.761	0.666	0.725	0.725
Adjusted R^2	0.713	0.733	0.751	0.653	0.714	0.714
Residual Std. Error	1.123 (df = 1183)	1.083 (df = 1182)	1.045 (df = 1181)	1.234 (df = 1183)	1.121 (df = 1181)	1.121 (df = 1181)
F Statistic	64.635*** (df = 48; 1183)	69.814*** (df = 49; 1182)	75.360*** (df = 50; 1181)	49.218*** (df = 48; 1183)	62.411*** (df = 50; 1181)	62.411*** (df = 50; 1181)
Note:						*p<0.1; **p<0.05; ***p<0.01
						Underlying variables previously PPP-adjusted in constant 2010 USD

If you look at model (1) you'll see that a 10K increase in AIC corresponds to about a 3 percentage point increase in HCE as a percentage of GDP whereas a 10K increase in Net Exports and Fixed Capital corresponds to about a 1.6 and 2.3 PP *decrease* respectively. Models 2 and 3 suggest this is robust to fixed effect adjustments for US and/or Luxembourg. Model 4-6 are much the same but instead of AIC I crudely subtract HCE from AIC to address potential concerns that HCE primarily falls under AIC and thus causes a mechanical increase…. and still a 10K increase in this predicts about a 3 PP increase in HCE as a percentage of GDP, that Net Exports and Fixed Capital Formation are still distinctly negative, and is robust to including USA as a variable (model 5) and so on and so forth.

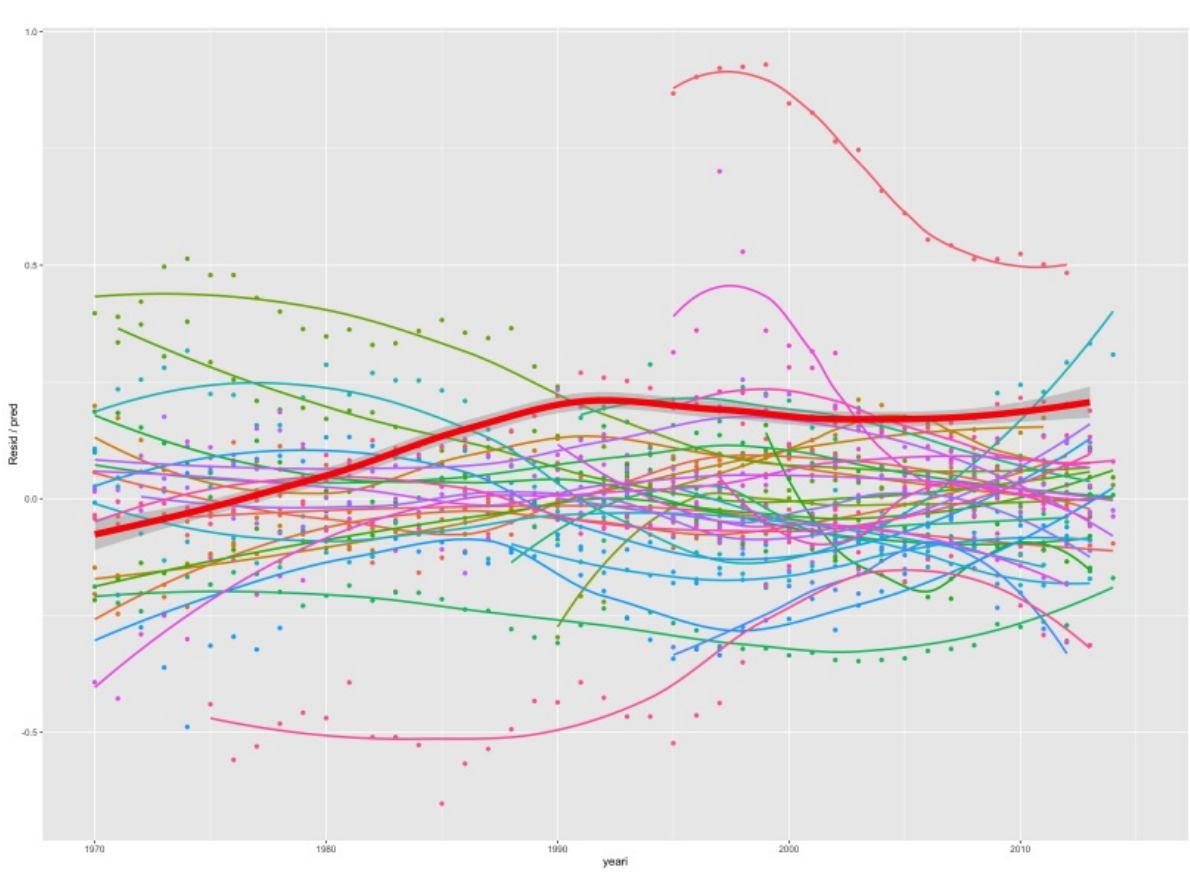
I will use model 1 for plotting here since I feel that's the cleanest and best model for these purposes.



The US looks above average in percentage of GDP terms starting roughly in mid-80s, but keep in mind (1) it's well to right in expected terms, i.e., the great majority of the US lead in HCE/GDP terms is explained by its GDP size *and* composition (2) expressing this as a function of GDP tends to exaggerate the relevance of the residuals since HCE is driven largely by AIC and AIC comprises a larger fraction of GDP in the US than other highly developed countries (3) percentage point differences are somewhat overstated by substantially higher *expected* demand/cost, i.e., the same PP difference for a country that expects to spend 5% of GDP is different for a country that expects 10% of GDP (more discretionary resources->relatively more indifference to health care expenditures).



HCE/GDP, Percentage point residuals by year



HCE/GDP, percentage residuals by year (residual / prediction)

Note: These patterns are pretty consistent with what I observed modeling in per capita terms with AIC and GDP components earlier (not surprisingly).

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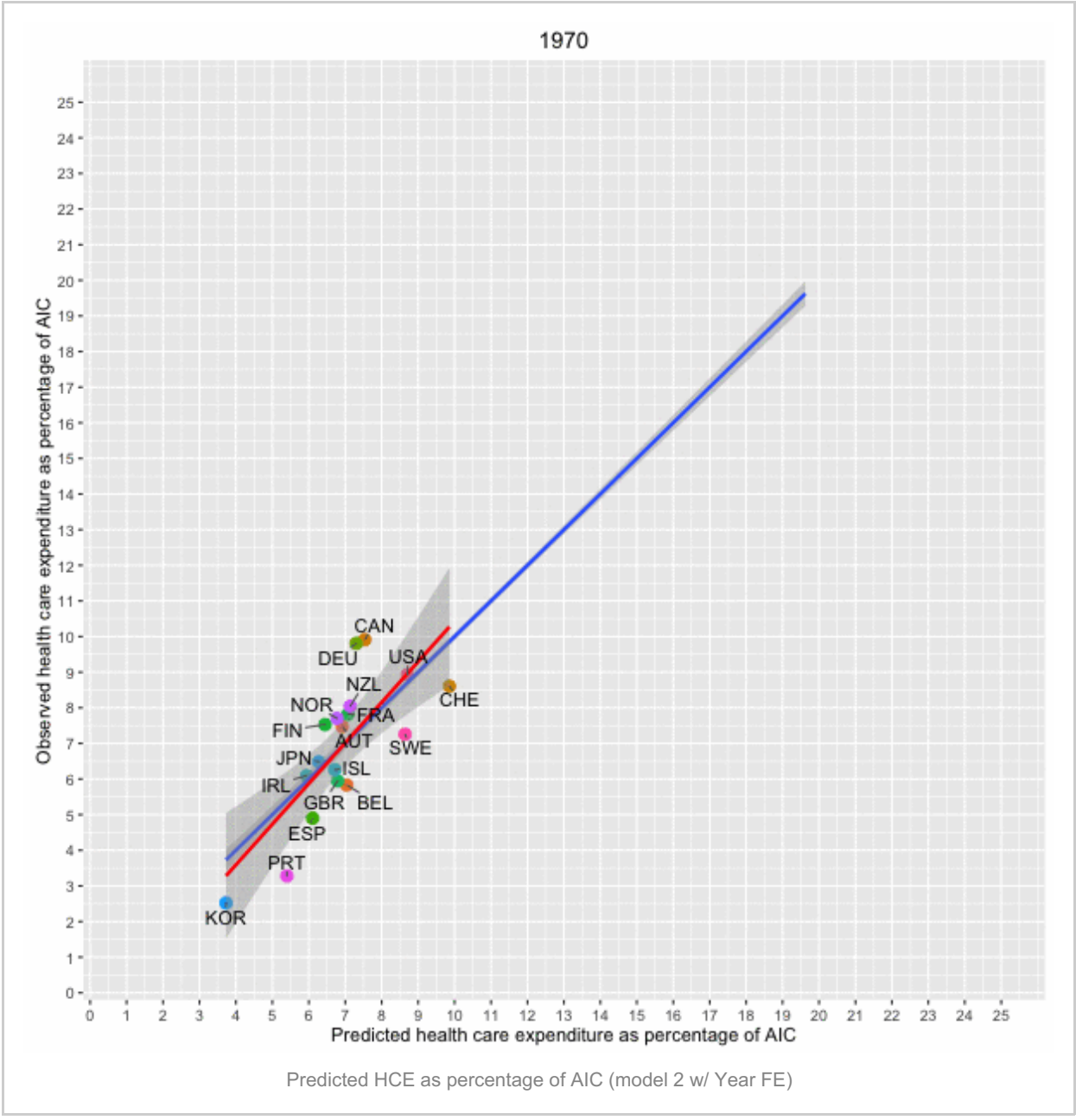
Modeling HCE as a percentage of AIC

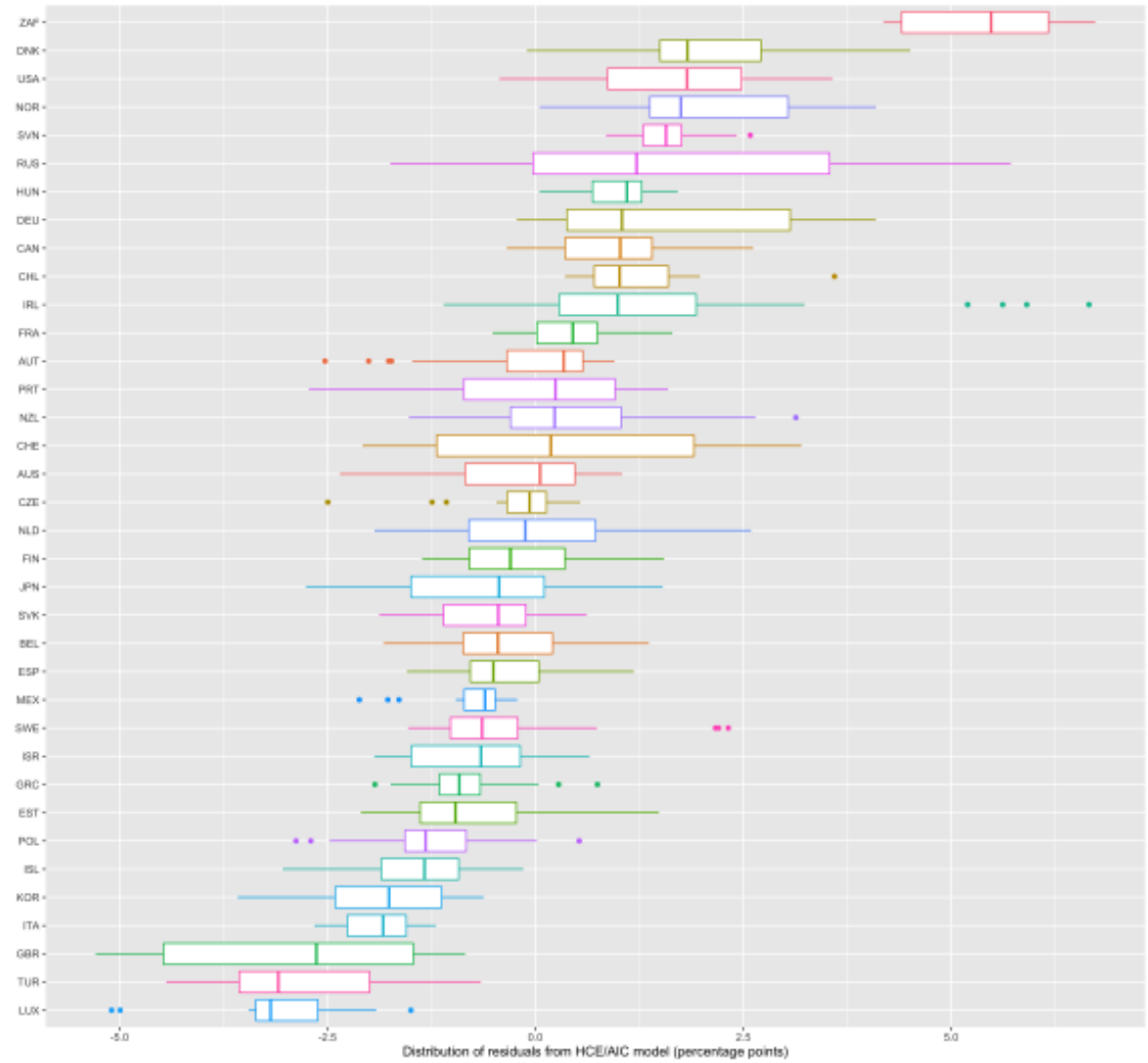
Very quickly, because I think AIC is a better baseline with which to judge against but do not wish to waste too much time, I will show also model for HCE as a percentage of consumption (AIC).

	Dependent variable:	
	hce_pct_aic_100	
	(1)	(2)
aic_pc_10k	4.093***	3.653***
	(0.086)	(0.093)
Constant	3.500***	2.760***
	(0.164)	(0.451)
Year FE?	No	Yes
Observations	1,225	1,225
R^2	0.649	0.691
Adjusted R^2	0.649	0.679
Residual Std. Error	1.947 (df = 1223)	1.862 (df = 1180)
F Statistic	2,265.114*** (df = 1; 1223)	59.837*** (df = 44; 1180)
Note:		*p<0.1; **p<0.05; ***p<0.01

A 10K increase in AIC per capita corresponds to about a 3.6 percentage point increase in HCE as a percentage of AIC accounting for year fixed effects.



Predicted HCE as percentage of AIC (model 2 w/ Year FE)



Distribution of annual residuals by country in PP

As a percentage of AIC the US HCE looks like even less of an outlier (median annual residual about +1.5 percentage points)

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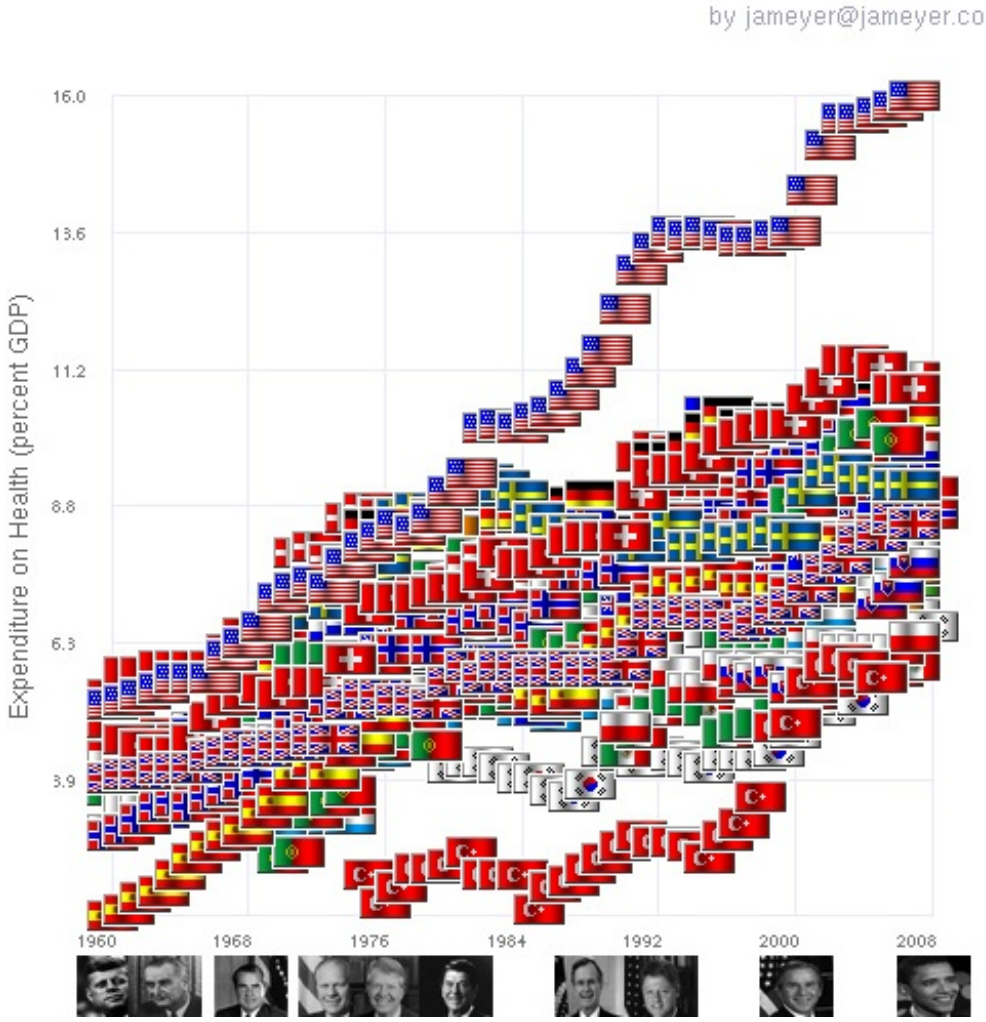
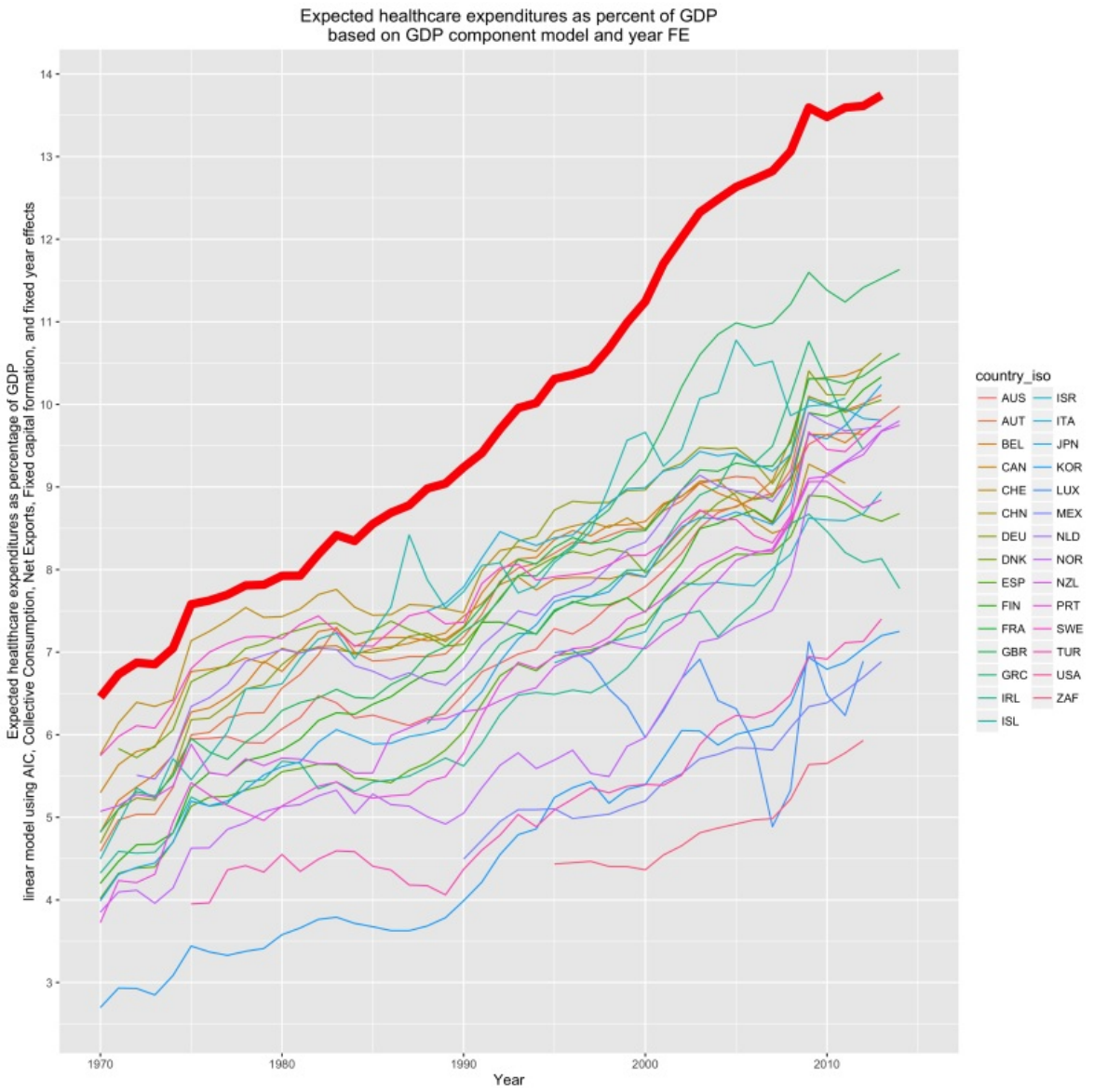
A bit on the spending divergence in the 80s

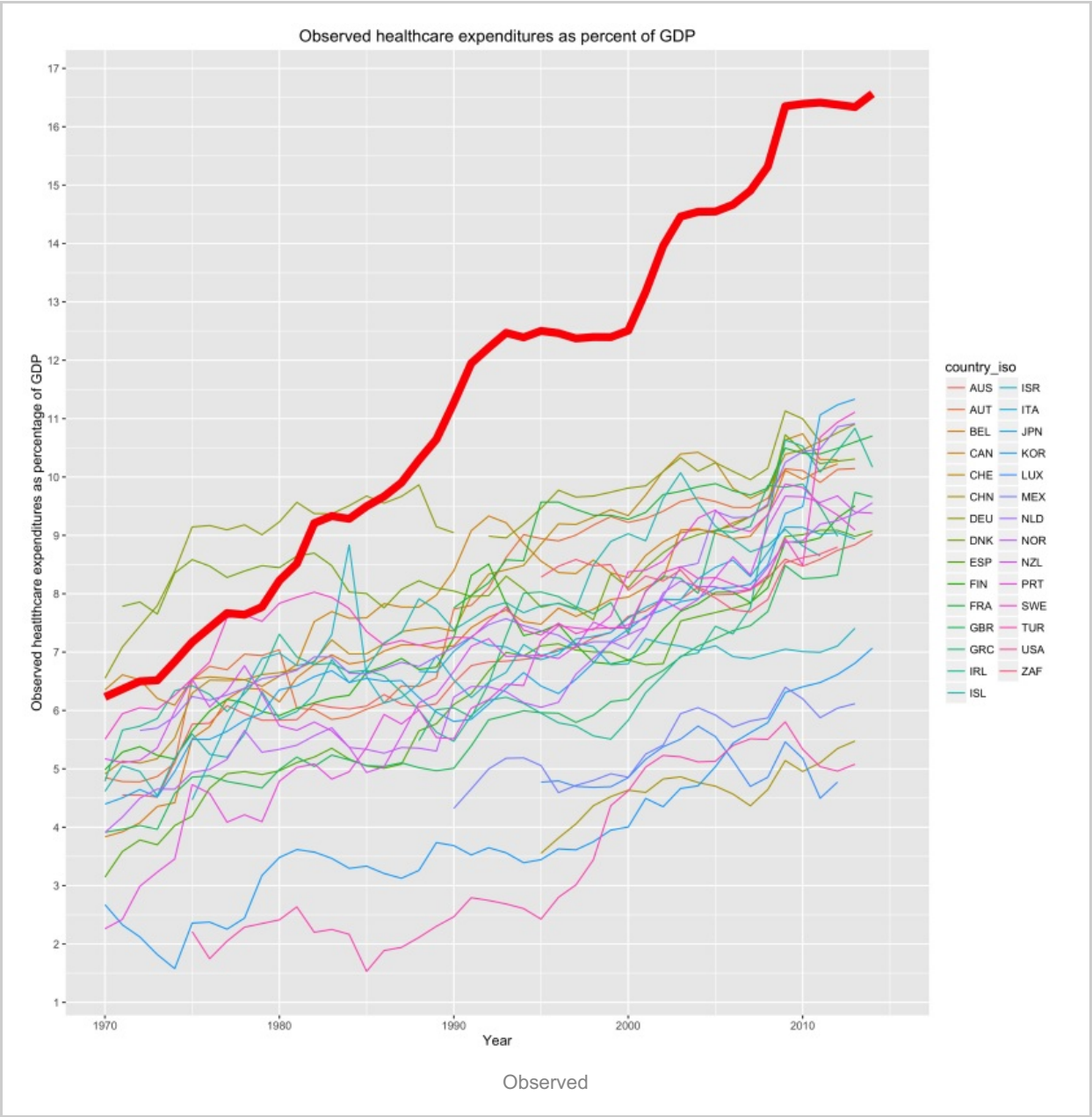
A few years back Cowen, McArdle, and others in my blog feed drew attention to this graph (and those like it) wherein the US pulls away from other OECD countries starting around 80s.



Although I certainly don't think the divergence can be *entirely* explained by this alone, it's worth pointing out that my HCE/GDP component model specification (above) certainly suggests that we should have expected the US to substantially diverge from the rest based just on differences in GDP growth and compositional changes in GDP.

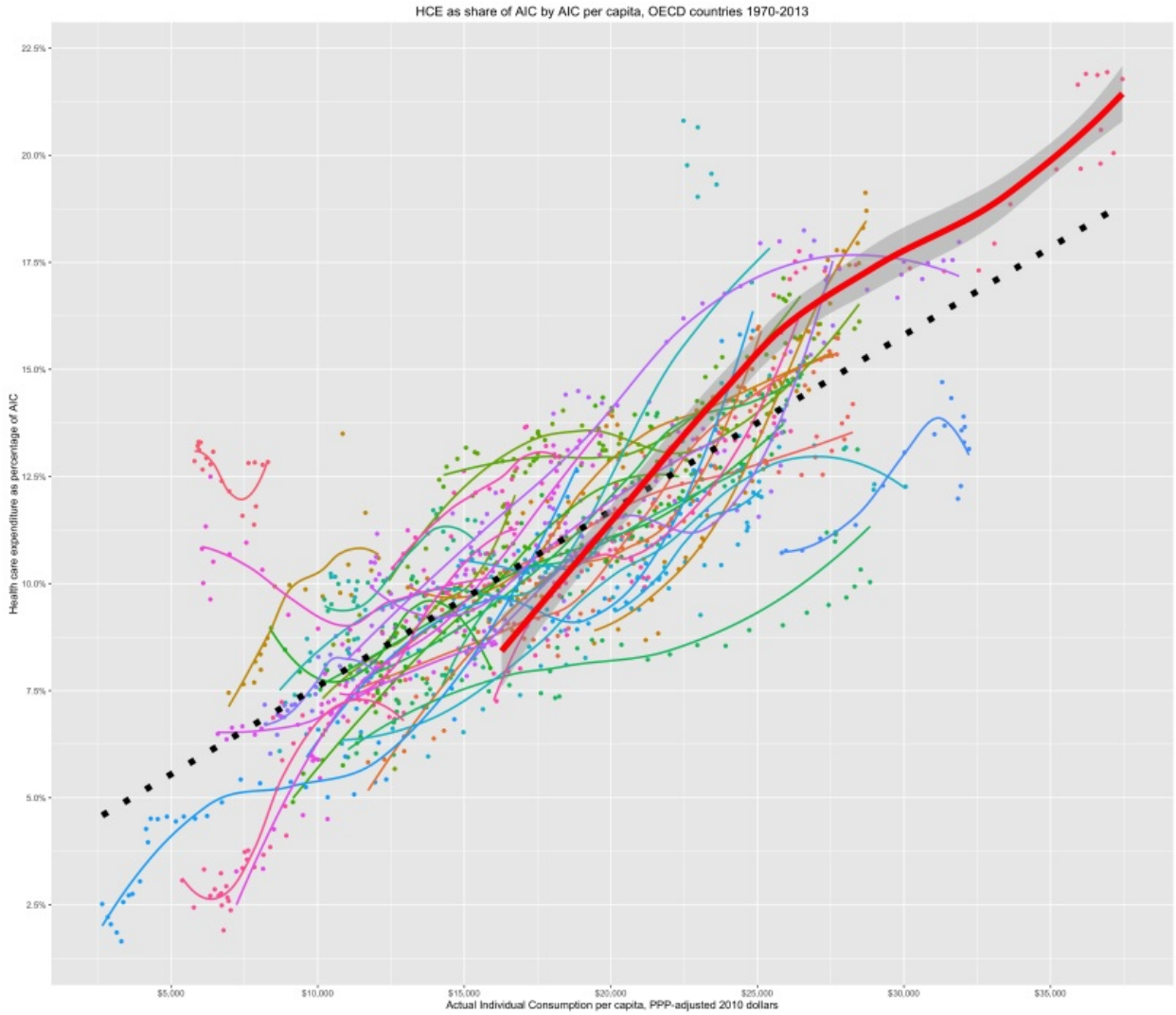


Model expectations



Again, my view is that it makes more sense to look at this as a share of AIC (or, at least, consumption more broadly).

Here is one way to look at the data quickly:



Note: the thin lines here are loess trend lines for each country, the fat red line being the US, and the (linear) black dotted line the trend across all data points in the merged OECD data set. I am not correcting for anything tricky here or correcting for year fixed effect…. still a useful perspective though IMO

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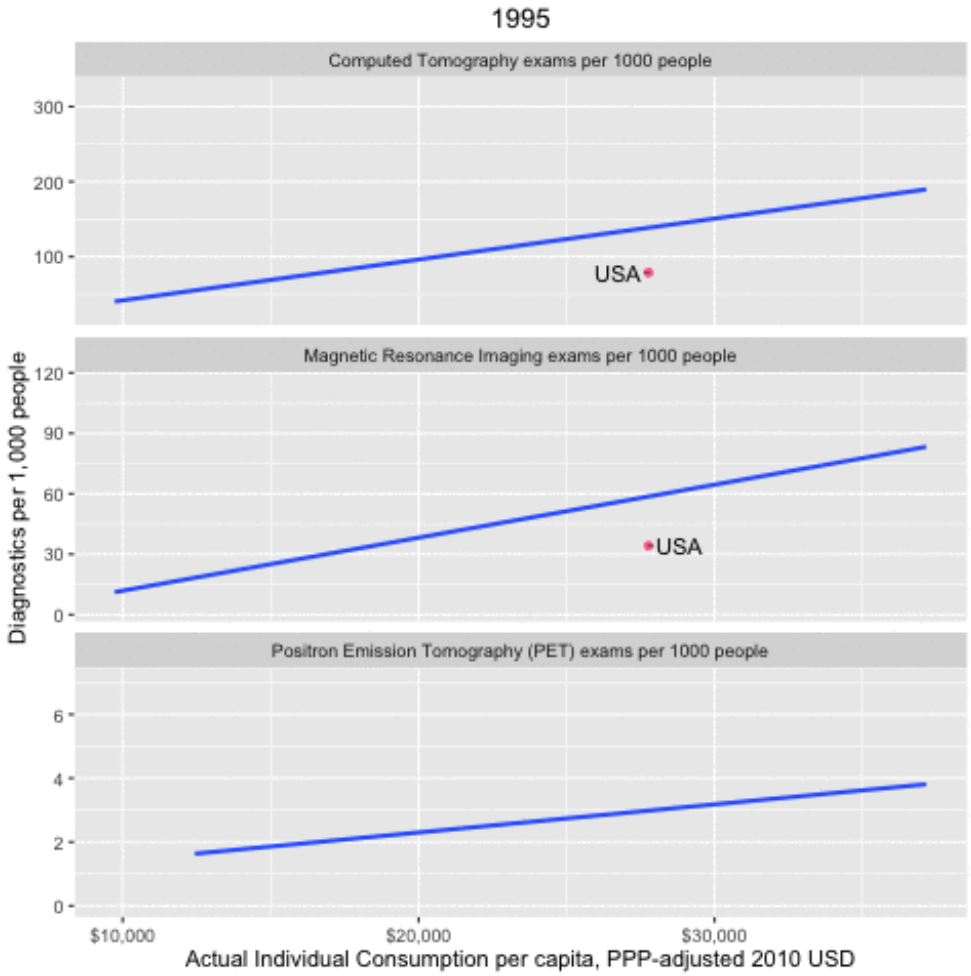
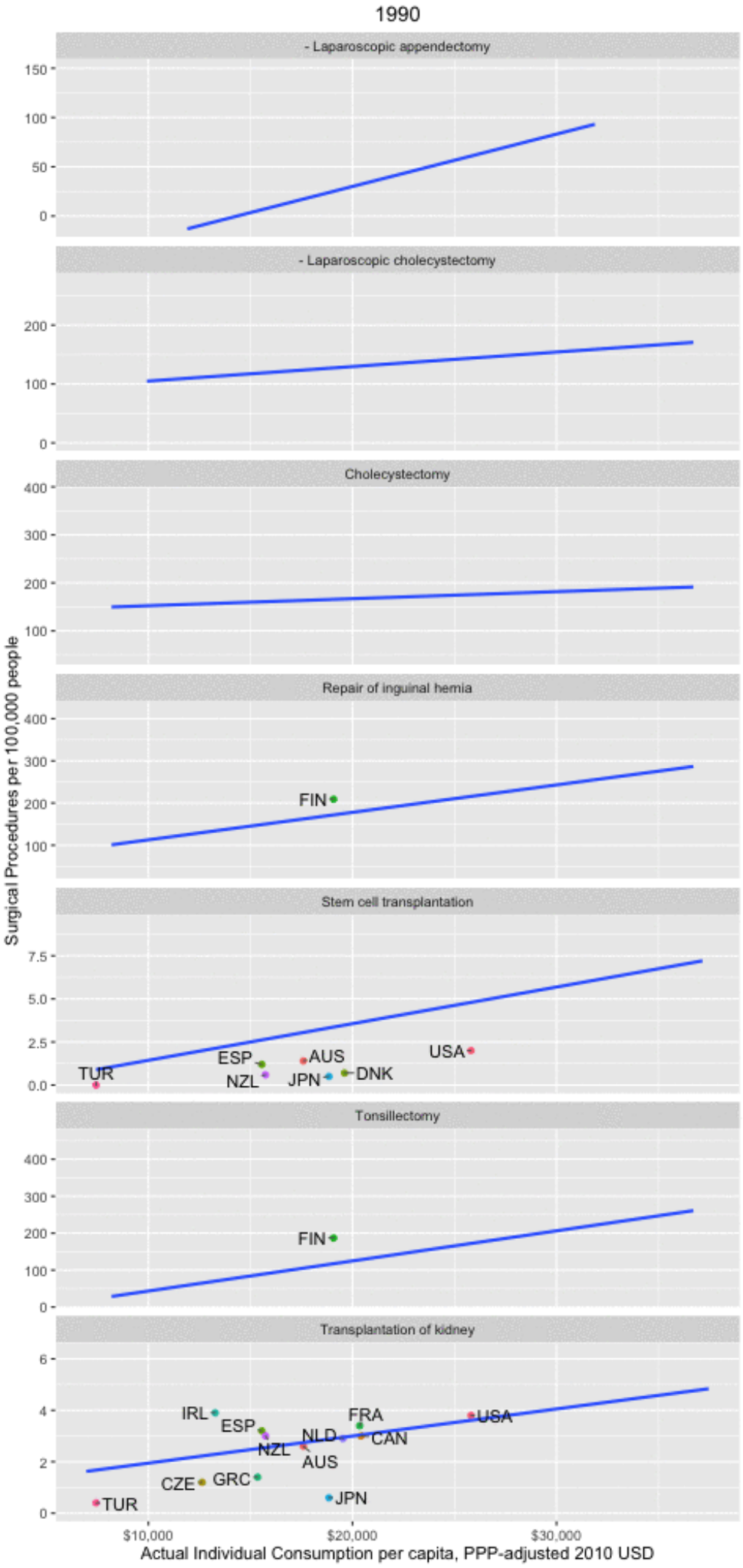
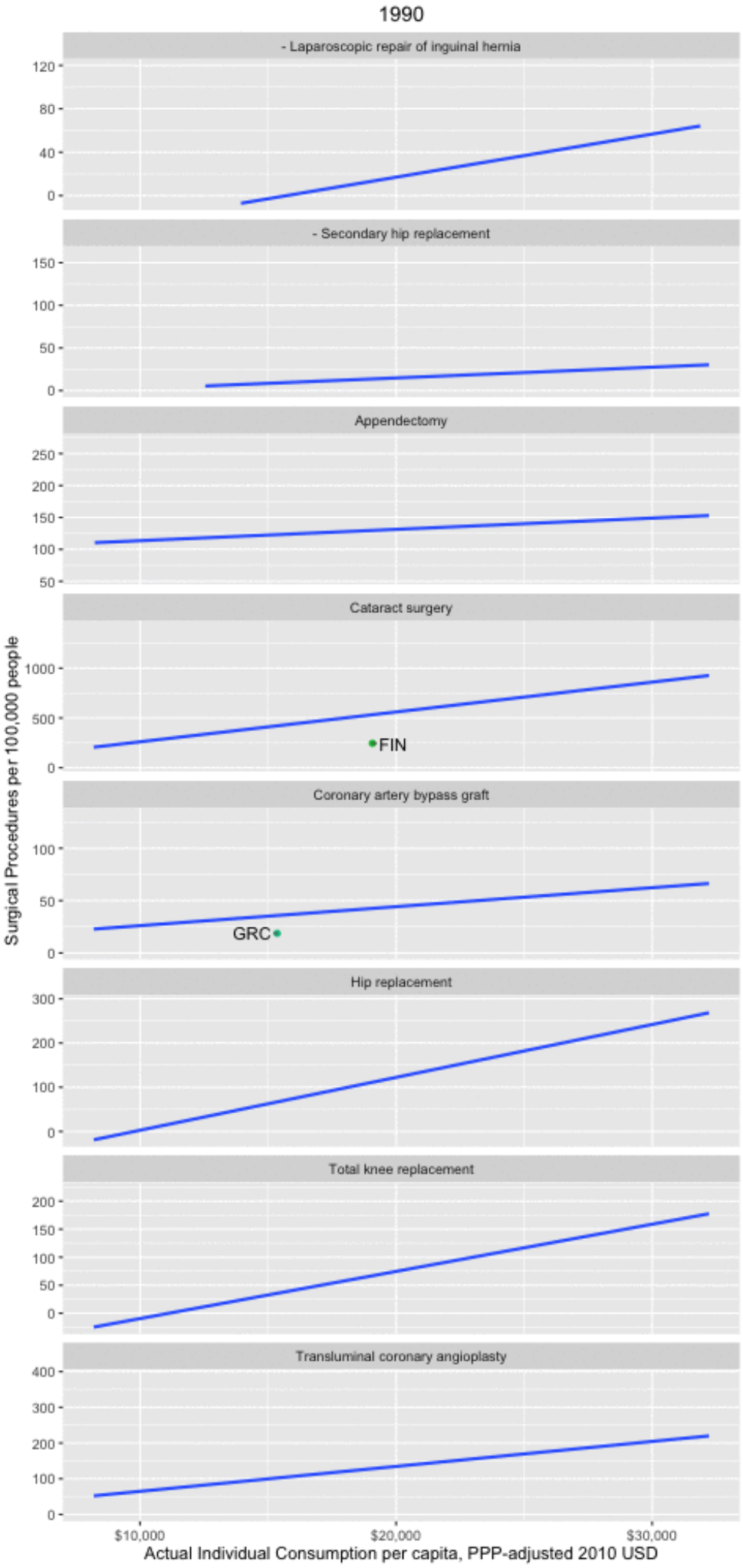
A bit of spending data on volume

Besides the top level figures on healthcare expenditures, we can also see, unsurprisingly, that significant drivers of expenditures like diagnostics, surgical procedures, and the like correlate with AIC, both between countries and within countries (across years). I am presenting all per capita (or comparable) data available in these series to avoid potential cherry-picking. The US isn't always available in all of these series, however we can still observe that **countries with higher material standards of living actually do more "stuff" in healthcare and the US is the wealthiest country in these series.** When people talk about health care "inflation" they are **not just** (or even mainly) referring to actual price increases for the same good or services as an ever expanding package of goods and services and/or expanding coverage for more people to get pre-existing technology (diagnostics, procedures, pharmaceuticals, etc).

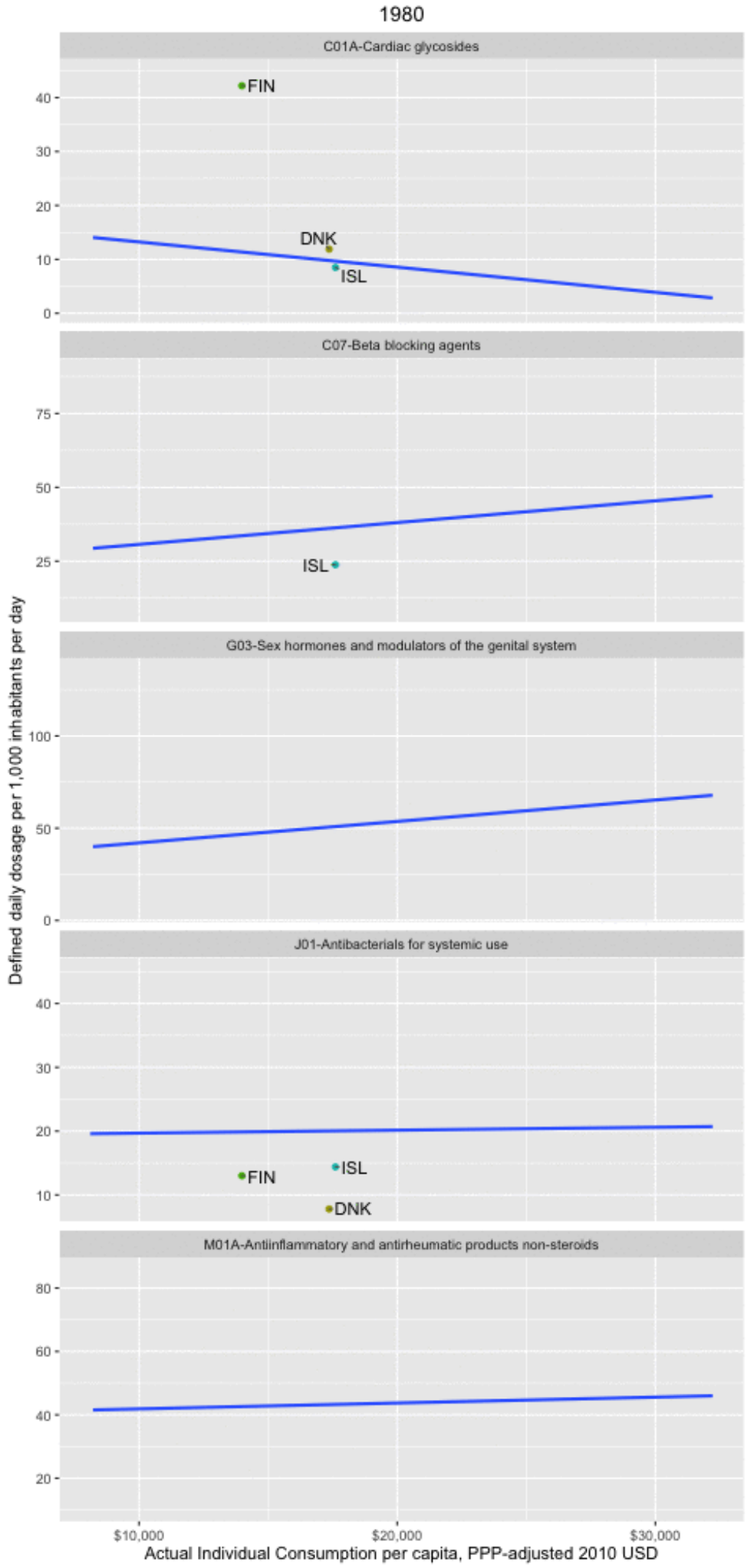


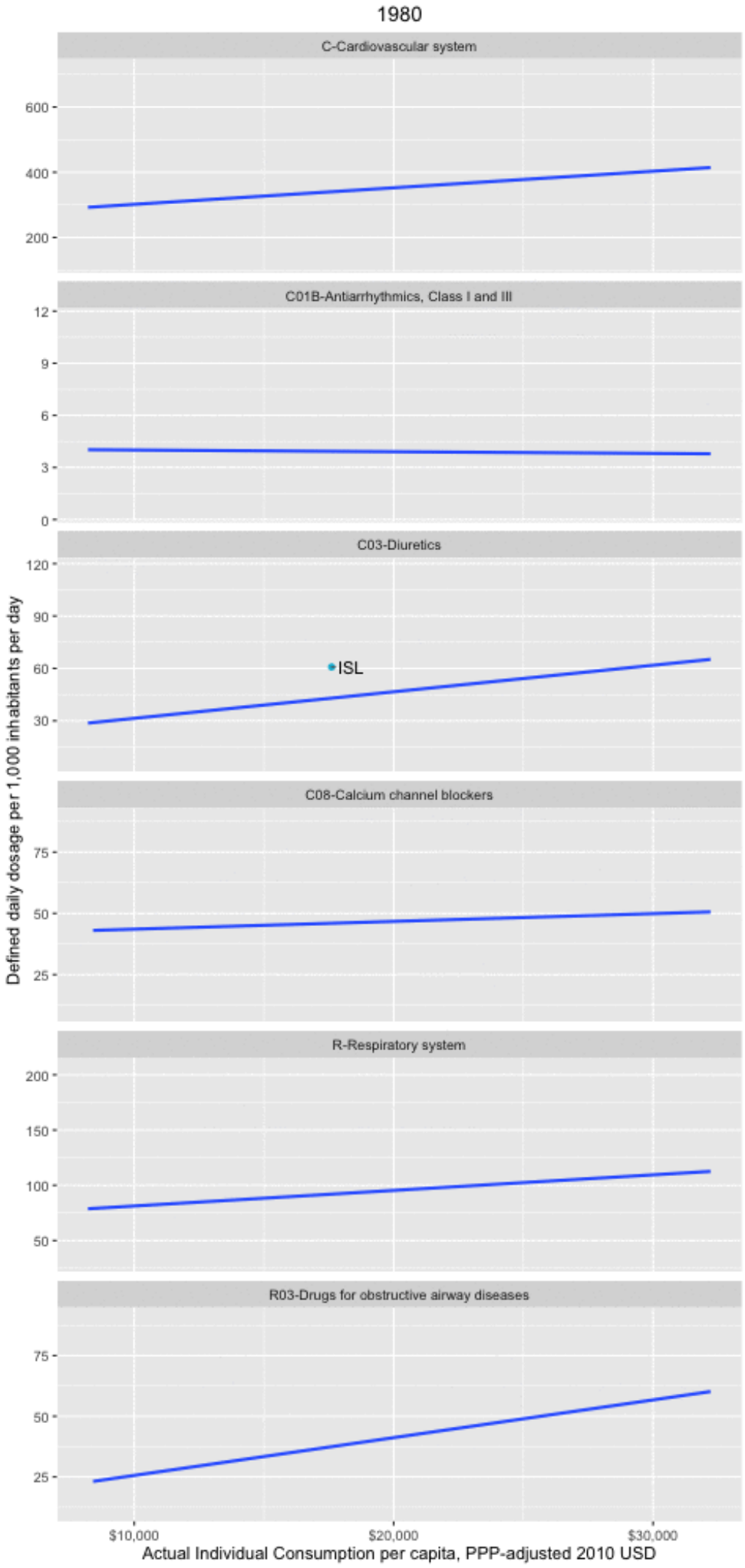
Surgical series, part 1

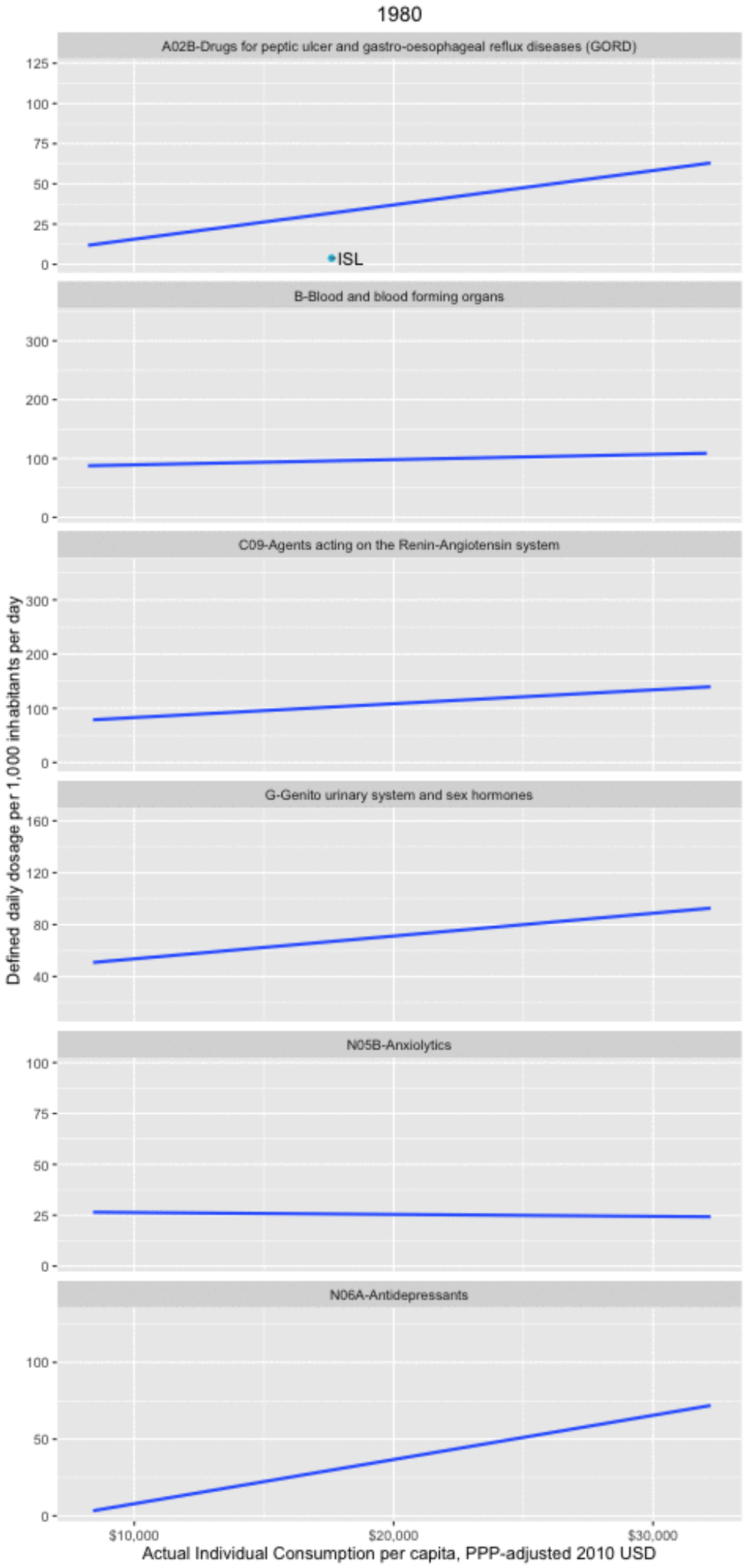

1990
- Laparoscopic appendectomy
- Laparoscopic cholecystectomy
Cholecystectomy
Repair of inguinal hernia
Stem cell transplantation
Tonsillectomy
Transplantation of kidney
Surgical Procedures per 100,000 people
Actual Individual Consumption per capita, PPP-adjusted 2010 USD
$10,000
$20,000
$30,000
FIN
TUR
ESP
NZL
AUS
JPN
DNK
USA
IRL
FRA
NLD
CAN
CZE
GRC

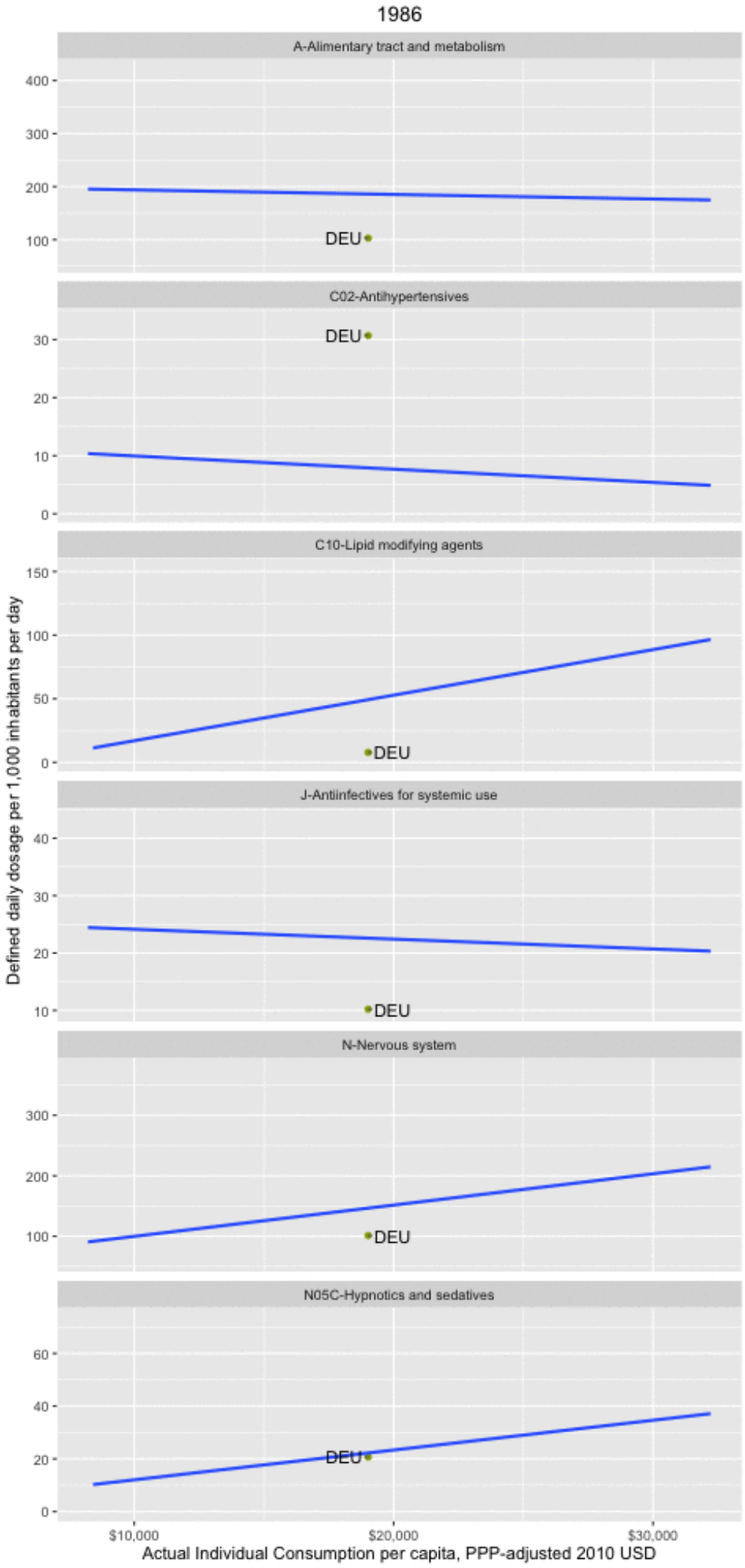

1990
- Laparoscopic repair of inguinal hernia
- Secondary hip replacement
Appendectomy
Cataract surgery
Coronary artery bypass graft
Hip replacement
Total knee replacement
Transluminal coronary angioplasty
FIN
GRC
Surgical Procedures per 100,000 people
$10,000
$20,000
$30,000
Actual Individual Consumption per capita, PPP-adjusted 2010 USD

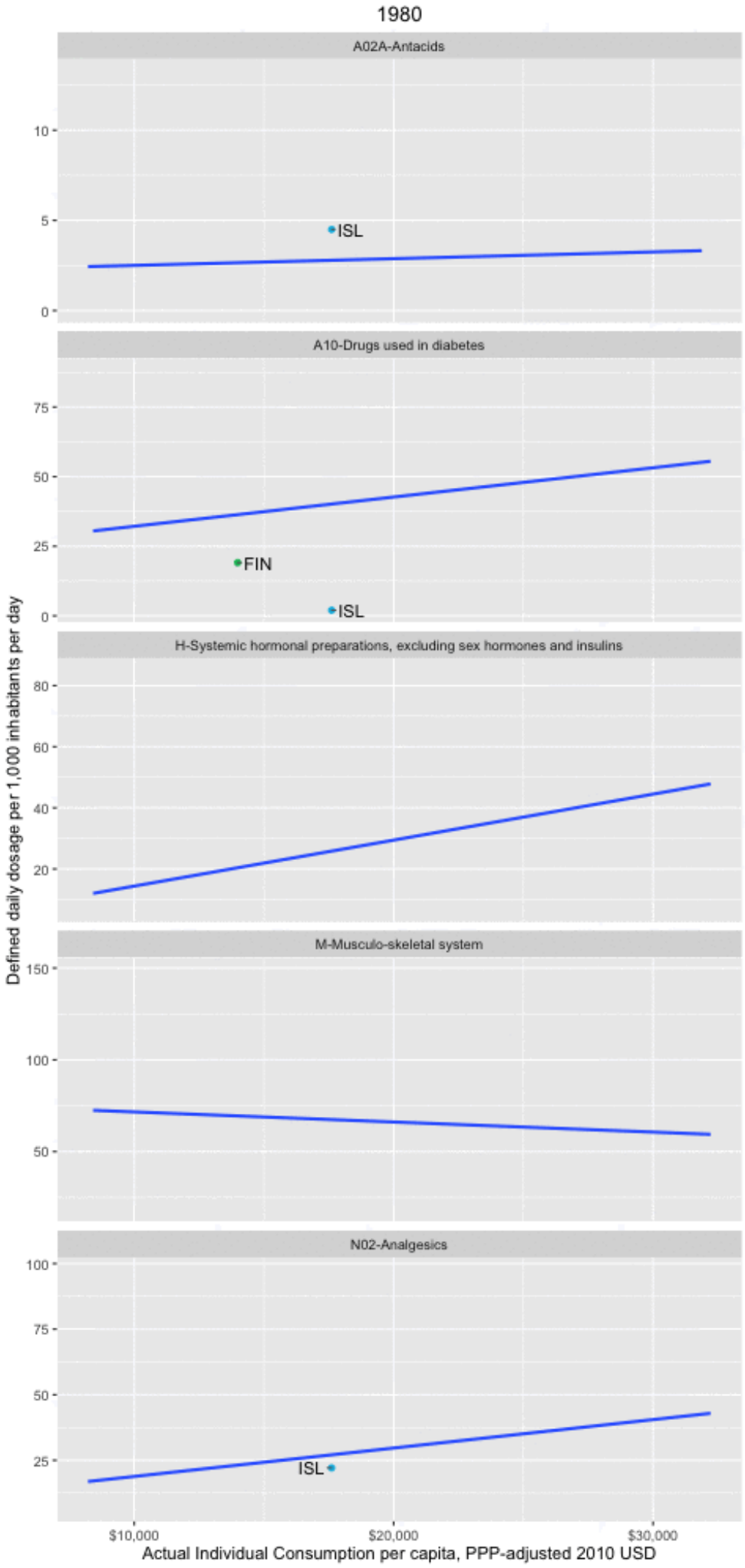
Note: I am presenting all per capita data available from OECD stats tables to avoid potential cherry-picking. Not worrying about formatting and aesthetics too much here!


1980
C01A-Cardiac glycosides
FIN
DNK
ISL
C07-Beta blocking agents
ISL
G03-Sex hormones and modulators of the genital system
J01-Antibacterials for systemic use
FIN
ISL
DNK
M01A-Antiinflammatory and antirheumatic products non-steroids
Defined daily dosage per 1,000 inhabitants per day
$10,000
$20,000
$30,000
Actual Individual Consumption per capita, PPP-adjusted 2010 USD


1980
C-Cardiovascular system
600
400
200
C01B-Antiarrhythmics, Class I and III
12
9
6
3
0
C03-Diuretics
120
90
60
30
ISL
C08-Calcium channel blockers
75
50
25
R-Respiratory system
200
150
100
50
R03-Drugs for obstructive airway diseases
75
50
25
Defined daily dosage per 1,000 inhabitants per day
$10,000
$20,000
$30,000
Actual Individual Consumption per capita, PPP-adjusted 2010 USD


1980
A02B-Drugs for peptic ulcer and gastro-oesophageal reflux diseases (GORD)
ISL
B-Blood and blood forming organs
C09-Agents acting on the Renin-Angiotensin system
G-Genito urinary system and sex hormones
N05B-Anxiolytics
N06A-Antidepressants
Defined daily dosage per 1,000 inhabitants per day
$10,000
$20,000
$30,000
Actual Individual Consumption per capita, PPP-adjusted 2010 USD

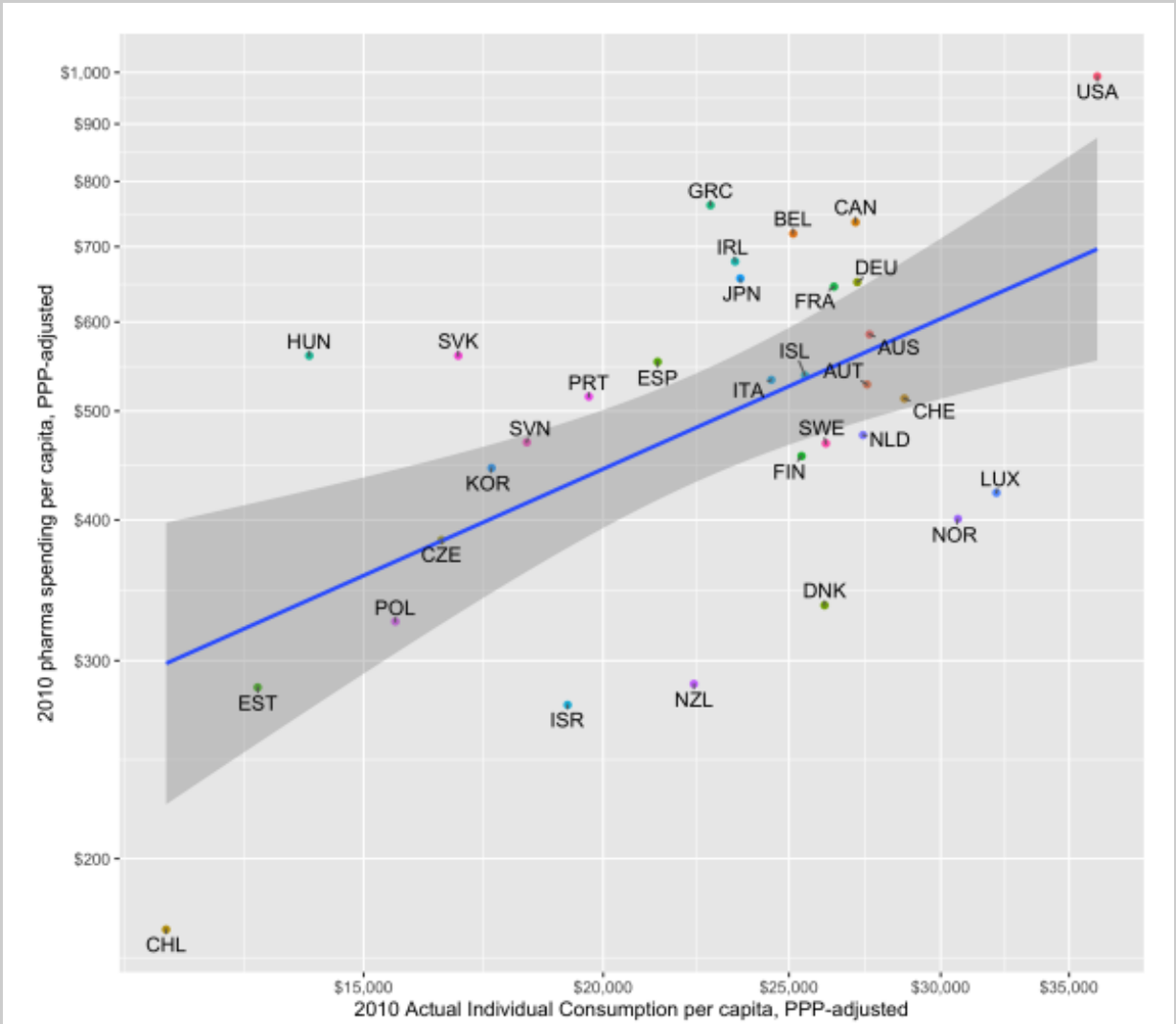

1986
A-Alimentary tract and metabolism
C02-Antihypertensives
C10-Lipid modifying agents
J-Antiinfectives for systemic use
N-Nervous system
N05C-Hypnotics and sedatives
DEU
Defined daily dosage per 1,000 inhabitants per day
$10,000
$20,000
$30,000
Actual Individual Consumption per capita, PPP-adjusted 2010 USD


1980
A02A-Antacids
10
5
0
ISL
A10-Drugs used in diabetes
75
50
25
0
FIN
ISL
H-Systemic hormonal preparations, excluding sex hormones and insulins
80
60
40
20
M-Musculo-skeletal system
150
100
50
N02-Analgesics
100
75
50
25
ISL
Defined daily dosage per 1,000 inhabitants per day
$10,000
$20,000
$30,000
Actual Individual Consumption per capita, PPP-adjusted 2010 USD

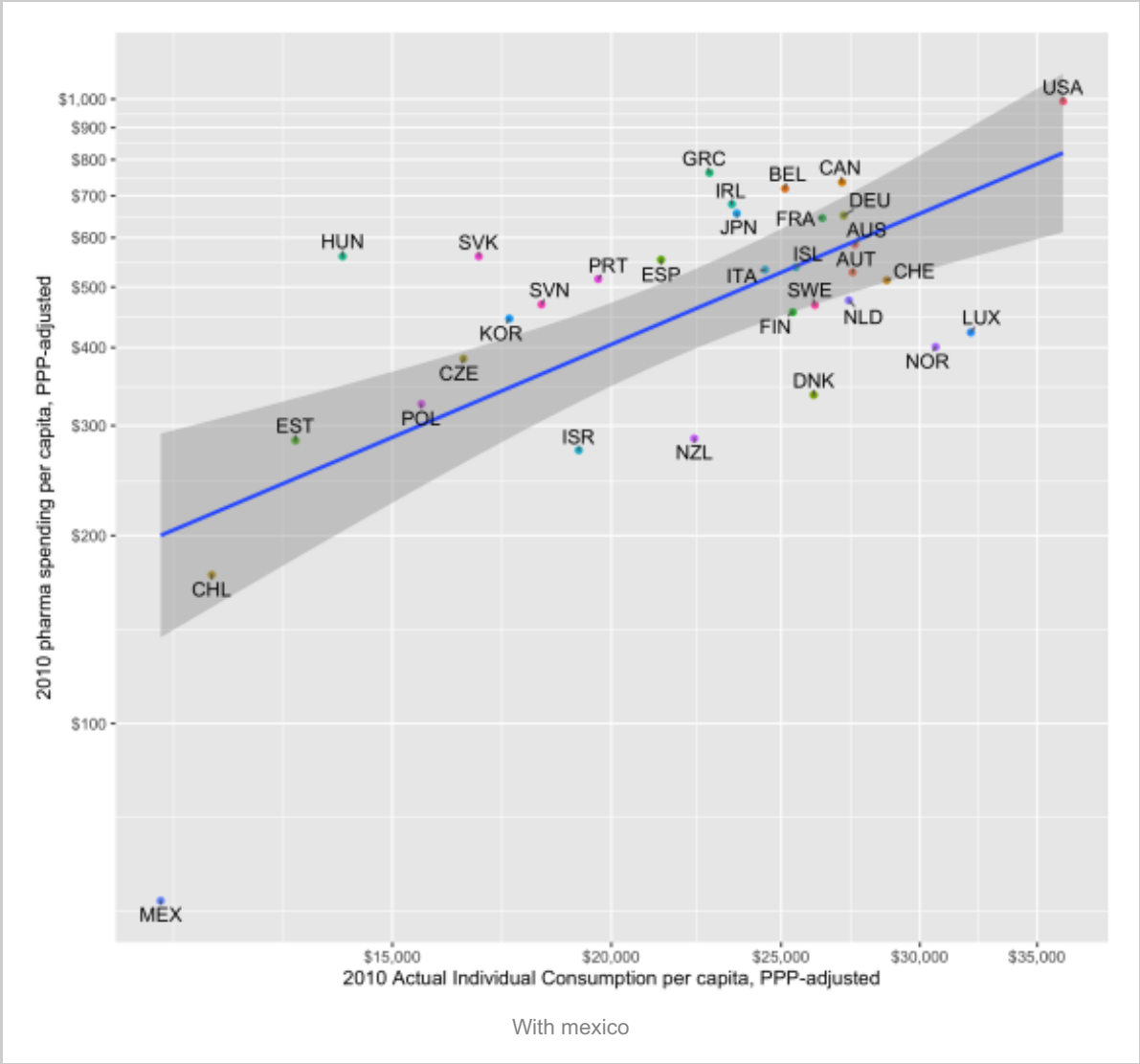
Those plots are admittedly a bit of a mess, but you can still see that quite a few of them correlate quite strongly with material living conditions and that, where US data are available, it tends to be at or near the top.
[back to top]

Overall pharmaceutical spending is not extremely high

US pharmaceutical spending is above average, but there is a reasonable relationship with wealth and the US is not way out of line with many of the others.



Without Mexico

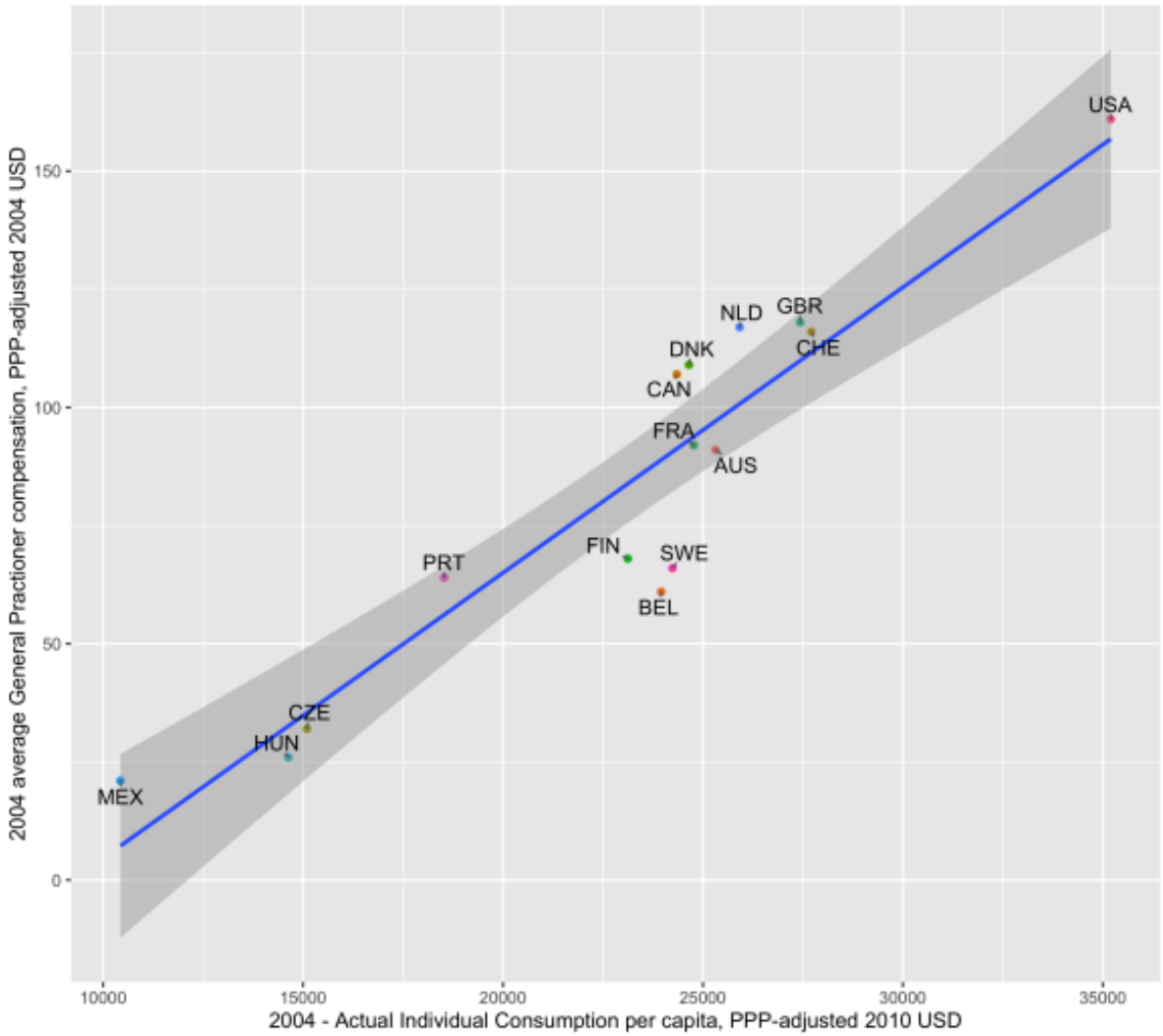


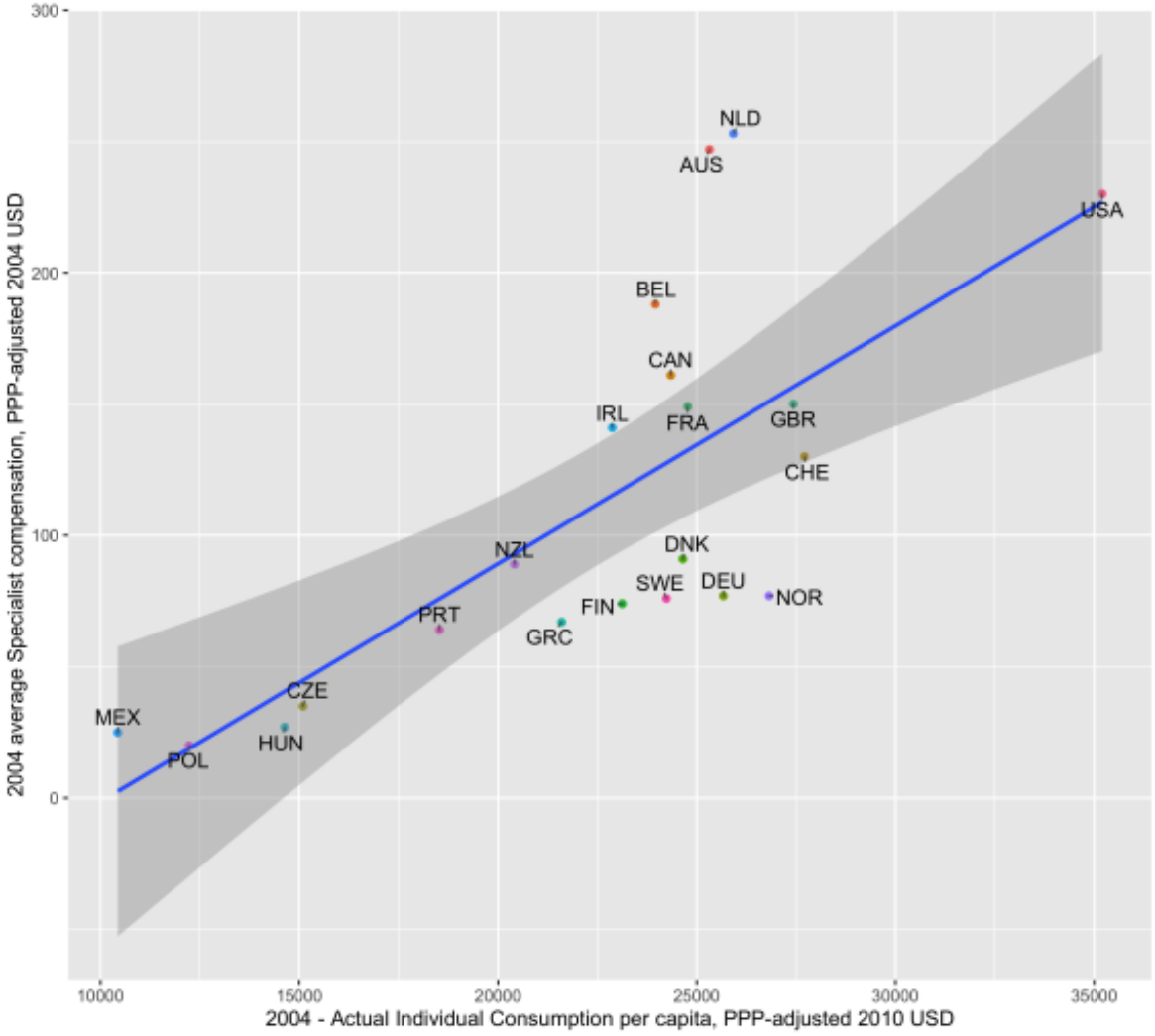
With mexico

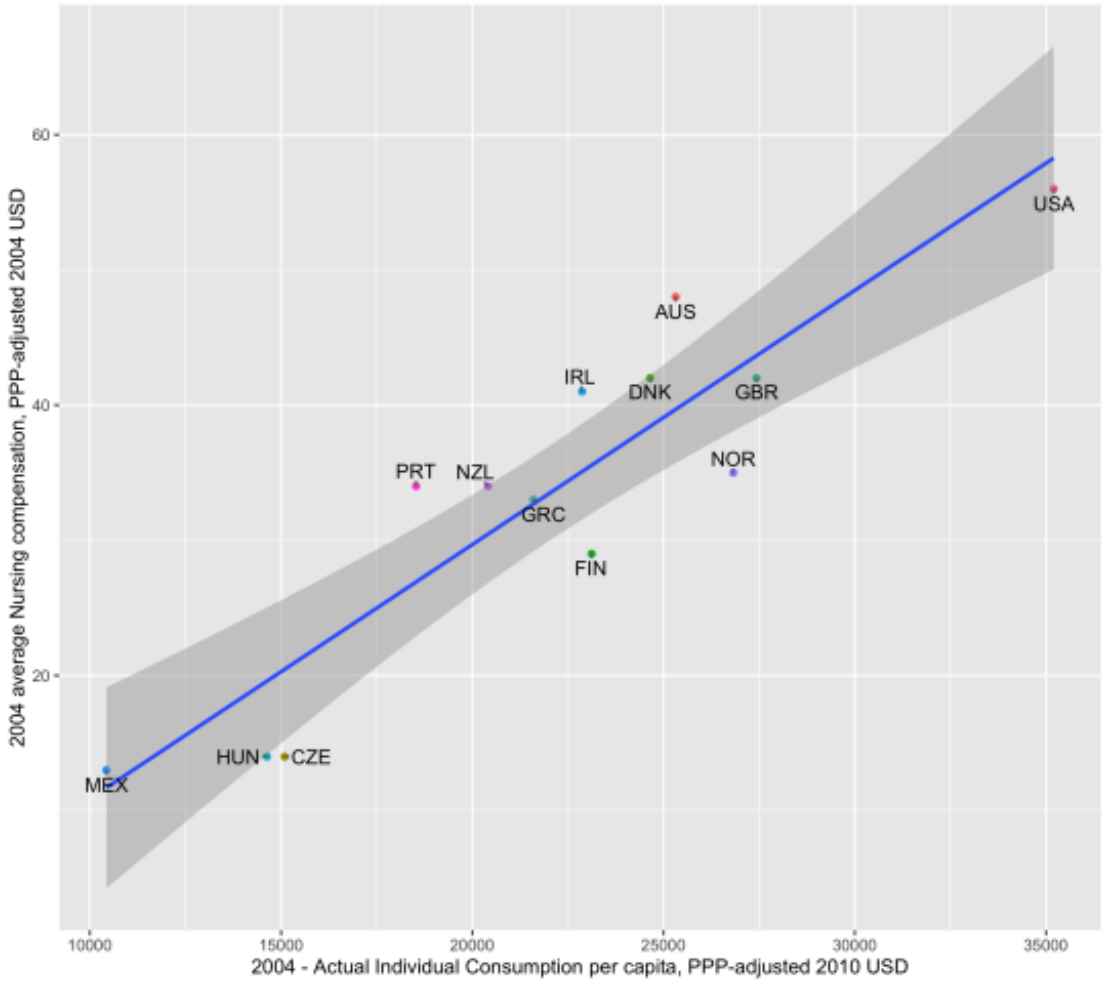
[back to top]

Nor are physician or nursing compensation out of proportion to AIC

US physician and nursing compensation is very much inline with what we would expect based on our material standard of living relative to others.


2004 average General Practioner compensation, PPP-adjusted 2004 USD
150
100
50
0
10000
15000
20000
25000
30000
35000
2004 - Actual Individual Consumption per capita, PPP-adjusted 2010 USD
USA
NLD
GBR
DNK
CHE
CAN
FRA
AUS
FIN
SWE
PRT
BEL
CZE
HUN
MEX


2004 average Specialist compensation, PPP-adjusted 2004 USD
300
200
100
0
NLD
AUS
USA
BEL
CAN
IRL
FRA
GBR
CHE
NZL
DNK
SWE
DEU
NOR
FIN
PRT
GRC
CZE
MEX
HUN
POL
10000
15000
20000
25000
30000
35000
2004 - Actual Individual Consumption per capita, PPP-adjusted 2010 USD


2004 average Nursing compensation, PPP-adjusted 2004 USD
60
40
20
USA
AUS
IRL
DNK
GBR
NOR
PRT
NZL
GRC
FIN
HUN
CZE
MEX
10000
15000
20000
25000
30000
35000
2004 - Actual Individual Consumption per capita, PPP-adjusted 2010 USD

Actual PPP adjusted wages tend to correlate with PPP adjusted AIC much better than PPP-adjusted GDP.
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Admin costs are substantially above trend, but don't drive large differences in spending

The OECD provides a category under the National Health accounts system called "Governance and health system and financing administration" that basically includes all collective aspects of the system (e.g., CDC, HHS, CMS/Medicare/Medicaid, private payer, non-profit services, etc) not on the provider/hospital side.

> ***HC.7 Governance, and health system and financing administration***
>
> These services focus on the health system rather than direct health care, and are considered to be collective, as they are not allocated to specific individuals but benefit all health system users. They direct and support health system functioning. These services are expected to maintain and increase the effectiveness and efficiency of the health system and may enhance its equity.
>
> These expenditures are incurred mostly but not exclusively by governments. Included are the formulation and administration of government policy; the setting of standards; the regulation, licensing or supervision of producers; management of the fund collection; and the administration, monitoring and evaluation of such resources, etc. However, some of these services are also provided by private entities, including by civil society (NGOs) and private medical insurance. Clear examples of such civil participation are health advocacy, health observatories and health user/consumer associations.

[snip]

HC.7.2 Administration of health financing

This class involves a subcomponent specific to health financing, regardless of its public and private origin or its public and private provision, *e.g.* budgeting and fund-raising (Poullier, 1992; Nicolle and Mathauer, 2010). It contains the management of the collection of funds and the administration, monitoring and evaluation of such resources. Among the specific services linked to resource mobilisation are the identification of members of the schemes; their enrolment; the billing and collection of contributions; and the management of exemptions. Within the pooling function, risk equalisation is one important service. As for the purchasing function, the services included are selecting, negotiating, purchasing and contracting with health providers, as well as the claims processing system, which includes gate-keeping, making payments to providers, and patient reimbursement.

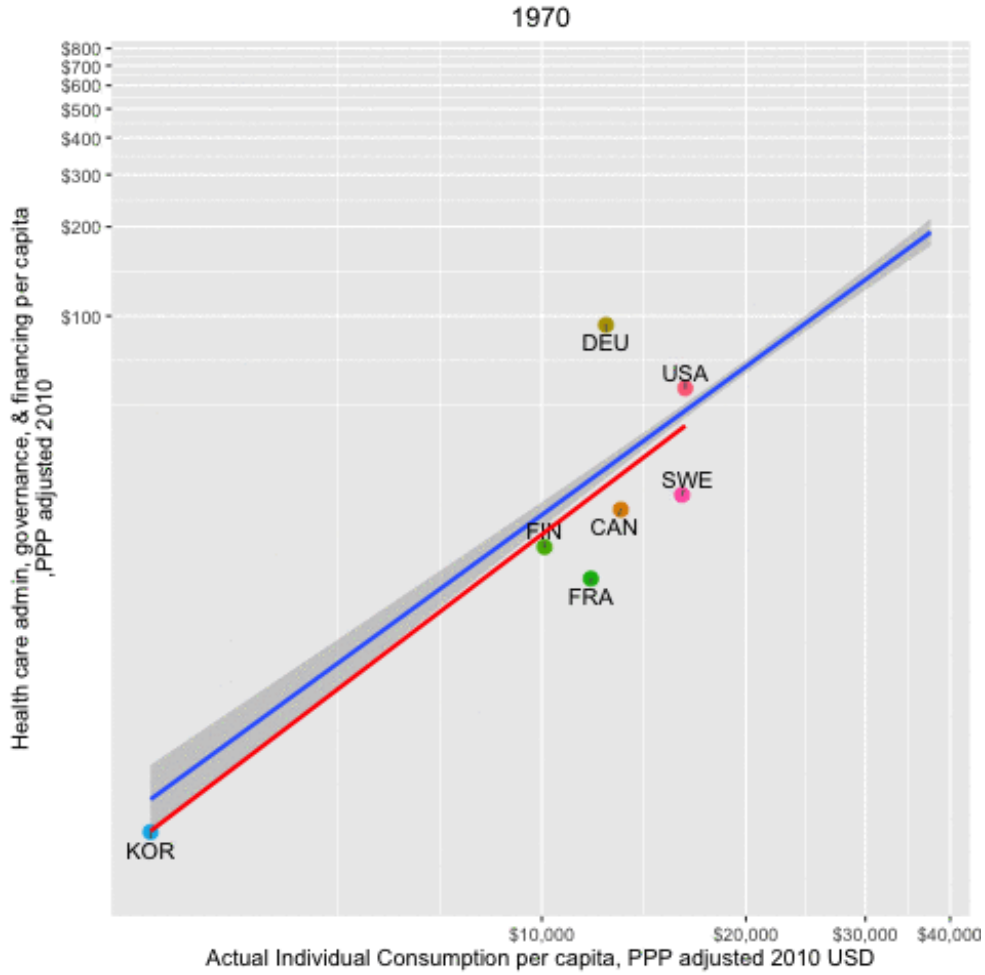
A further optional split at the third-digit level is proposed by public and private financing schemes.

Administration of private health insurance essentially means the health insurance service and the service charge[43] for this. This covers expenditure on sales, enrolment and policy service, claim adjudication, actuarial functions, legal support services, investment functions, corporate overheads and risk charges.

For public agencies it is expected to also involve the administrative costs of Federal, State and local government health programmes.

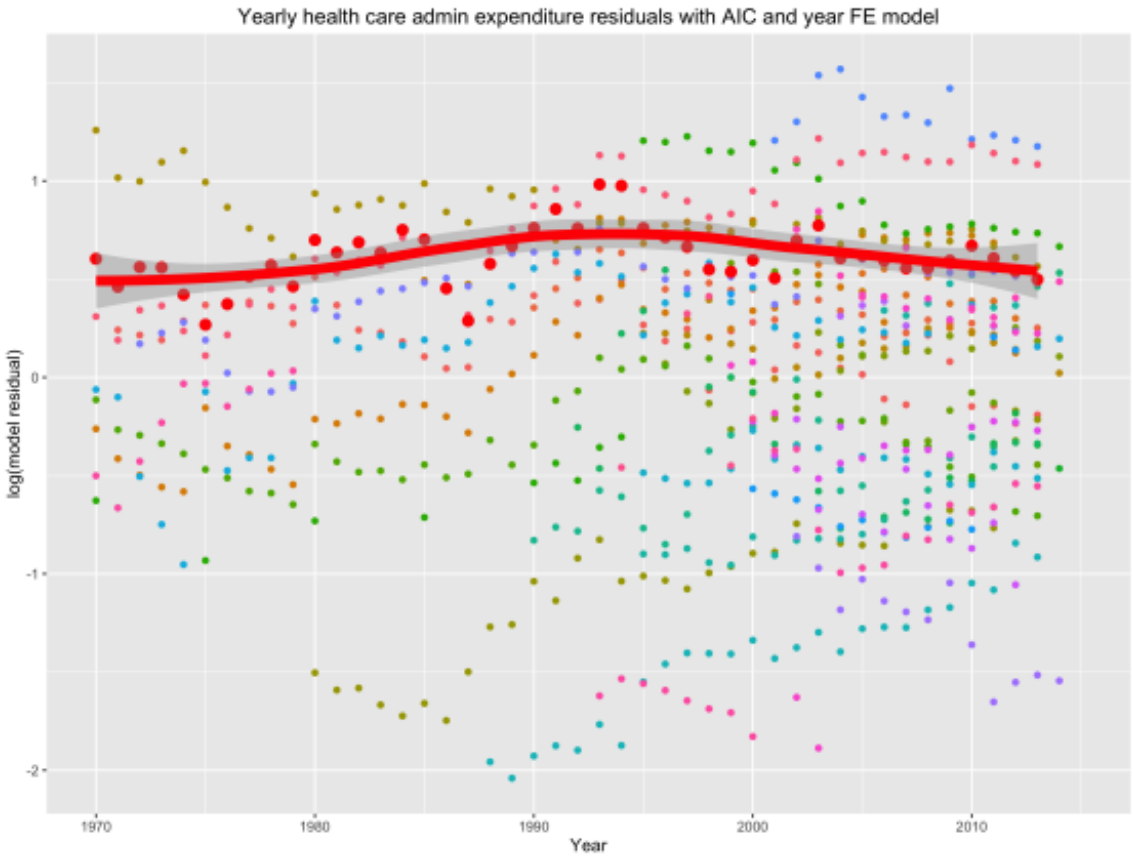
Excludes: the administrative costs of the health providers and the health care goods and services they provide. Also excluded are the opportunity costs of paperwork for consumers and the associated general revenue tax collection.

source

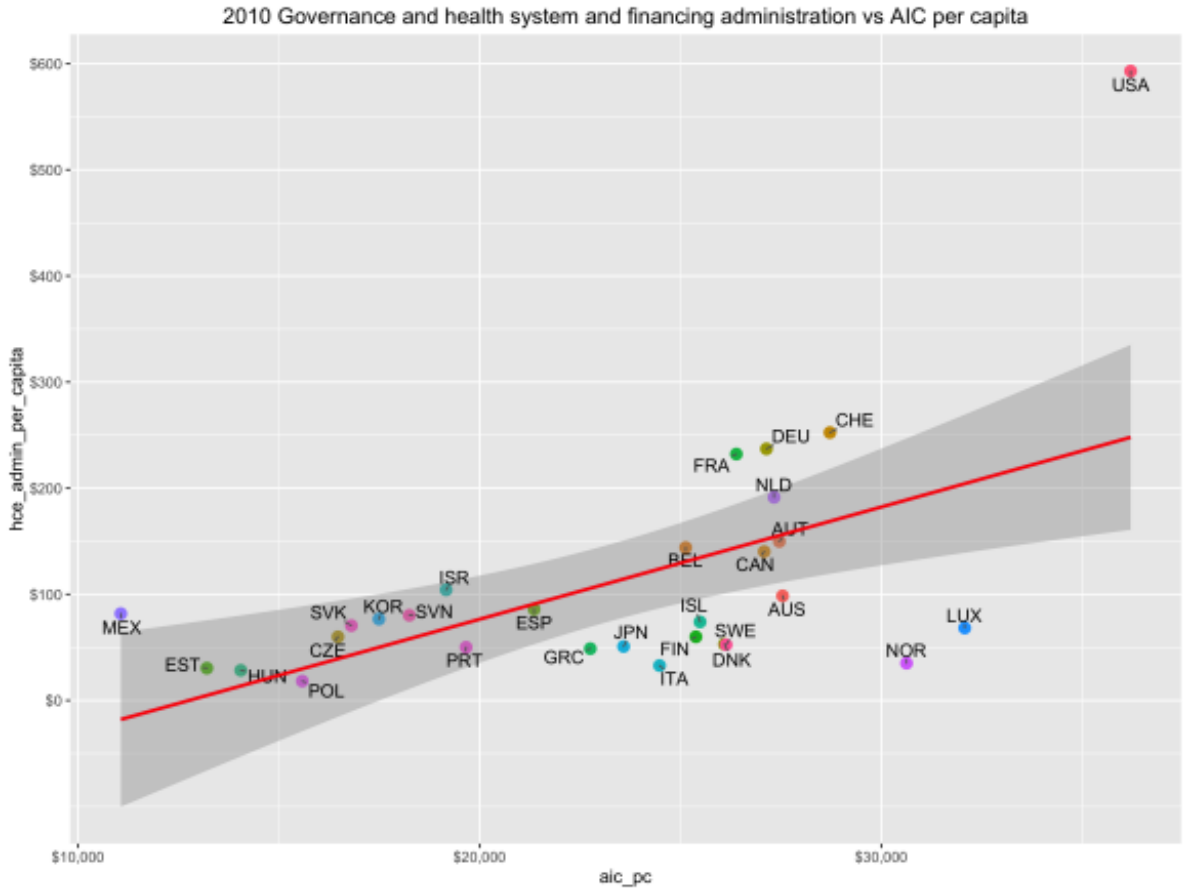


	Dependent variable:	
	log(hce_admin_per_capita)	
	(1)	(2)
log(aic_pc)	1.695***	1.659***
	(0.078)	(0.068)
Constant	−12.704***	−12.219***
	(0.773)	(0.666)
Year FE?	Yes	No
Observations	730	730
R^2	0.462	0.453
Adjusted R^2	0.427	0.452
Residual Std. Error	0.727 (df = 684)	0.710 (df = 728)
F Statistic	13.053*** (df = 45; 684)	603.243*** (df = 1; 728)
Note:		*p<0.1; **p<0.05; ***p<0.01

These log-log residuals appear to be fairly stable over ~30 years:



Of course on a linear plot this looks more extreme:



But it's worth pointing out that (1) roughly 50% of US admin expenditures are attributed to the public, not private sector and (2) the actual dollar amount differences are pretty small in the scheme of things. Long story short, **our complex reimbursement system simply cannot explain much here** (especially not of the large *apparent* delta based off GDP per capita alone…. most of which, as I've been arguing, is well explained by AIC).
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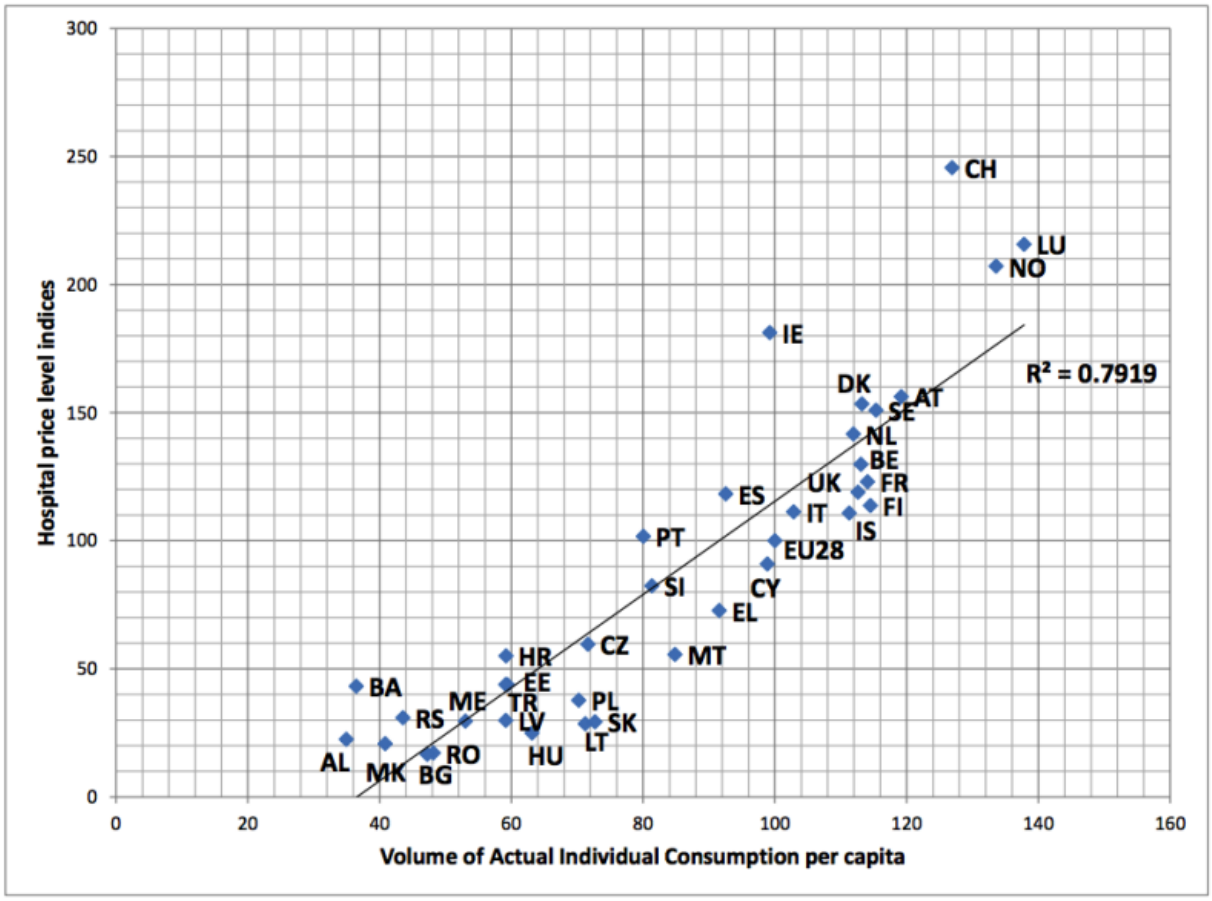
US price levels well explained by AIC

Though it is true that hospital expenditures drive a very large fraction of healthcare costs in the United States and that US hospital costs, according to most sources, are well above average this, too, is very well explained by Actual Individual Consumption (AIC).

Some OECD affiliated researchers recently studied healthcare-wide and hospital-specific price levels using both input (as in, labor cost, supplies, etc) and output methods (as in, average cost to do procedure X) comparing apples-t0-apples (as in, same procedures, treatments, etc) as best they could and discovered that, lo and behold, AIC per capita explains most of the variance in price levels internationally.

Figure 2. Comparison of price level indices for hospital services and volume of Actual Individual Consumption per capita, 2011, EU28=100



Source: 2013 Eurostat/OECD Hospitals PPPs Survey; OECD Purchasing Power Parities Statistics 2013

source

These “price level” indices here are defined as the ratio between health-specific PPPs, weighted for country-specific consumption patterns, divided by the exchange rate scaled relative to the mean for 28 EU countries. In their words:

The survey also collects data on the number of cases recorded for each case type. Multiplying the average quasi-prices by the corresponding case numbers provides each case type with a value. These case type values can be summed across case types to give a total value for all case types with which the individual case type values can be converted into percentage shares. The percentage shares are used as weights when calculating PPPs for hospital services.[11]

PPPs for hospital services were first compiled for the 37 countries which could report quasi-prices and weights according to the agreed methodology and PPPs for the ten remaining countries were estimated according to the input approach. The methodology used to calculate PPPs can be found in Chapter 7 of the Eurostat-OECD PPP Manual (Eurostat, OECD 2012).

PPPs were then used to derive price level indices (PLIs). PLIs are the ratios of PPPs to exchange rates. The average PLI of the group of 28 EU Member States was calculated as the weighted average of the PLIs of the different countries (with total expenditure on hospitals as weights). This average was then set to equal 100 and each country's PLI expressed in relation to it. PLIs provide a measure of the difference in price levels between countries by indicating—for a given category or aggregate—the number of units of the common currency needed to buy the same volume of the category or aggregate. Price levels depend on exchange rates and maybe subject to large variations in line with exchange rate swings and should therefore be interpreted with caution.

This method isn't without some limitations, but it's nonetheless a good indicator of relative costs. We can clearly see that there is a very strong relationship between how wealthy a country is (particularly when measured with AIC) and what we can expect the same procedure to cost as compared to other countries.

They also found that countries with high economy-wide (GDP) price level indices (PLIs) have even higher health specific PLIs. In other words, health and economy-wide PLIs are positively correlated and health PLIs rise faster than GDP PLIs.

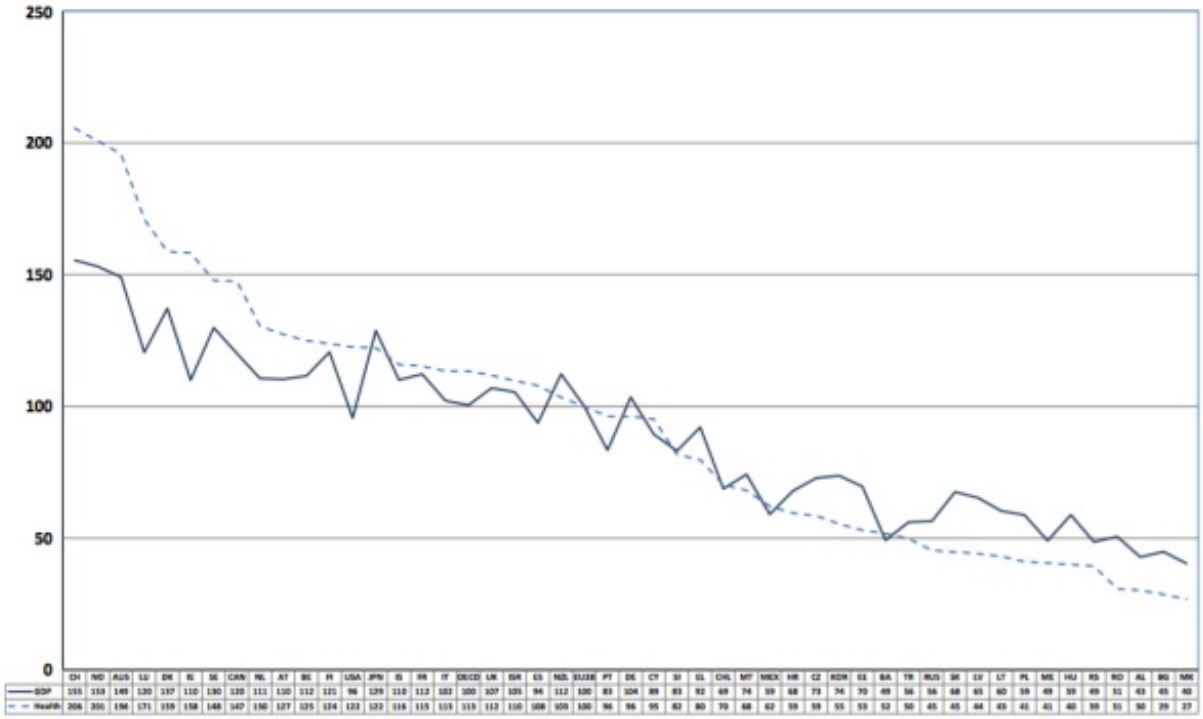


Fig. 7 Comparison of price levels indices for GDP and health, 2011, EU28 = 100

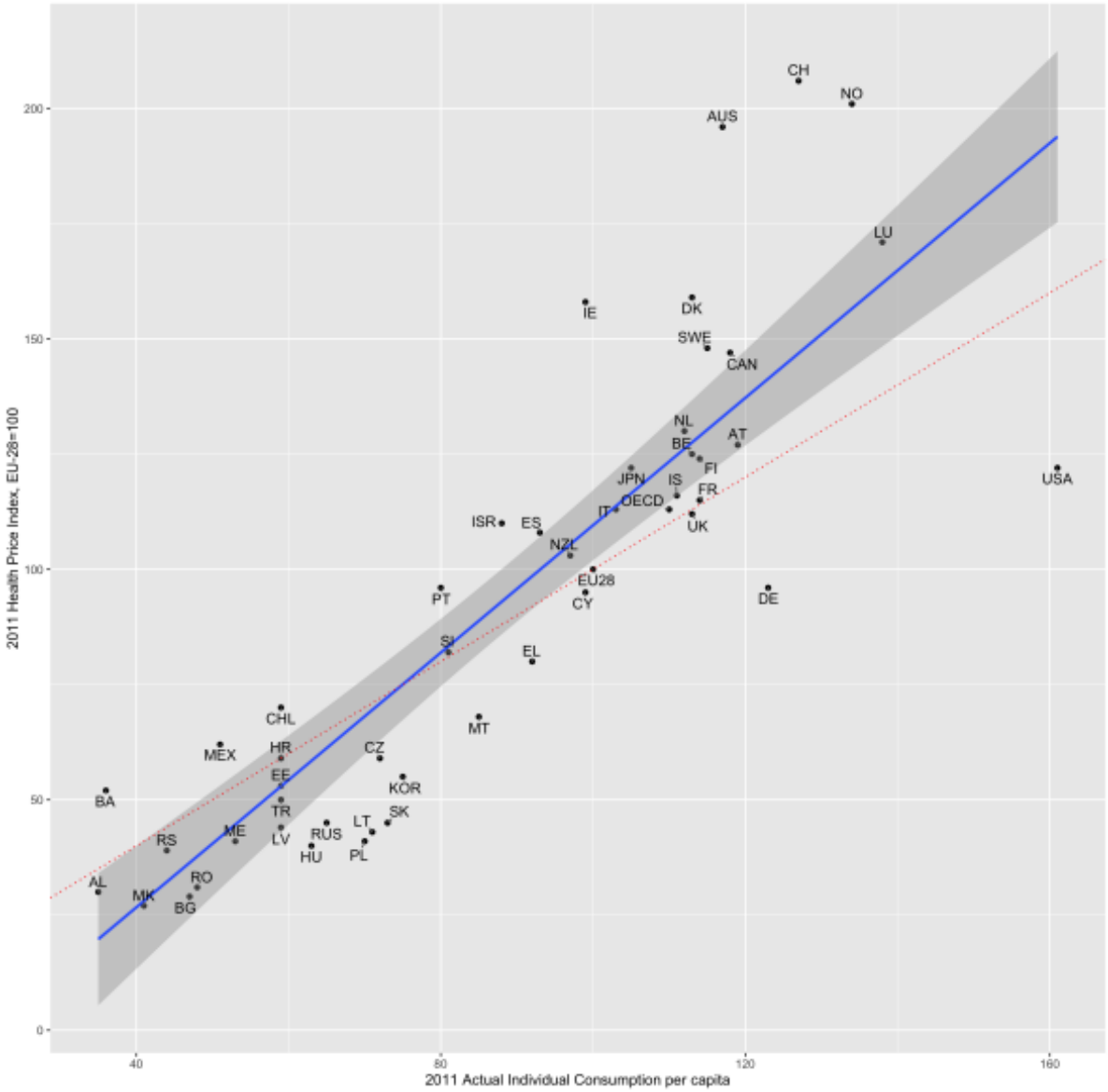
For example, while Switzerland (top) is 55% higher than EU-28 in GDP PLIs it's 106%

higher in health PLIs whereas Macedonia (bottom) is 60% less than EU-28 in GDP terms it's 73% lower in health PLIs.

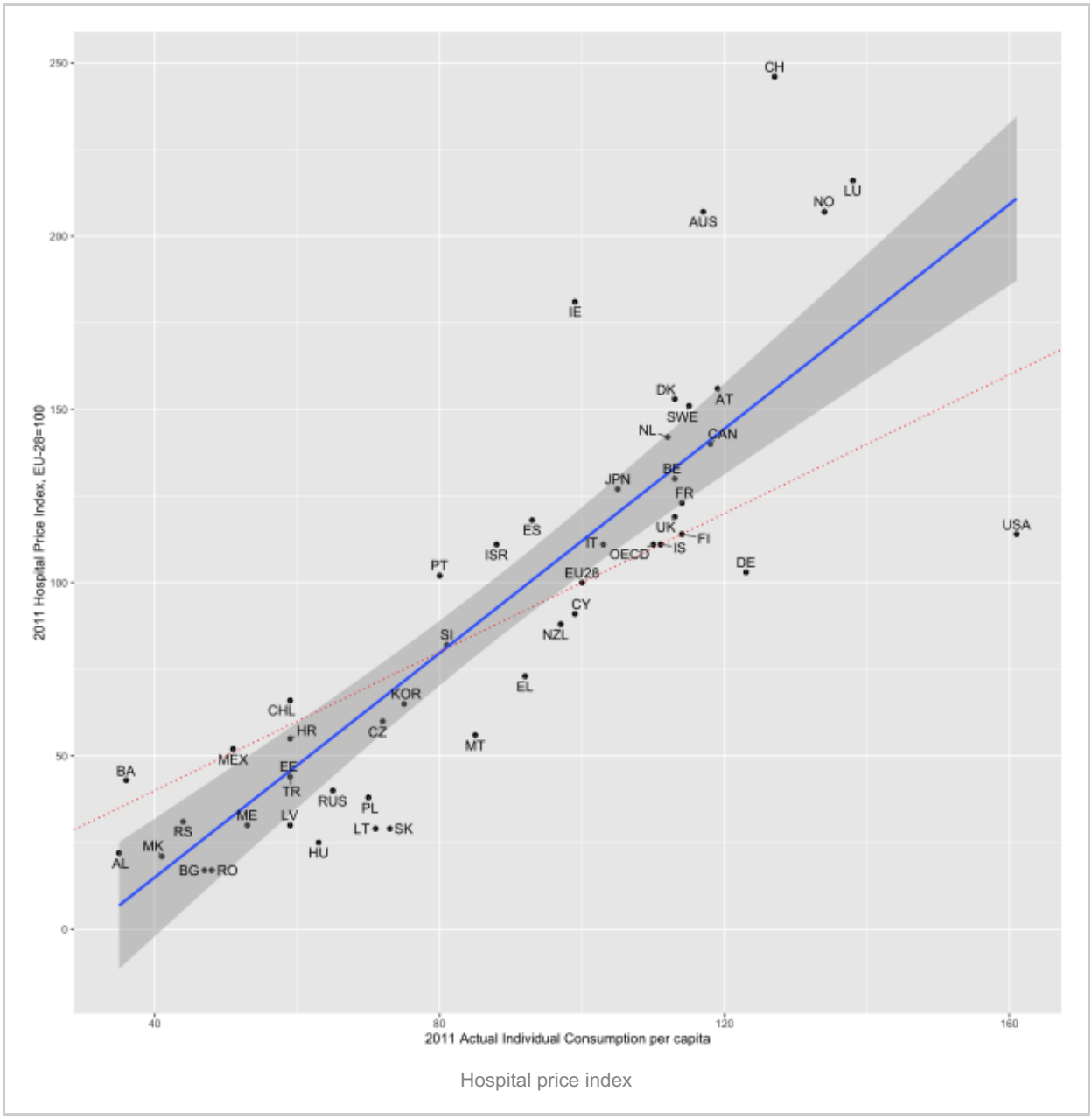
This much should be unsurprising to people that think about the issues carefully. Of course healthcare productivity can't match productivity in, say, manufacturing, agriculture, etc.

They actually find that US is just *slightly* above EU-28 mean in both healthcare-wide and hospital-specific PLIs, 122 and 114 respectively, and that derived volume is *twice as high as EU-28* (i.e., price levels substantially *less* and volume substantially *more* given AIC per capita).

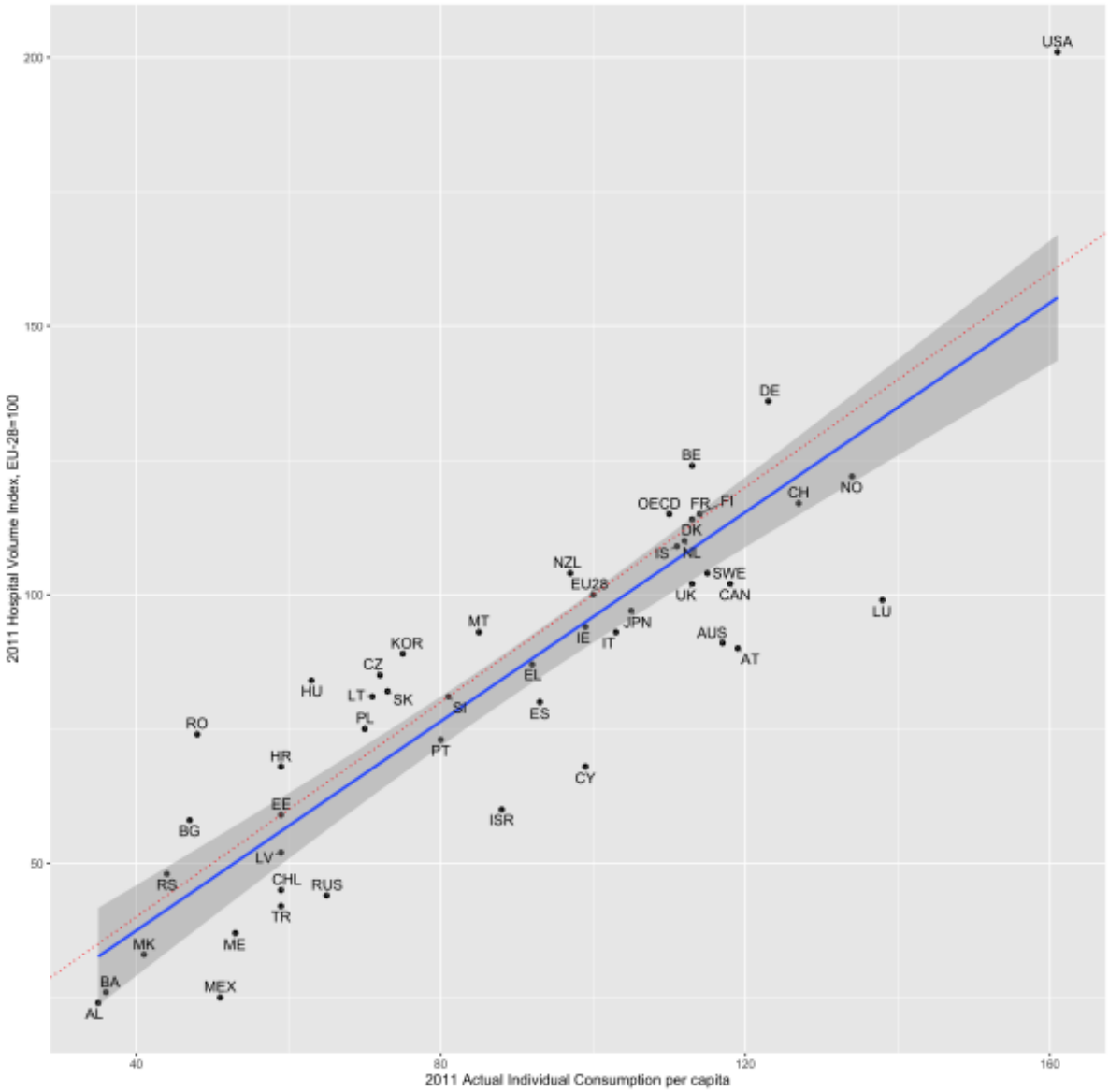
I do not want to hang my hat on this, but I'll briefly plot these from their own data for completeness (For now, I am more interested in establishing the strength of the relationship between health system price levels and wealth for now).



Health system wide price index



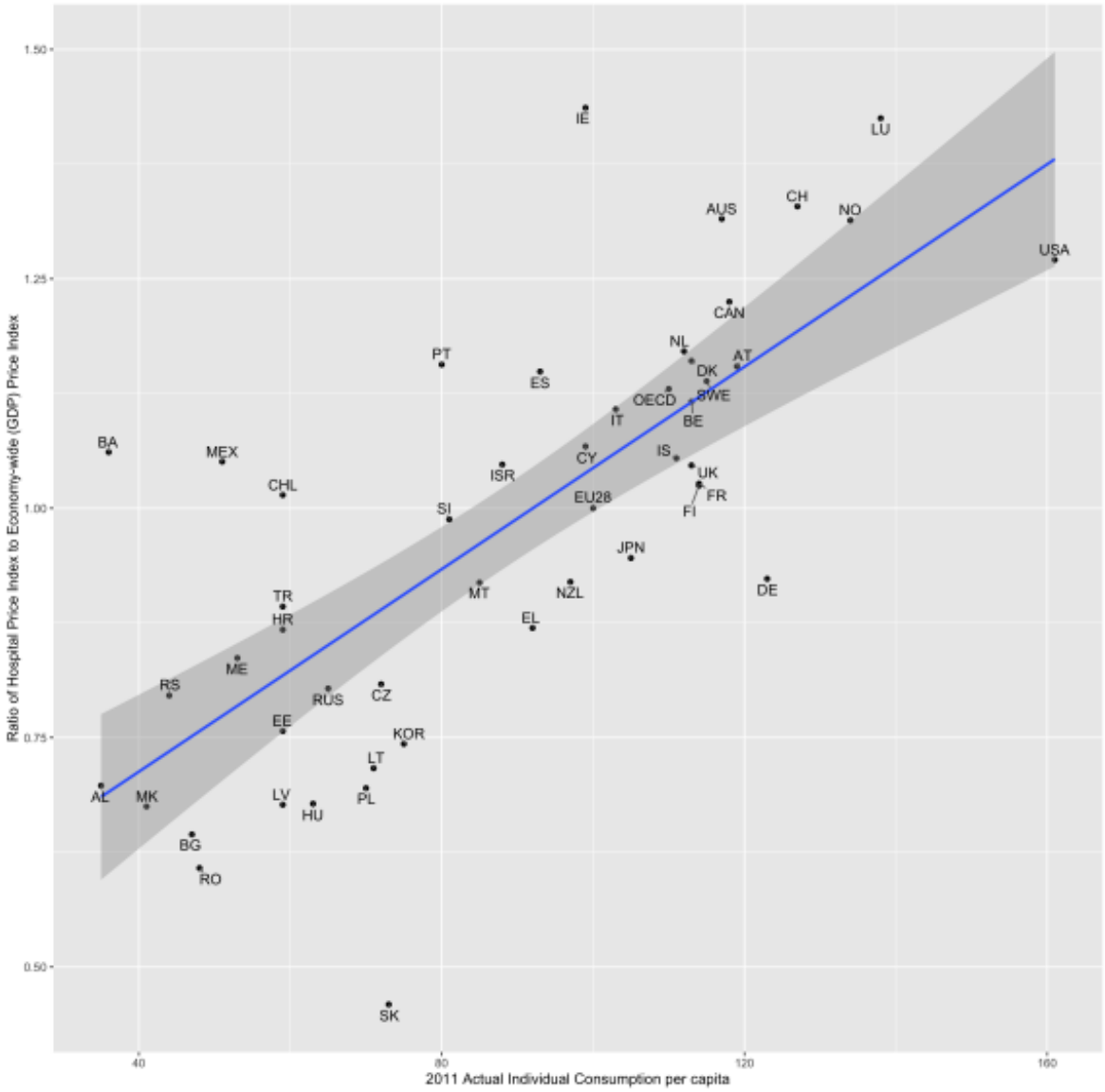
Hospital price index



Volume Index (derived from health expenditures and price levels)

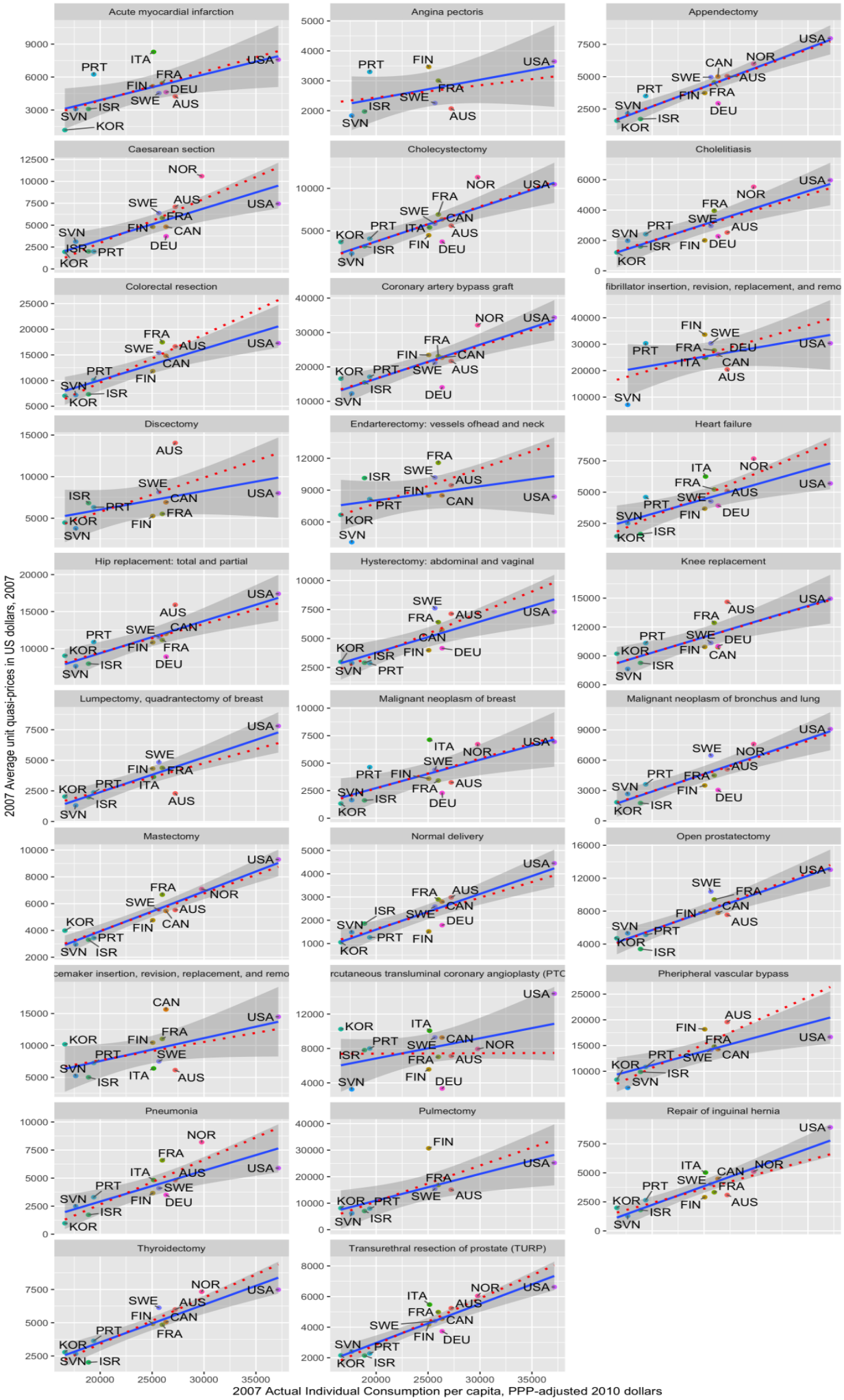
The plot above (volume) strongly suggests that **the volume of health goods and services is much higher in the United States.** This data argues pretty strongly against the popular notion that it's prices that drive US health care expenditures (presumably due to lack of market power on part of payers) above trend, i.e., this data suggests costs are actually below what you'd expect with AIC and volume significantly above what you'd expect with AIC (*note: it would also help explain why US spends more than average on administrative costs*).

I also calculated the ratio between the health price index level and the GDP price index level:



This tends to suggest that health care is relatively more expensive, as compared to other goods and services in the same economy, in countries with higher material standards of living and, assuming this particular US data is reasonably correct, US doesn't look like it costs more than you'd expect relative to AIC per capita. However, even if the US data is wrong, the methodology used is still sound and the relationship between AIC and price levels are very strong, ergo **we should expect, ceteris paribus, US prices to be much higher than the modal EU country**.

Now let's look at some specific hospital pricing cost against AIC per capita:


Acute myocardial infarction
Angina pectoris
Appendectomy
Caesarean section
Cholecystectomy
Cholelitiasis
Colorectal resection
Coronary artery bypass graft
fibrillator insertion, revision, replacement, and remo
Discectomy
Endarterectomy: vessels ofhead and neck
Heart failure
Hip replacement: total and partial
Hysterectomy: abdominal and vaginal
Knee replacement
Lumpectomy, quadrantectomy of breast
Malignant neoplasm of breast
Malignant neoplasm of bronchus and lung
Mastectomy
Normal delivery
Open prostatectomy
cemaker insertion, revision, replacement, and remo
rcutaneous transluminal coronary angioplasty (PTC
Pheripheral vascular bypass
Pneumonia
Pulmectomy
Repair of inguinal hernia
Thyroidectomy
Transurethral resection of prostate (TURP)
2007 Average unit quasi-prices in US dollars, 2007
2007 Actual Individual Consumption per capita, PPP-adjusted 2010 dollars

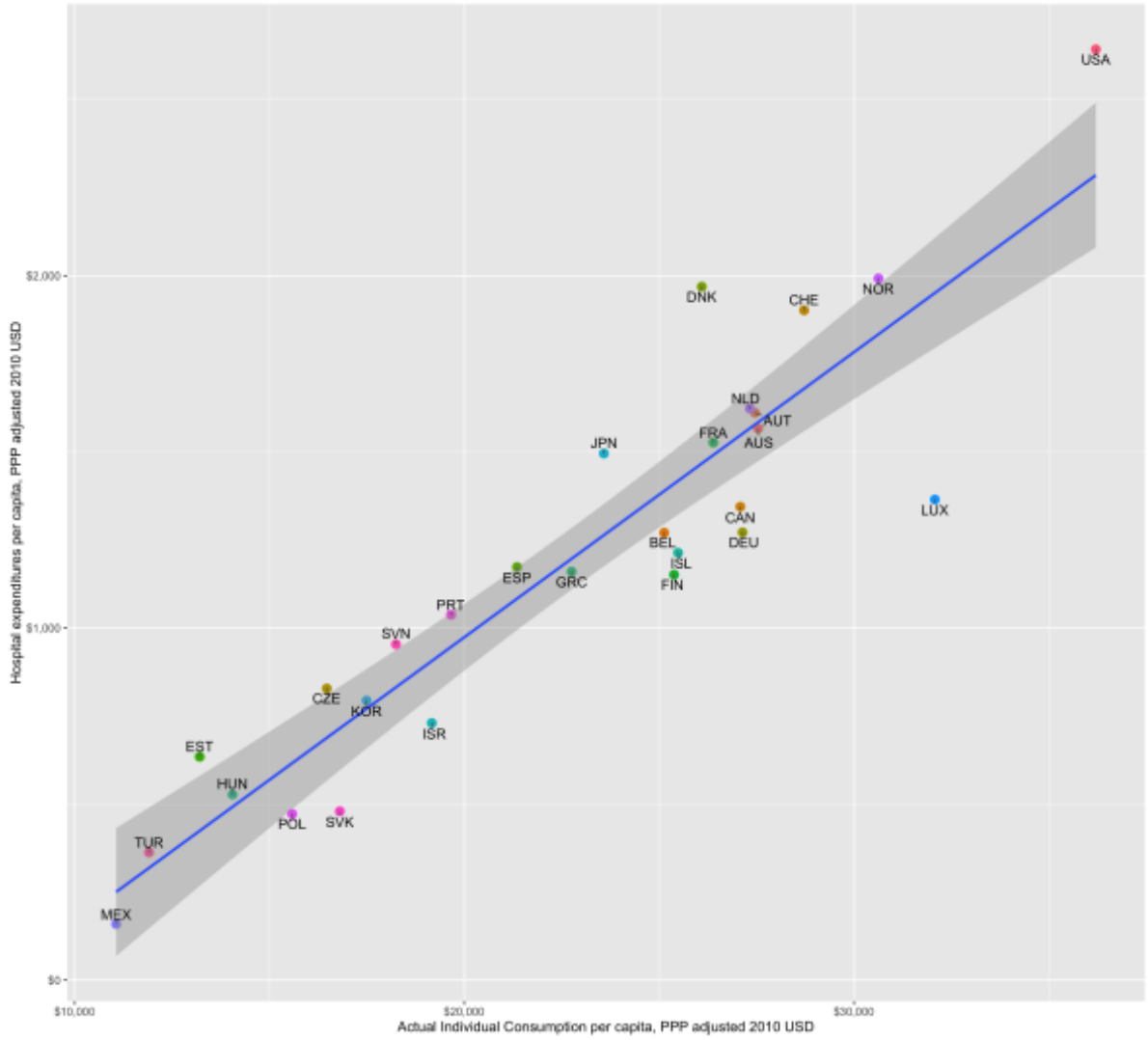
source

Note: The blue line is the trend line including US, the shaded area the confidence interval, whereas the red line is the trend line excluding the US.

Although there can be no doubt that US is usually well into the high end of the price range, it's also abundantly clear in most plots that (1) (quasi)prices are well correlated with AIC per capita — even *excluding* the US (2) price levels in the US are not out of line with the trend (note the slope without USA is often steeper and US never significantly above trend).

Obviously I'd like more observations to make a tighter estimate, but if US costs were nearly as astronomical as they are thought to be this should stand out. **It simply does not**. This suggests that in approximately apples-to-apples comparisons US hospital prices are quite normal given our material standards of living (AIC per capita) even while being substantially higher than what you might expect in a more typical european country (with substantially lower material standards of living). *[Note: This does not necessarily mean that hospital visits or treating particular conditions aren't more expensive on average because the types of procedures, diagnostics, and various extras (e.g., private vs semi-private room) can certainly add to the overall cost]*

Furthermore, if we look at all expenditures per capita in the entire hospital sector, we find a **very strong relationship with AIC and that the US is generally well within normal range.** (Note: This includes inpatient, outpatient, etc under hospital umbrella)



2010 hospital expenditures per capita by 2010 AIC per capita

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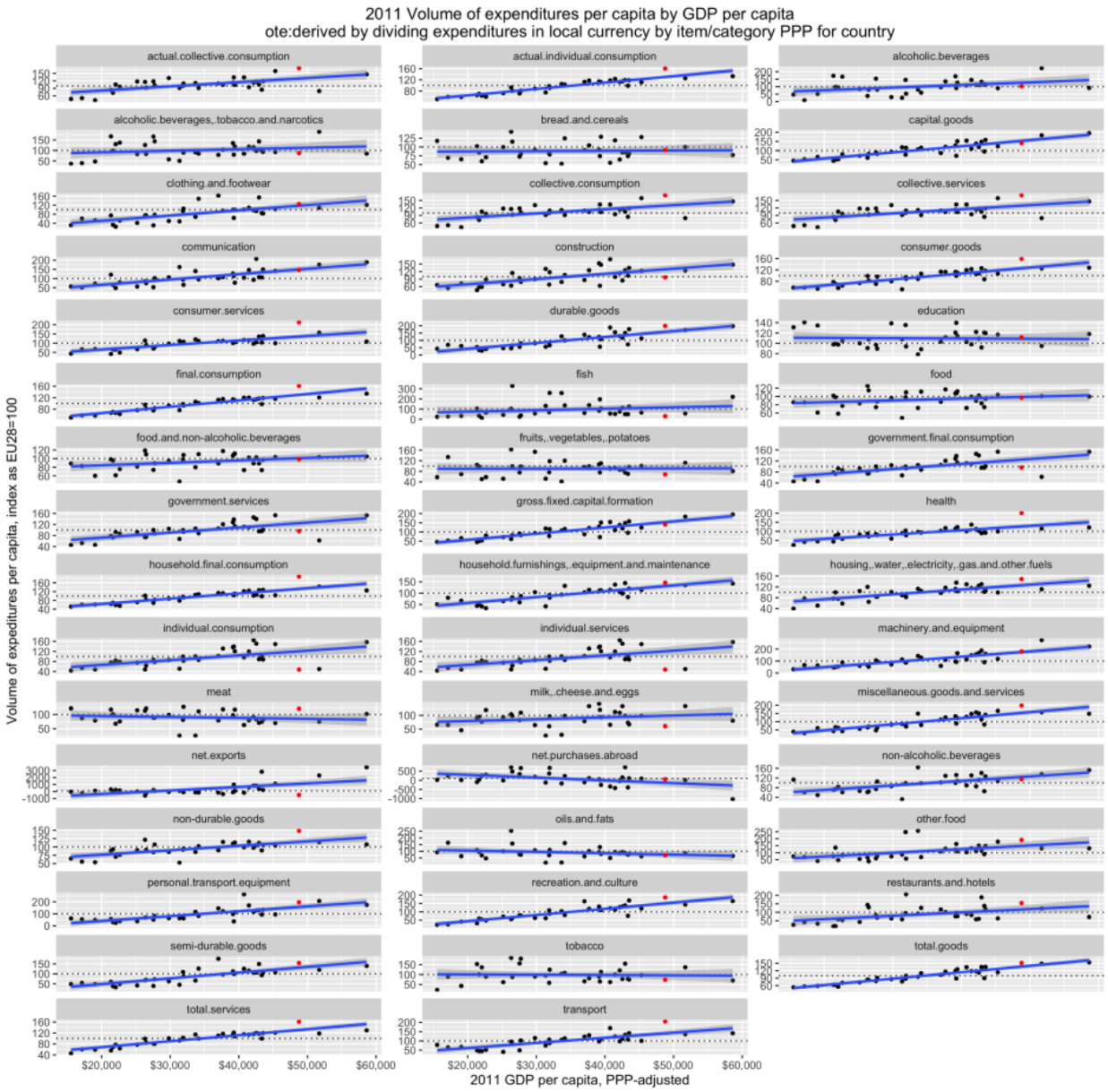
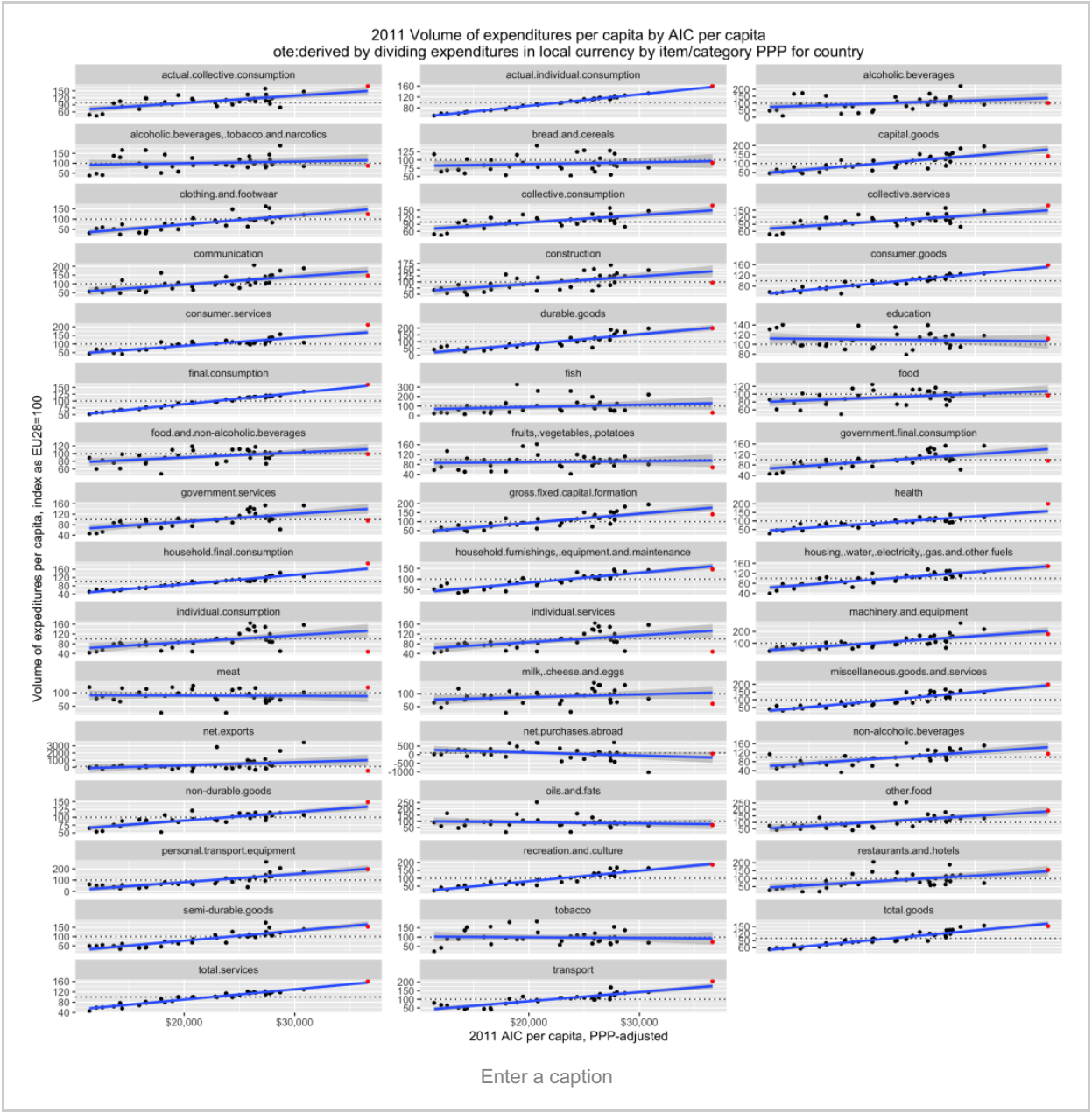
Comparison of volume of goods and services (PPP study)

Actually using the same volume derivation above, i.e., taking final expenditures by category from national accounts in local currency and dividing it by same item-specific PPPs, I can estimate the volume of goods and services consumed relative to the a common EU baseline (EU28=100).



As you can see above the US (the red dot) consumes substantially more in volume across several major categories, not just health and not just when those categories include health, e.g., actual collective consumption, transport, non durable goods, recreation and culture, restaurants, etc. Similarly, many countries that are below trend in health are also below trend in these other consumption categories (as in, amongst high exporters like Norway.

Similarly, we find AIC per capita correlates better with volume across most categories (or at least those that fall relatively squarely under the broad consumption umbrella like health care!)



Enter a caption

r-squared values for derived volume estimates per capita and (AIC|GDP) per capita					
Category	AIC	GDP	log-log AIC	log-log GDP	r-squared delta
non-durable.goods	0.65	0.46	0.63	0.49	0.19
household.final.consumption	0.92	0.74	0.95	0.82	0.18
consumer.goods	0.90	0.73	0.87	0.73	0.18
consumer.services	0.75	0.58	0.78	0.68	0.18
transport	0.77	0.61	0.70	0.59	0.17
health	0.76	0.61	0.76	0.72	0.15
semi-durable.goods	0.78	0.64	0.77	0.67	0.14
final.consumption	0.99	0.85	0.99	0.90	0.14
actual.individual.consumption	0.99	0.85	0.99	0.90	0.14
housing,.water,.electricity,.gas.and.other.fuels	0.71	0.58	0.71	0.63	0.13
clothing.and.footwear	0.60	0.47	0.62	0.53	0.12
total.services	0.94	0.82	0.93	0.88	0.12
household.furnishings,.equipment.and.mainter	0.79	0.69	0.73	0.62	0.10
food.and.non-alcoholic.beverages	0.22	0.12	0.23	0.12	0.09
other.food	0.36	0.26	0.45	0.38	0.09
restaurants.and.hotels	0.30	0.21	0.45	0.39	0.09
recreation.and.culture	0.88	0.79	0.88	0.85	0.09
food	0.14	0.07	0.17	0.08	0.08
collective.services	0.46	0.39	0.50	0.47	0.07
collective.consumption	0.46	0.39	0.50	0.47	0.07
actual.collective.consumption	0.46	0.39	0.50	0.47	0.07
miscellaneous.goods.and.services	0.82	0.76	0.83	0.81	0.06
durable.goods	0.76	0.70	0.71	0.67	0.06
personal.transport.equipment	0.62	0.58	0.63	0.58	0.05
non-alcoholic.beverages	0.43	0.39	0.40	0.32	0.04
bread.and.cereals	0.02	0.00	0.03	0.00	0.02
total.goods	0.87	0.86	0.90	0.88	0.01
fruits,.vegetables,.potatoes	0.01	0.00	0.04	0.01	0.01
education	0.01	0.00	0.01	0.01	0.01
tobacco	0.00	0.00	0.02	0.02	0.00
fish	0.04	0.04	0.17	0.16	(0.00)
milk,.cheese.and.eggs	0.05	0.06	0.05	0.05	(0.01)
meat	0.00	0.02	0.00	0.01	(0.02)
alcoholic.beverages,.tobacco.and.narcotics	0.02	0.04	0.10	0.13	(0.02)
oils.and.fats	0.02	0.06	0.00	0.02	(0.04)
alcoholic.beverages	0.11	0.15	0.18	0.22	(0.04)
government.final.consumption	0.41	0.46	0.50	0.52	(0.05)
government.services	0.41	0.46	0.50	0.52	(0.05)
individual.services	0.25	0.33	0.27	0.33	(0.08)
individual.consumption	0.25	0.33	0.27	0.33	(0.08)
net.purchases.abroad	0.09	0.19			(0.10)
construction	0.35	0.46	0.40	0.51	(0.10)
communication	0.45	0.55	0.50	0.57	(0.11)
gross.fixed.capital.formation	0.63	0.78	0.67	0.79	(0.15)
capital.goods	0.63	0.78	0.67	0.79	(0.15)
machinery.and.equipment	0.54	0.70	0.60	0.72	(0.15)
net.exports	0.09	0.35	0.38	0.51	(0.26)

This is mostly as I would expect. You might note:

1. PPP-adjusted AIC per capita can explain most of the variance in consumption volume in most categories
2. Differences in category/item specific price levels appear to cause relatively little incremental variance, i.e., most price levels are fairly well correlated within countries
3. Health appears to correlate similarly to several other major consumption categories in volume at least
4. Wealth explains little of the volume differences amongst these relatively rich OECD economies in food, education, alcohol, etc
5. GDP is generally better correlated with the non-consumption categories under the GDP expenditure method (exports, fixed capital, etc)
6. AIC significantly outperforms GDP as a predictor of consumption *volume* across multiple categories (*not just healthcare!!*).

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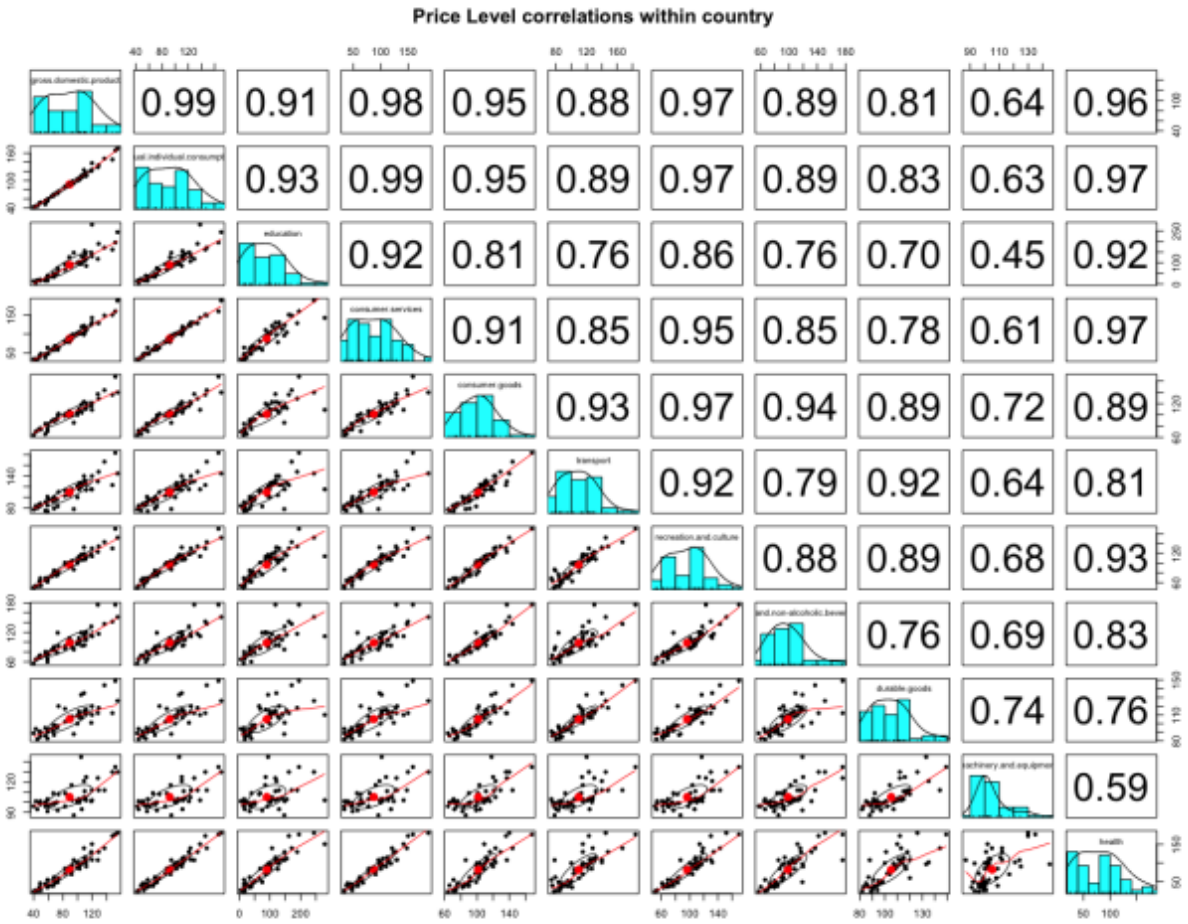
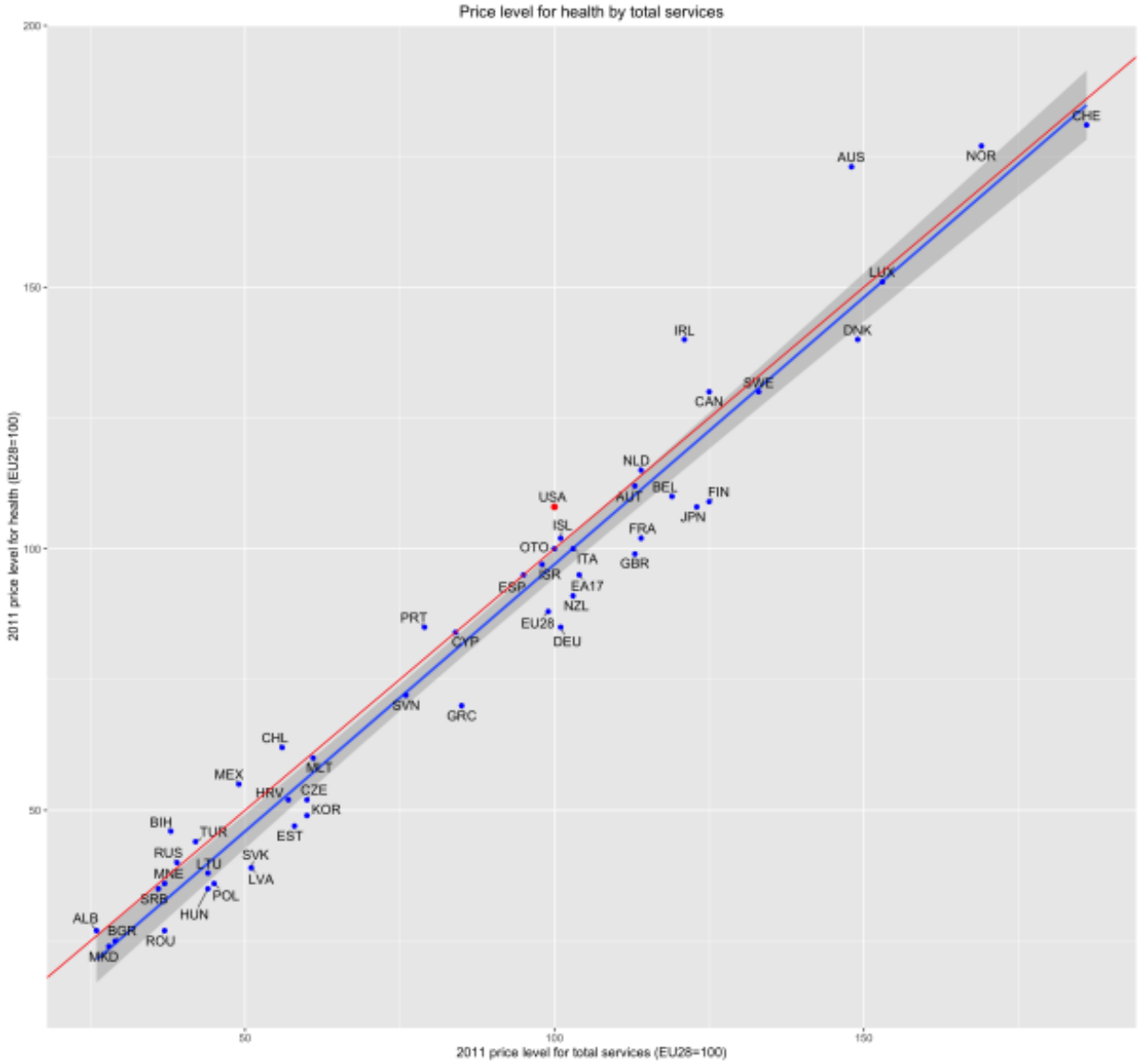
Comparison of multiple price levels

Again using the 2011 OECD Purchasing Price Parity study data, we can see that price levels are strongly correlated within a country. If you know the (broad) price level for GDP or AIC, you can pretty well predict the price level for health care with good accuracy (or at least the price level as carefully determined by these OECD researchers!). The GDP and AIC PPP estimates explain about 92% of the variance in health price levels.

Failing that, a reasonably broad measure of service price levels will get you pretty close too (hint: it will certainly more closely predict domestic price levels than, say, tradable goods).

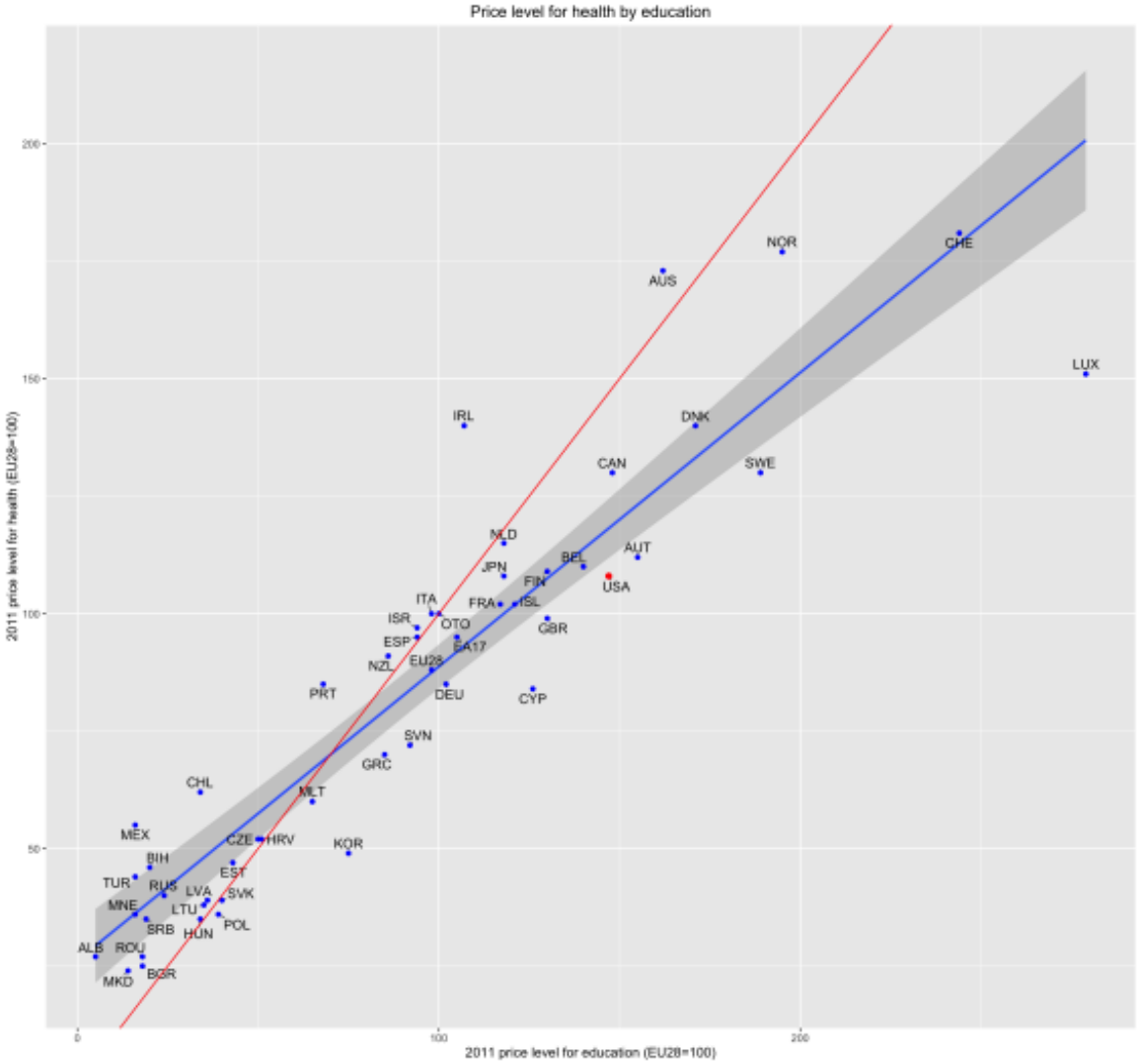


So, what I'm trying to say is, if you have a good PPP adjusted measure of material living conditions (as in AIC), the specific health price level data won't tell you *that* much that you didn't already know. That is not to say that there are not differences in price levels; there are, but they're already quite well reflected in national price level measures.

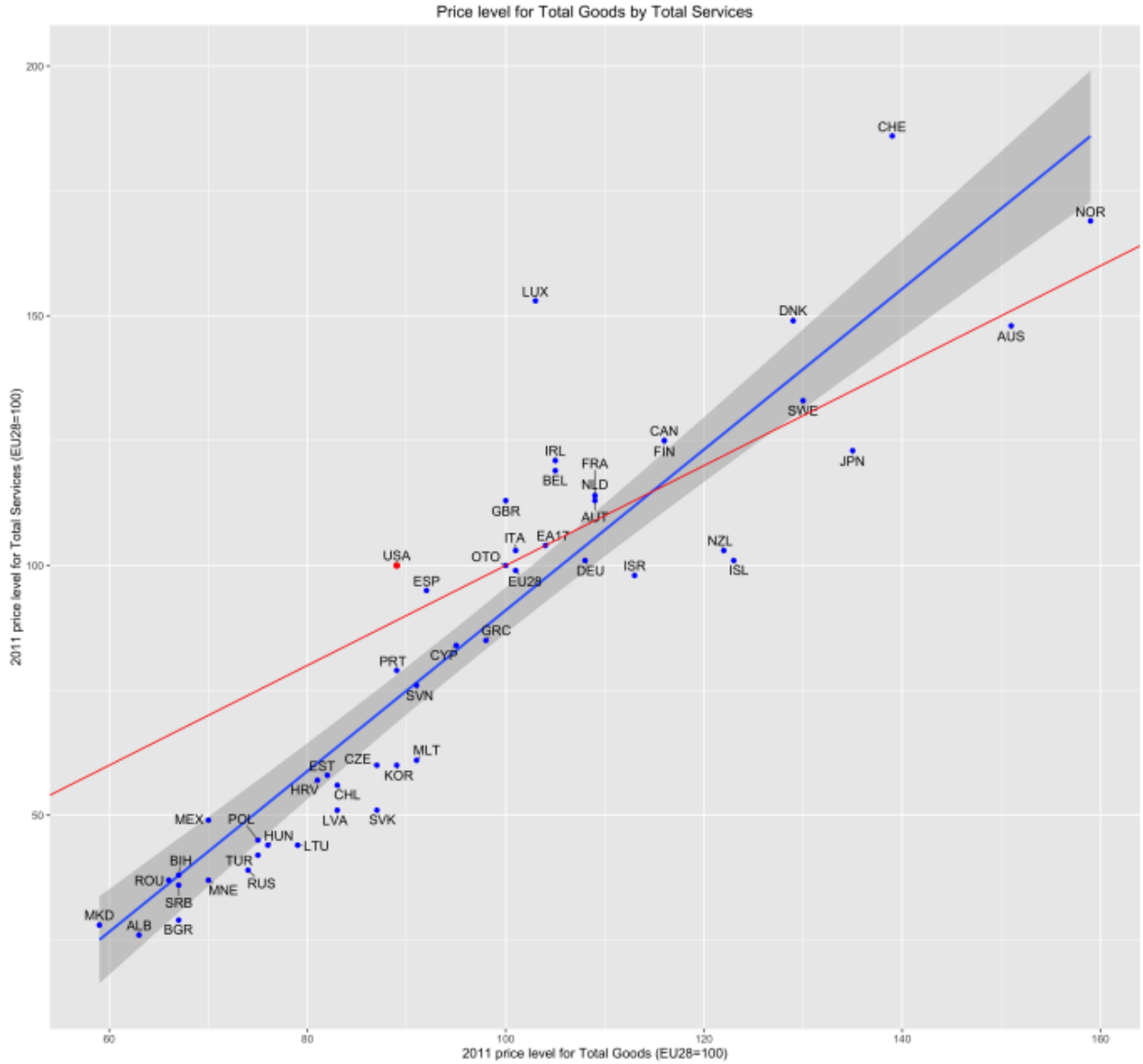


Note: The red line is set to intercept=0 and slope=1 so that if price levels track roughly 1:1 the regression line should roughly correspond to it.

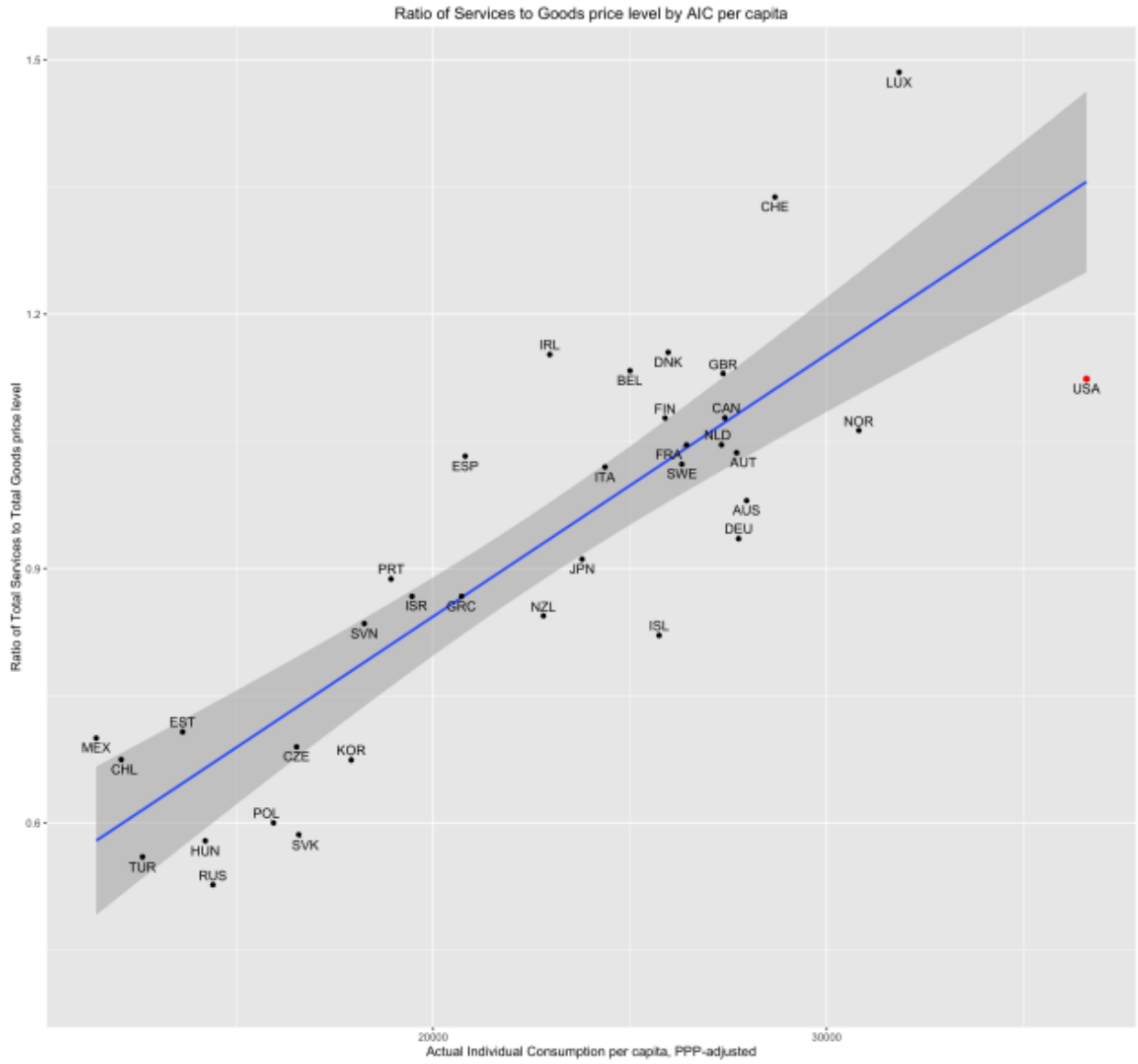
You'll even find a decent correlation if you compare another heavily service driven expenditure like education.



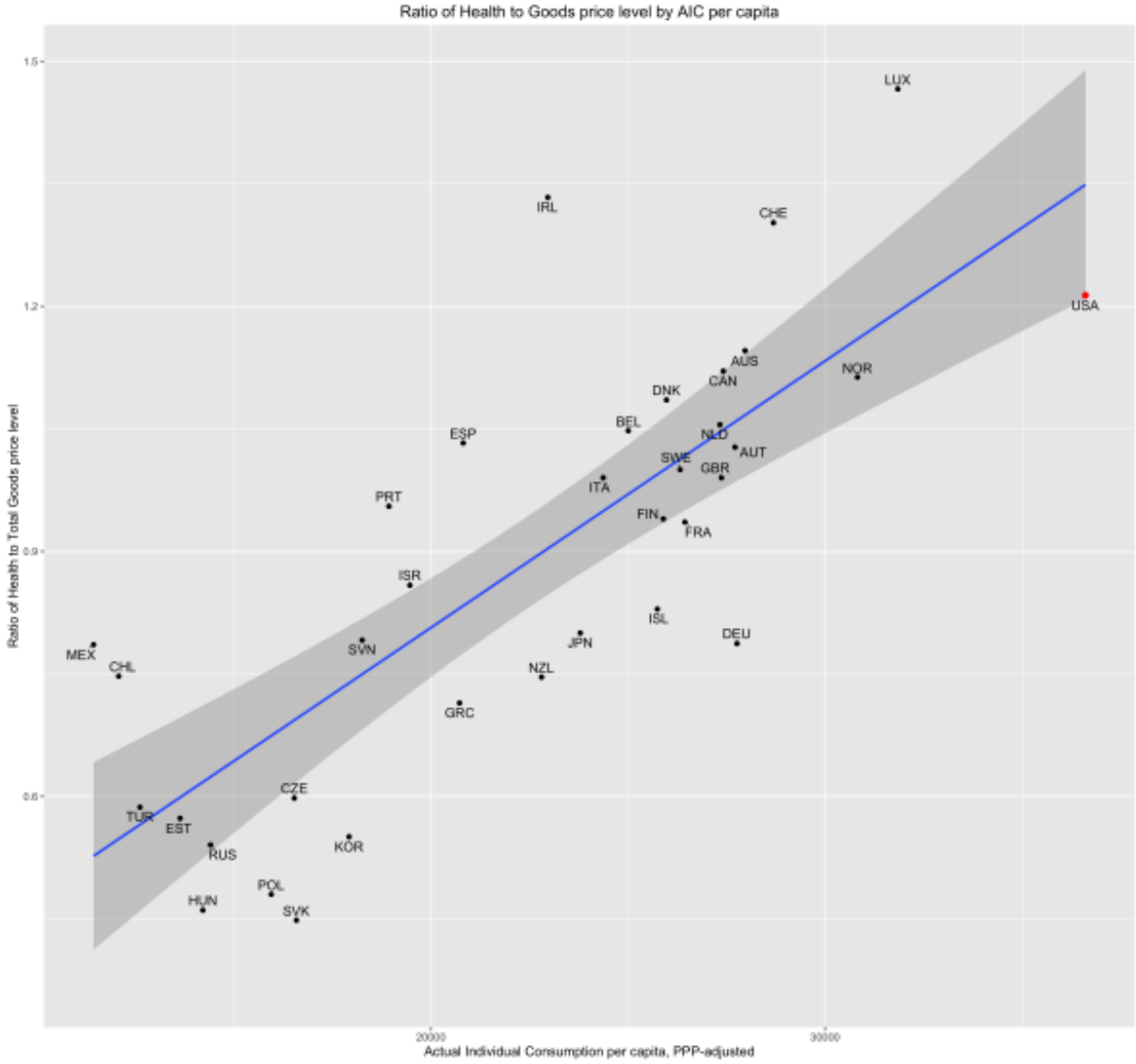
Countries with high price levels for services tends to have high price levels for goods too, but these tend to rise and fall at significantly different rates.



In other words, the price level of services tends to increase faster than price levels of goods in rich countries with respect to wealth. However, while the United States has a relatively high price level ratio, it's actually on the low side relative to its AIC.



Health price level ratio looks much the same!



In short, the other price level data seems to accord quite well with the health price level data. **This tends to support the view that this isn't being driven by apples-to-apples higher costs or, at least, not beyond that which you would expect given good measures of wealth.** We may pay more for *some particular* goods and particular services (e.g., particular prescription drugs still on patent), but on average the best data suggests that we simply don't pay appreciably real higher prices than you'd expect. Most likely the residuals I identified are better explained by higher volume (and/or consuming relatively more high cost services or services that simply aren't as readily available elsewhere).

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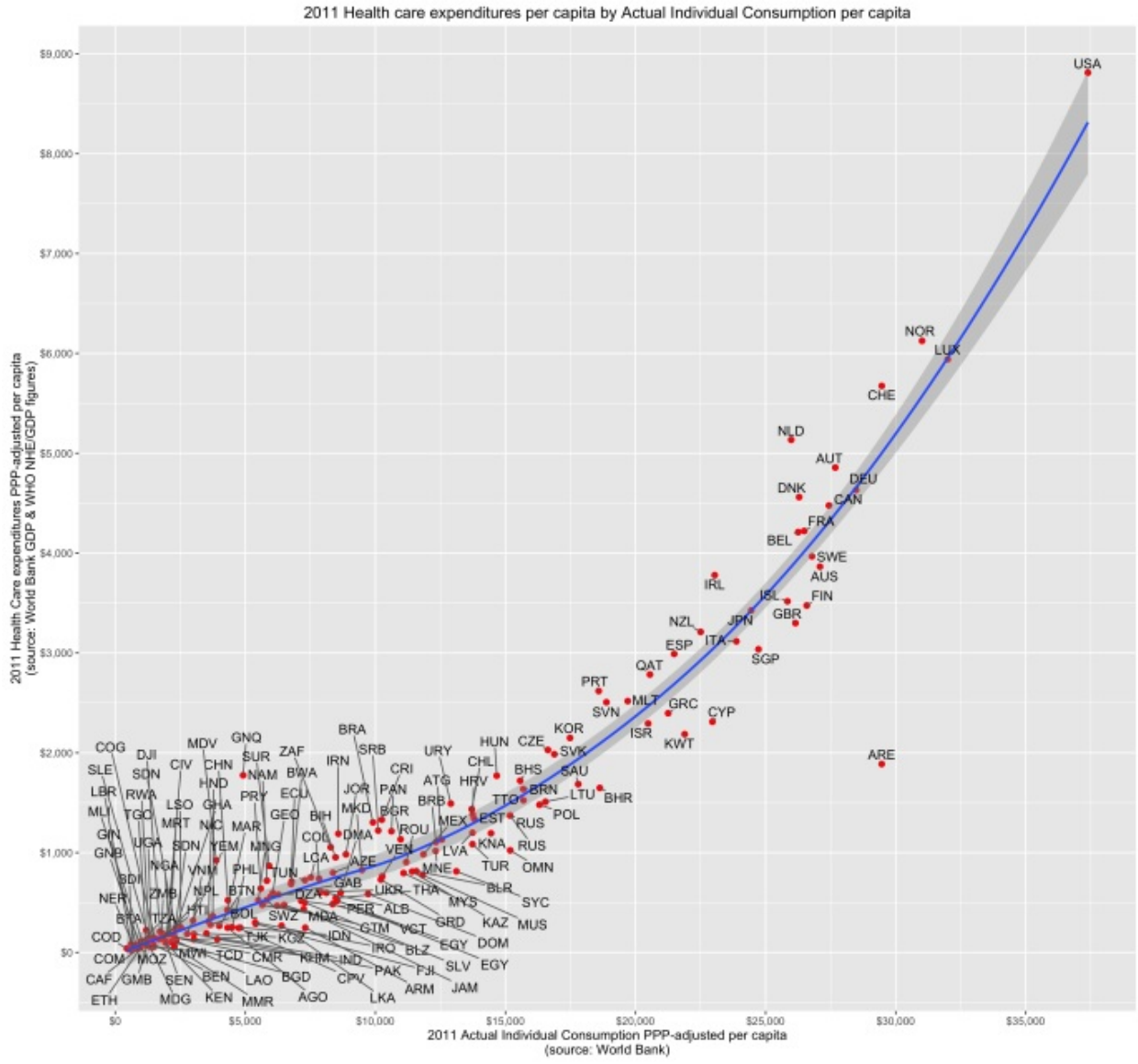
Even my models may overstate actual US excess

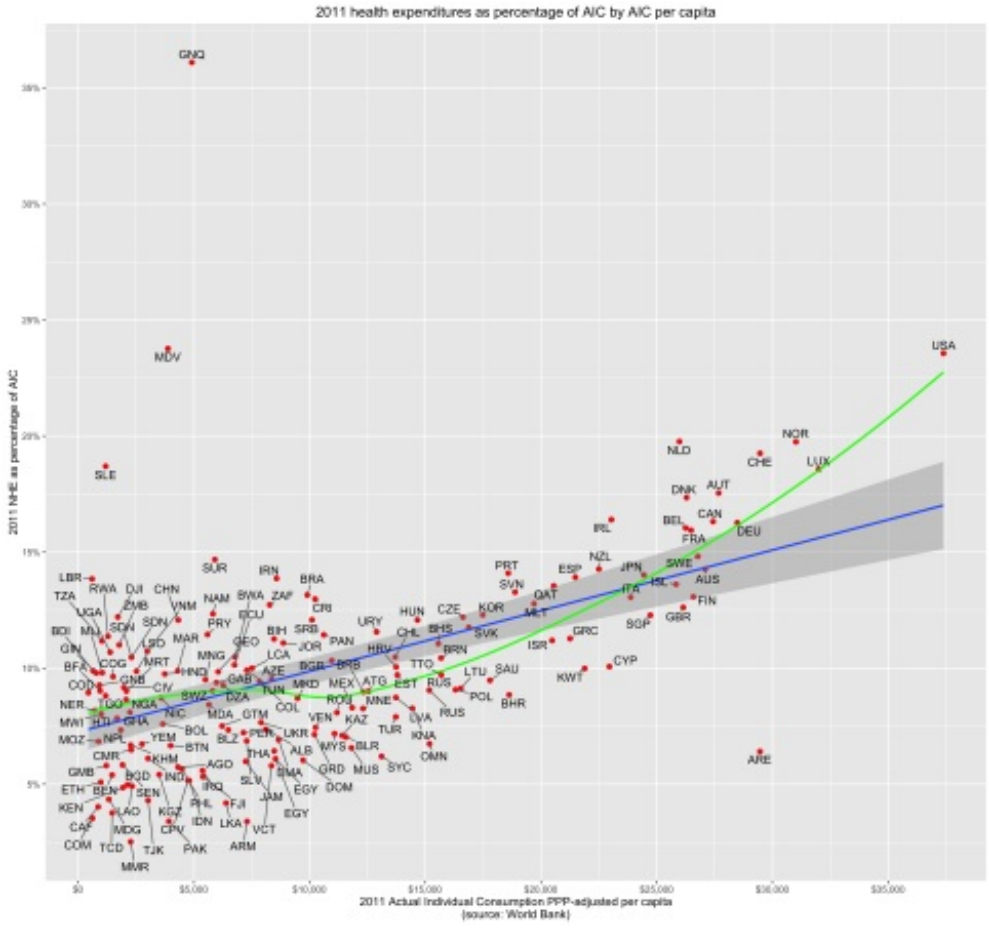
UPDATE (10/6/2016): See follow up post vis-a-vis non-linearity

In my earlier blog post I used many more observations from the WHO and WorldBank to analyze the data whereas throughout this analysis I focused on the handful of relatively rich countries for which OECD provides statistics (presumably better and more reliable data) over a period of several decades. It did strike me as pretty obvious at the time, even allowing for some error amongst poor countries, that there was a non-linear slope between NHE and AIC.

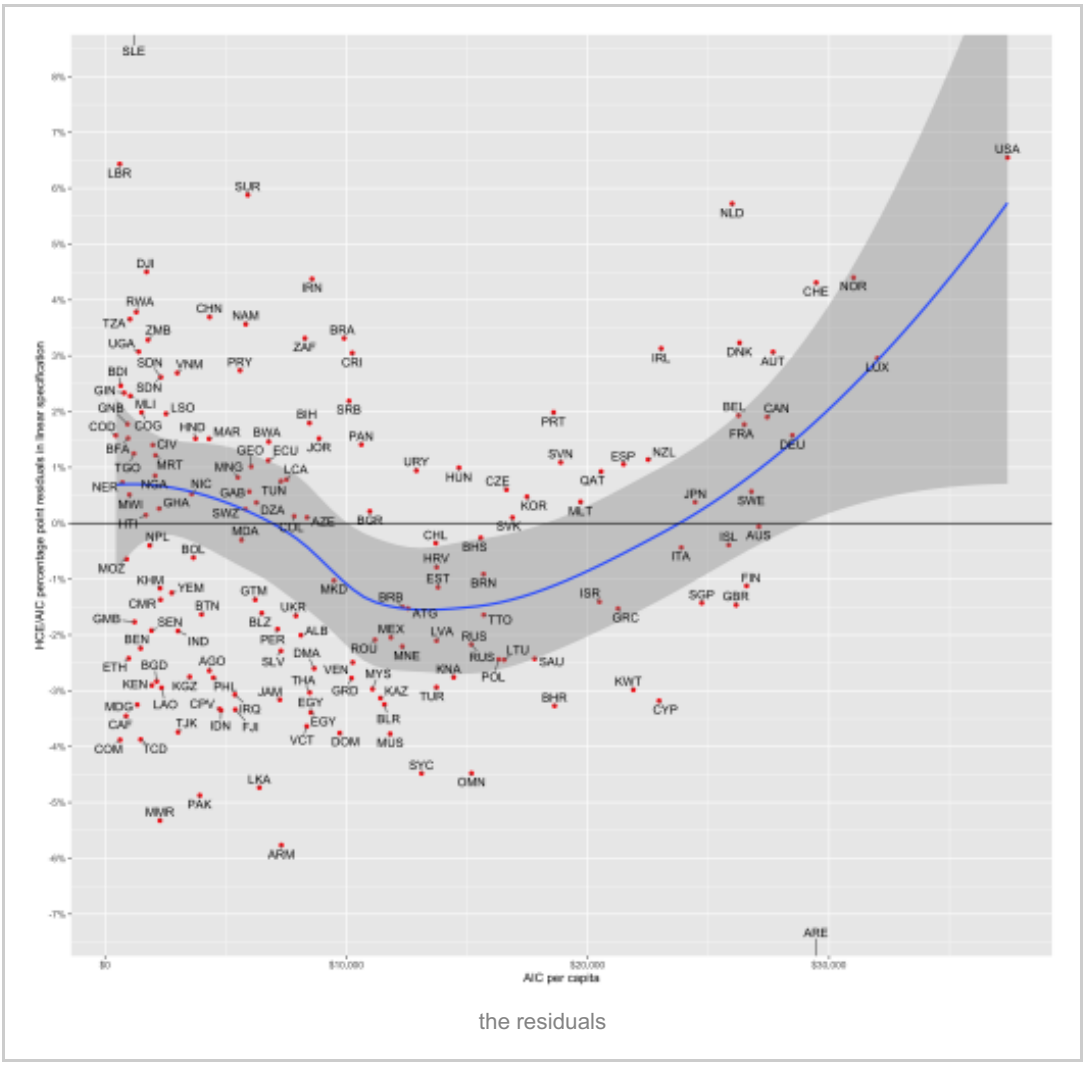
Re-plotting this data in R, it looks like this with the default loess regression line.



Alternatively if I run this as a percentage of AIC:



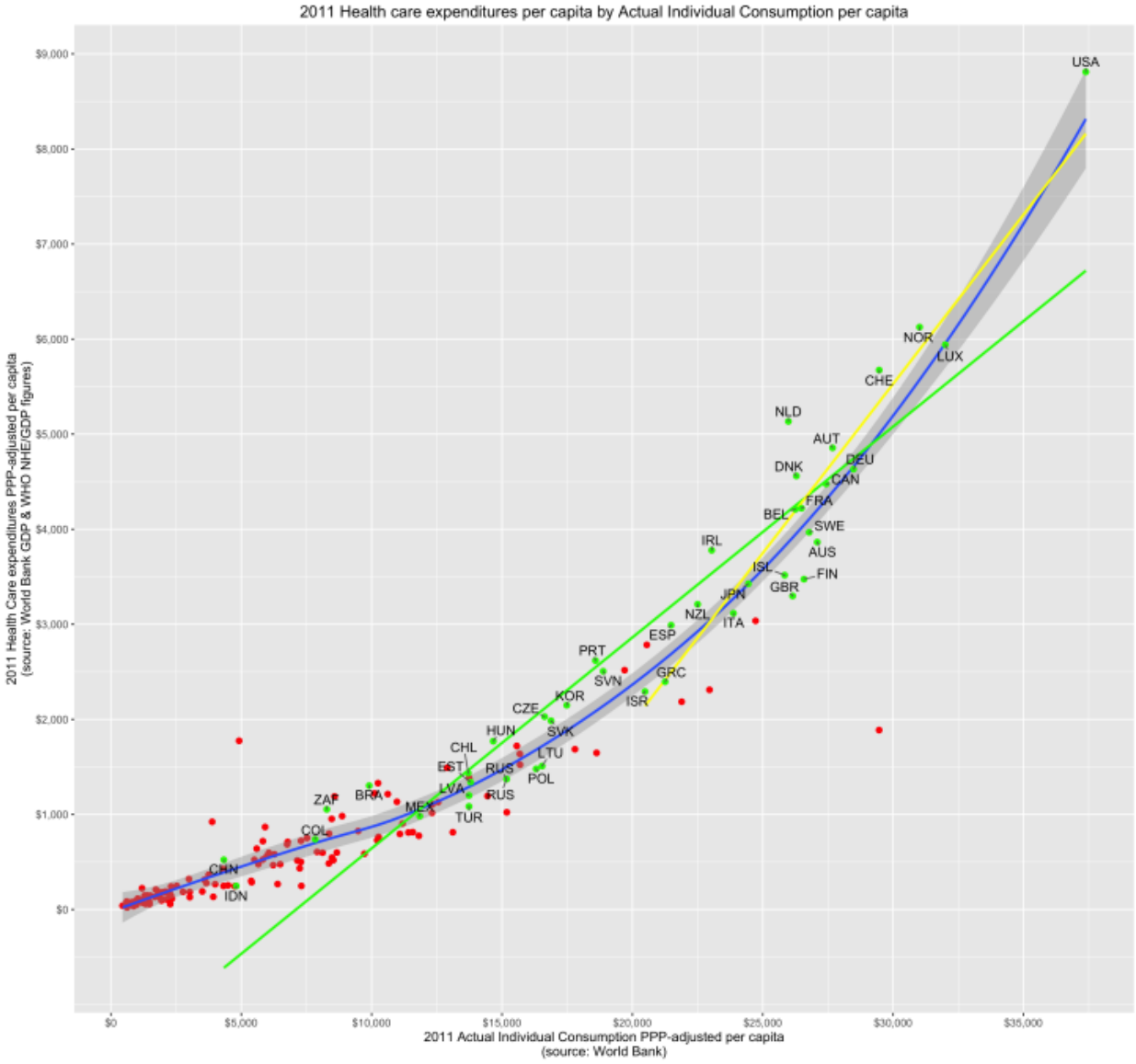
The green line is loess and the blue line is linear. It looks to me like most of the rich countries are significantly above the linear trend, middle income below, and poor slightly above — not really a very good fit.



the residuals

This is mostly beyond the scope of this argument, since even the various linear specification with AIC shows residuals much smaller than what is popularly accepted, but it seems likely this process is not entirely linear. If so the linear specification will tend to penalize the US, in particular, for being so far out on the right (high wealth). If it's not, then what does it mean when so many of these other presumably high functioning health care systems in wealthier parts of europe are *also* significantly above expectations? I don't think this can be explained by data quality issues or a few genuine outliers.

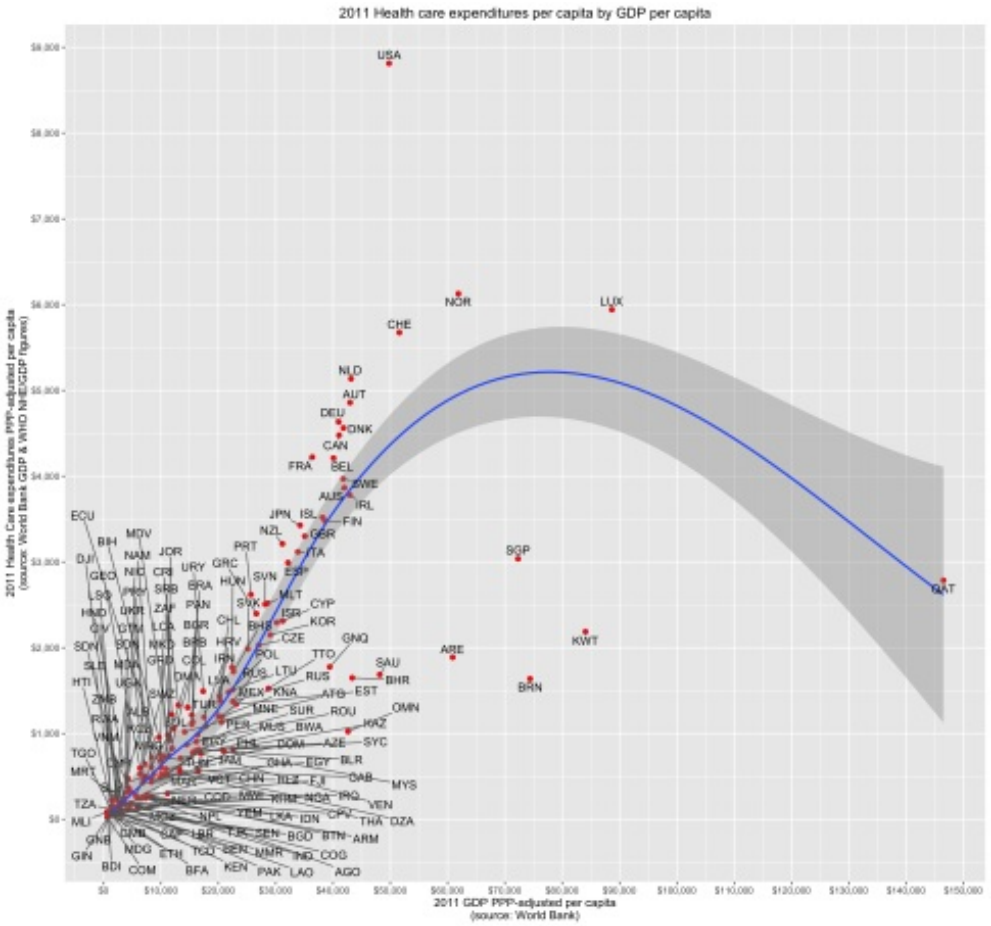
To get an idea for how significant this bias can might be, check out this out:



The green points, which are overlaid on top of red, are all of the data points contained in the OECD observations for 2011. The blue loess line is the entire data set (all WHO data which includes the entire OECD set), the green is the linear trend for the entire OECD set (all green points), and the yellow is the linear trend for the entire OECD set with AIC greater than $20,000. If the blue loess trend line is approximately the correct latent trend, you can see how this will downward bias the trend for rich countries and for very poor countries. Whereas the yellow line better approximates the trend for those countries with AIC expenditures greater than 20K (my models and their models certainly included countries with less wealth than that!)

Some non-linearity makes sense to me given the interaction between wealth and price levels and wealth and volume. That is to say if rich countries (1) consume more volume of health care goods and services and (2) their price levels for services like healthcare are significantly elevated as compared to other goods and services (especially tradable goods), I would expect to see some subtle non-linearity in these relationships.

Oh…. and yes, GDP still looks pretty terrible this way (FYI- all countries are the same in both sets)


2011 Health care expenditures per capita by GDP per capita
2011 Health Care expenditures PPP-adjusted per capita (source: World Bank GDP & WHO NHE/GDP figures)
2011 GDP PPP-adjusted per capita (source: World Bank)
USA
NOR
LUX
CHE
NLD
AUT
DEU
SWE
IRL
FIN
SGP
QAT
KWT
ARE
BRN
AUS
CAN
FRA
BEL
JPN
ISL
NZL
GBR
ITA
ESP
PRT
SVN
MLT
CYP
KOR
ISR
CZE
GNQ
SAU
BHR
OMN
KAZ
SYC
MYS
VEN
DZA
THA
ARM
ECU
BIH
MDV
DJI
NAM
JOR
URY
GRC
HUN
SVK
CHL
POL
TTO
RUS
LTU
MEX
KNA
ATG
EST
ROU
PER
BWA
AZE
BLR
EGY
GAB
IRQ
NGA
IDN
CPV
BGD
BTN
SEN
MMR
IND
COG
AGO
PAK
LAO
KEN
BFA
COM
BDI
ETH
MDG
GIN
GNB
MLI
TZA
MRT
TGO
HTI
ZMB
SWZ
LSO
SDN
SLB
$0
$10,000
$20,000
$30,000
$40,000
$50,000
$60,000
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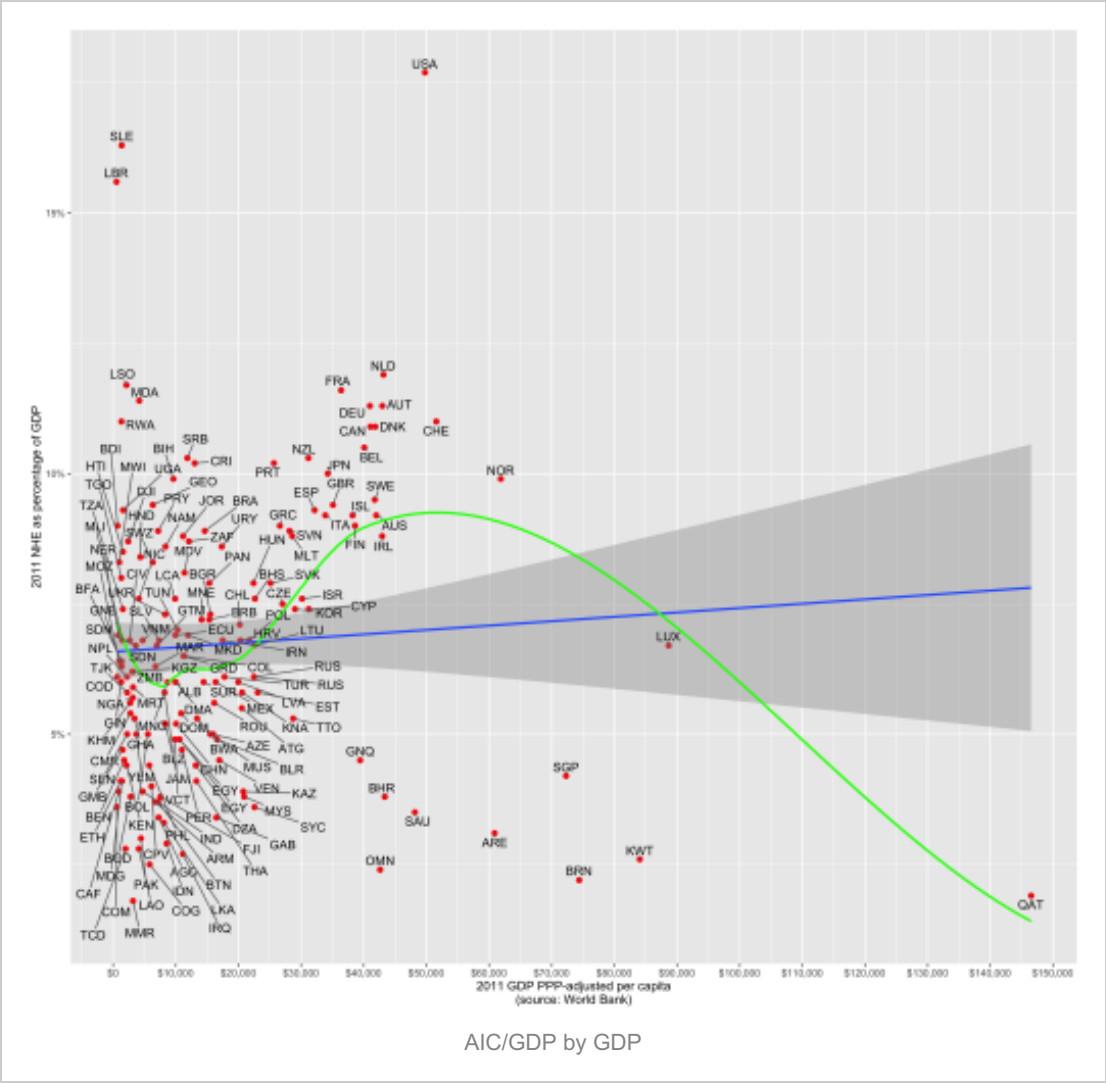
$120,000
$130,000
$140,000
$150,000

AIC by GDP



AIC/GDP by GDP

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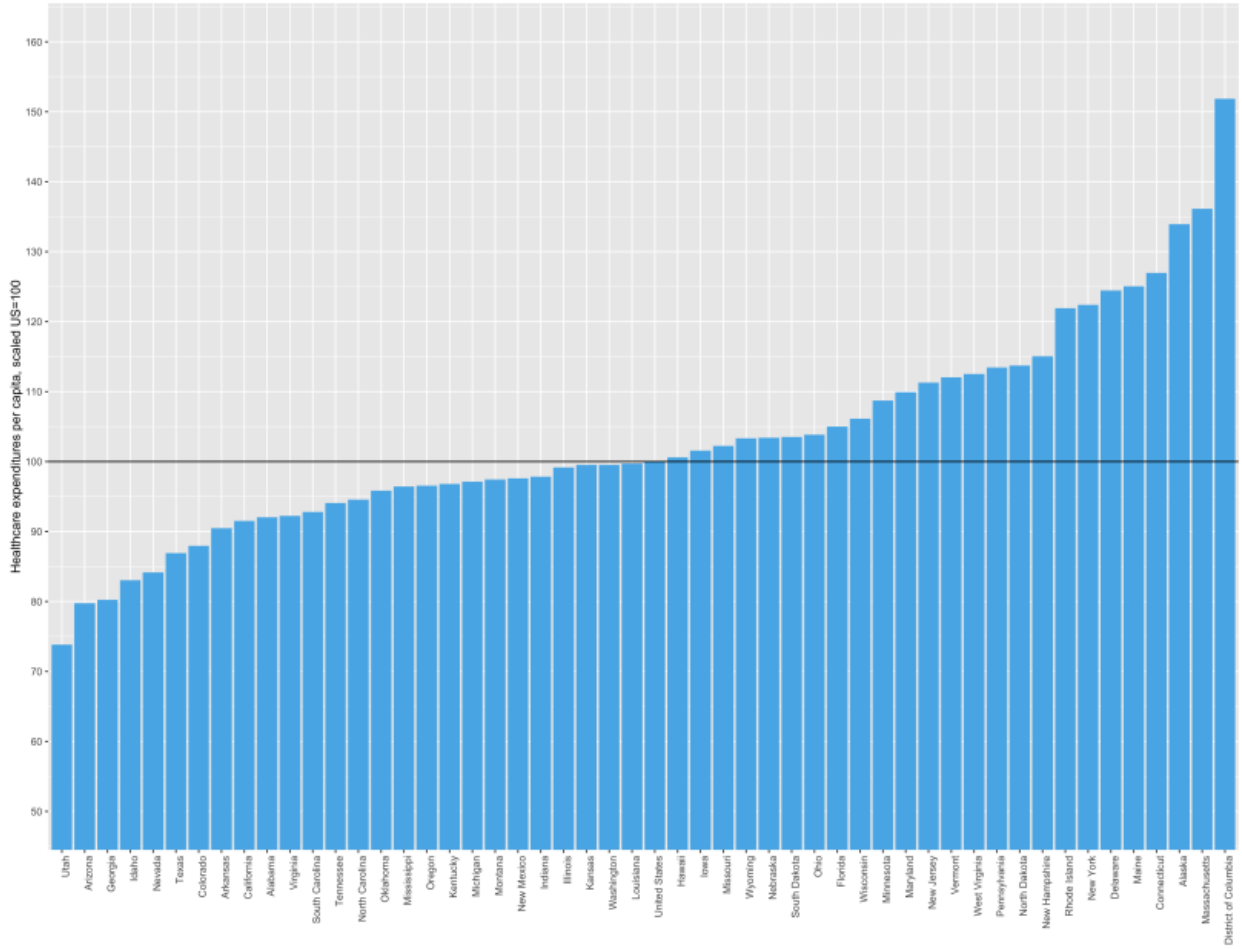
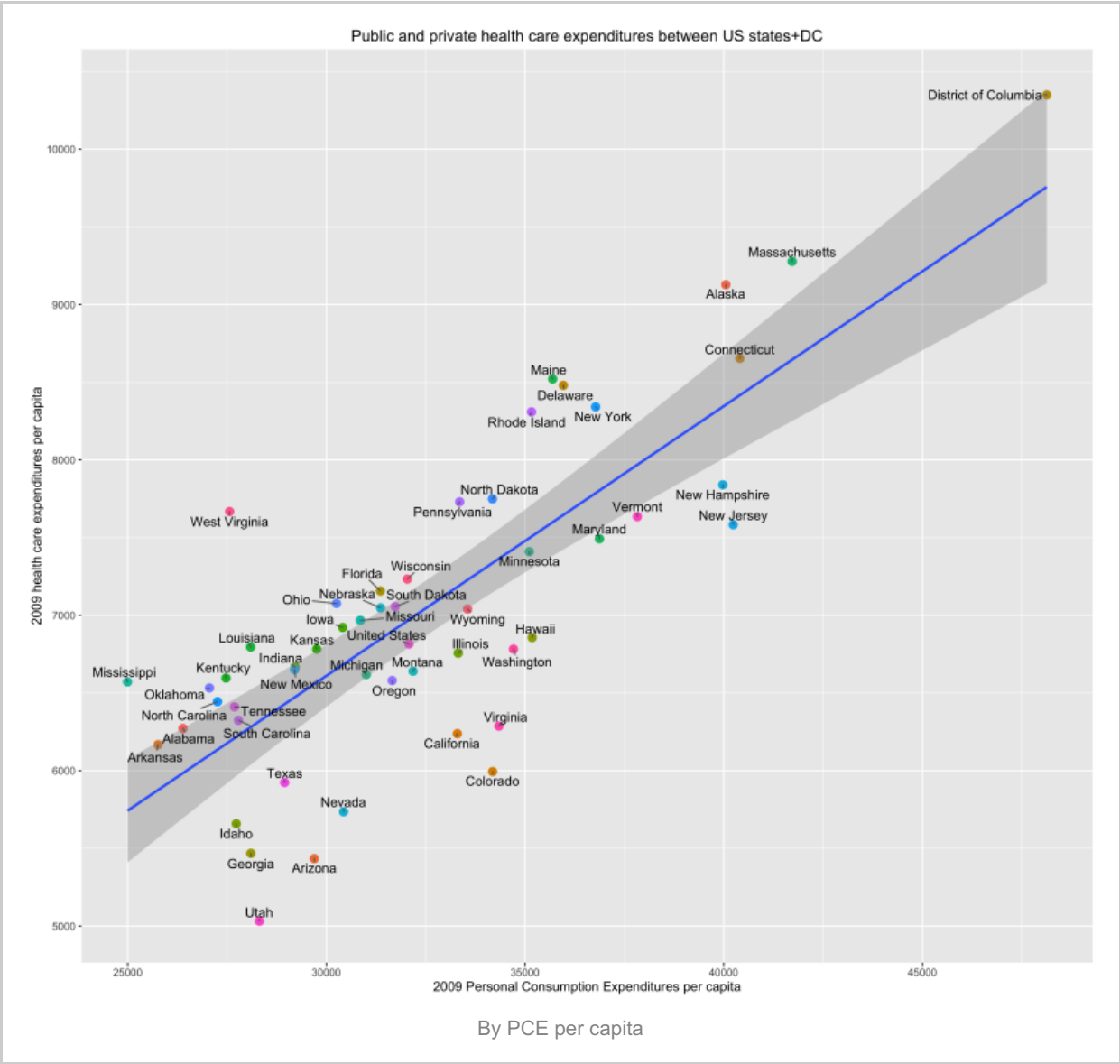
There is substantial variation in HCE between US states and consumption explains much of it

The highest spending location, DC, spends 106% more than the lowest spending state, Utah. Even if you throw out DC as a non-state, the highest spending state, Massachusetts spends 84% more! That is a huge difference.



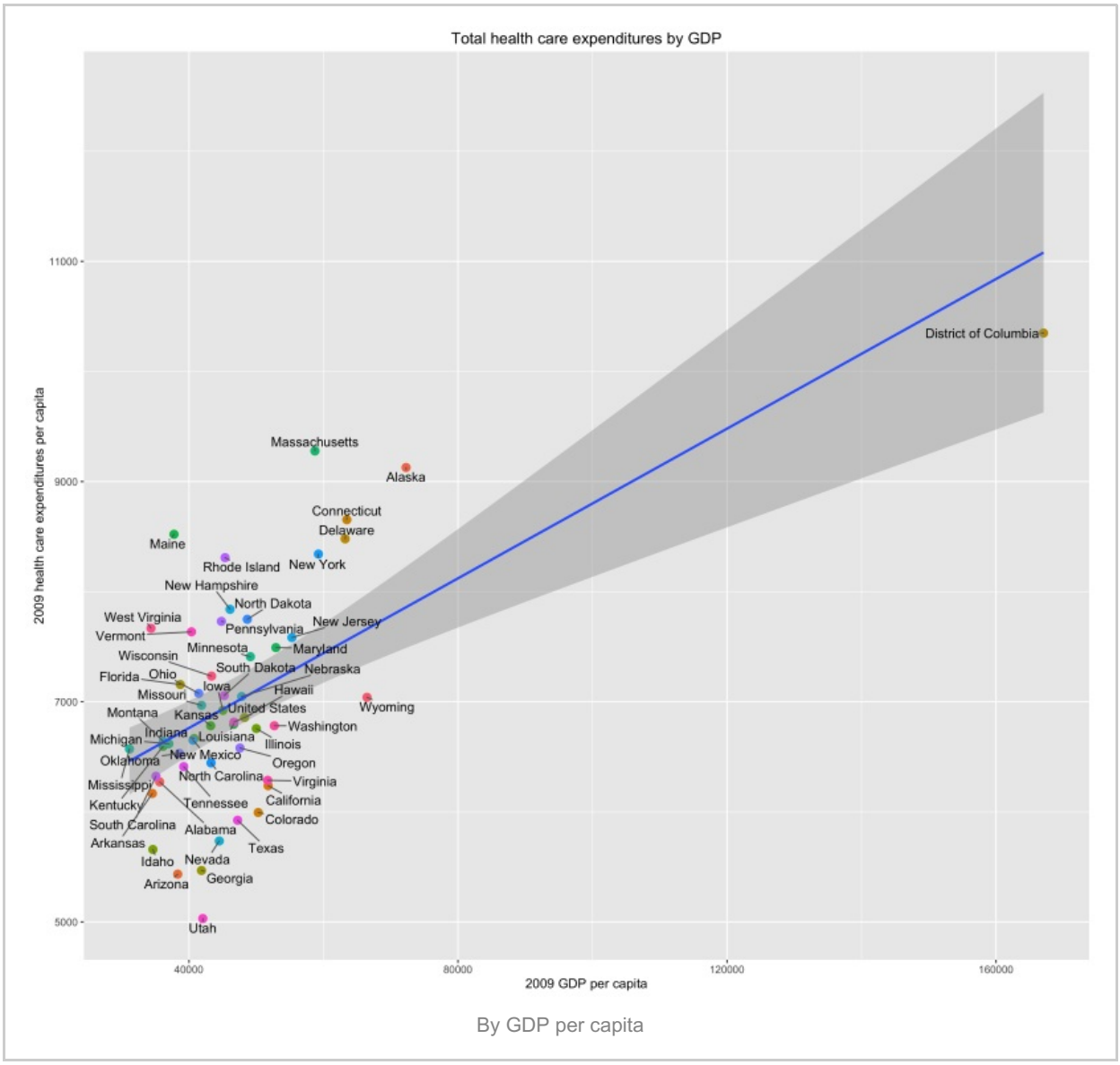
And, as it turns out, if we take a reasonable measure of consumption, thePersonal Consumption Expenditure (PCE) from the BEA we can also explain a large fraction of the variance at a state/place level within the US.



By PCE per capita

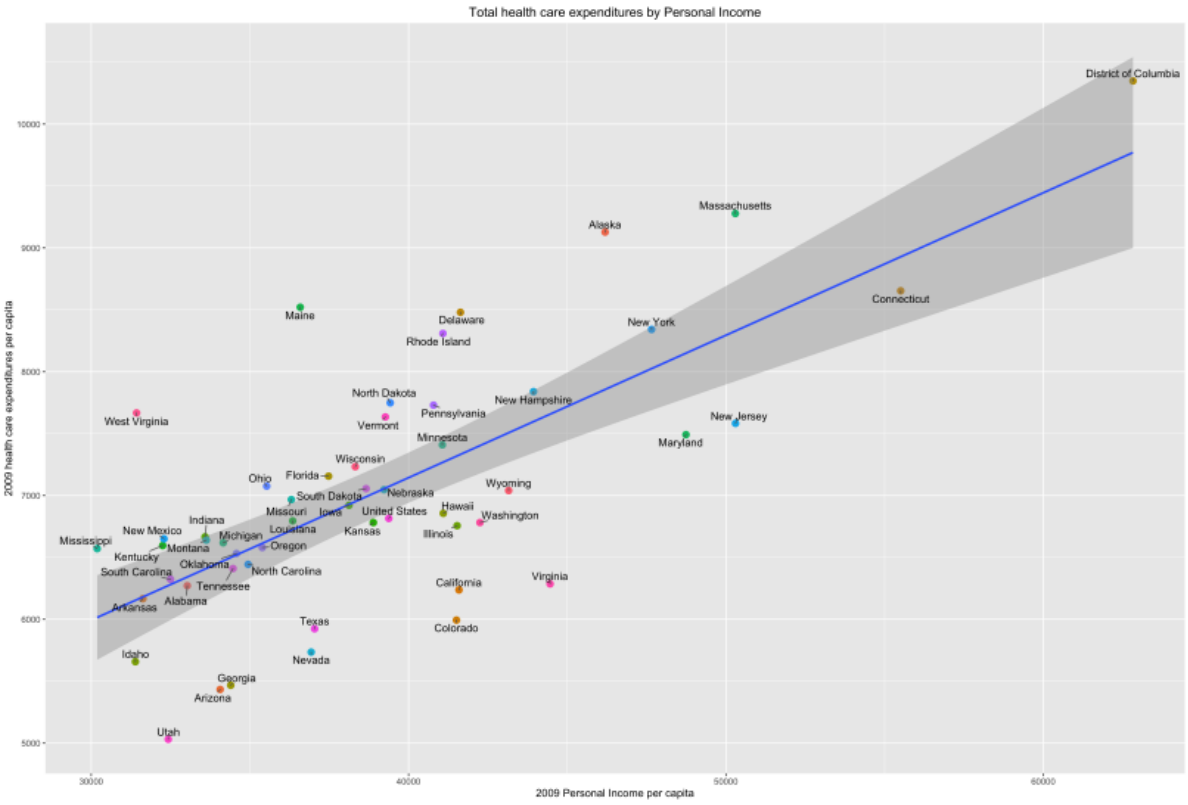
Note: PCE is not exactly the same as AIC, but it is a good broad measure of consumption and should generally correlate reasonably well within the US.

Now if we compare this to HCE:



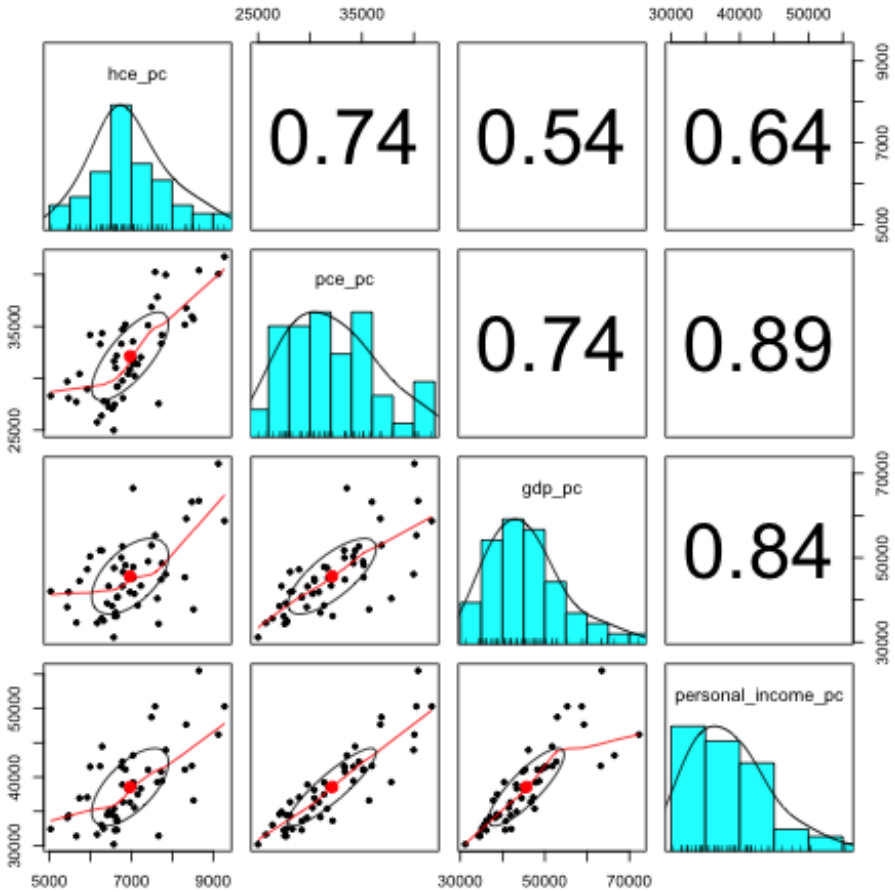
By GDP per capita

Personal Income performs reasonably well here, but PCE still outperform it.



By Personal Income per capita

Even if I treat DC as an outlier and exclude it from the data, PCE outperforms GDP by a large margin.



Ideally this data would be adjusted for purchasing power and the like, but still it shows that consumption is a good predictor of HCE and personal incomes at a state level (certainly much better than GDP).

	Dependent variable:			
	hce_pc			
	(1)	(2)	(3)	(4)
pce_less_hce_pc				0.127***
				(0.036)
gdp_pc	0.034***		0.006	0.016**
	(0.006)		(0.007)	(0.008)
pce_pc		0.174***	0.155***	
		(0.019)	(0.027)	
Constant	5,402.027***	1,404.234**	1,691.543**	3,058.878***
	(308.871)	(618.116)	(692.286)	(725.548)
Observations	52	52	52	52
R^2	0.391	0.629	0.635	0.513
Adjusted R^2	0.379	0.621	0.620	0.493
Residual Std. Error	813.047 (df = 50)	635.105 (df = 50)	636.003 (df = 49)	734.649 (df = 49)
F Statistic	32.146*** (df = 1; 50)	84.626*** (df = 1; 50)	42.623*** (df = 2; 49)	25.807*** (df = 2; 49)
Note:				*p<0.1; **p<0.05; ***p<0.01

I would think that people arguing over international differences in health expenditures would be much more interested in state differences and how spending can be so much higher in some states than others without the presence of single payer and the like.

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Conclusions

Total per capita health care spending increases as wealth increases because people actually demand more goods and services (volume) per capita and because it is relatively labor intensive sector that does not enjoy the productivity gains found in some other sectors of the economy, i.e., overall costs increase through both volume and price together (**volume * price**). GDP per capita is a relatively weak measure for these purposes and those few other high GDP countries happen to be much more export dependent (which does not independently predict significant increases in expenditures). If you use a better measure like Actual Individual Consumption (AIC) or run multiple regression analysis on GDP expenditure categories most of the apparent excess health care spending shrinks quite dramatically.

Additional analysis of several major claims here (e.g., high prices due to limited market power of payers, high physician incomes, etc) show that these arguments suffer from similar issues. The best available evidence show that across multiple measures our healthcare labor costs and overall apples-to-apples price levels are generally very much inline with our material standard of living. US total per capita costs are probably *somewhat* more than expected, but this appears to be driven through higher volume (~100% more than EU28 average according to PPP study estimates), though even this is significantly, if not quite entirely, explained by our higher material standards of living.

Now, to be clear, my position is not that we *ought* to be spending as much as we spend. My position is that the issues we face are very similar to the issues faced in Europe and other prosperous countries (and are generally similar to patterns many decades earlier). They are largely differences in degree, not kind. Our large apparent cost differences *mostly* originate from our significantly higher material standard of living. The long term increases found in the United States and other developed countries are generally a product of ever increasing material living conditions and varying levels of productivity in different economic sectors (healthcare being labor intensive and relatively high skilled at that). Despite the fact that all developed countries allocate a large and increasing share of their consumption expenditures on health care these these richer countries, including the United States, still spend more on other forms of consumption.

Reducing overall health care expenditures, if that is really our top priority, involves choices. Merely setting up single payer (or otherwise blindly aping them) is unlikely to produce large cost savings and, even if we have the will and ability to do it right, those cost savings are not "free". Those genuine and substantial savings (i.e., not that which is primarily the result of substantially less wealth) are not inevitable outcomes of those systems that merely come from some poorly specified efficiency improvements. They involve tradeoffs, many of them hard. Though I would be the first to argue that health care is subject to rapidly diminishing returns vis-a-vis life expectancy or mortality rates on (real) increases in expenditure and that some of this is of questionable subjective value, it is also quite clear that people actually want to consume more health care and do not much like being told "no." Likewise, cost containment through price reduction has consequences as the health care market does not operate in a vacuum (e.g., slash physician reimbursement/effective income relative to other skilled professionals and the bright people will generally start to avoid it; reduce contracted prices for pharmaceuticals will reduce market incentives for R&D->less new drug development, etc).

Those systems that appear to actually *generate* cost savings, like the UK's NHS, actually do a great deal more than other countries, especially the United States, to contain costs by rationing care and other cost containment strategies (and I have a hard time imagingstuff like this flying here when ~40% of the population would be excluded). There is much less low hanging fruit than people imagine, even less so at a political level when people can actually express their preferences at the voting booth and various other interest groups (providers, hospitals, etc) can influence the process.

More generally, it is not clear to me why we should want to specifically and target healthcare for broad cost containment over other expenditures we collectively make. (What else should we be spending our resources on???) A significant and growing fraction of these expenditures have little to do with increasing life expectancy (e.g., luxury, convenience, quality of life/subjective lifestyle/risk decisions, etc), so insisting that we judge it strictly in these terms strikes me as myopic. So long as there are reasonable cost effective options for more basic (proven) healthcare and so long as the government's share of expenditures are not breaking our budgets I see little need for the government to intervene further in the affairs of the rest of the health care market (note: the fact that volume, not prices, are most likely driving these *incremental* differences has some bearing

on this issue….). Government should *not* create economic distortions that encourage more expenditures through tax policy (e.g., taxing healthcare spending differently, save perhaps basic coverage), mandating ever broader coverage, and so on either though.