The "Weisbrod Quadrilemma" revisited: insurance incentives on new health technologies

June 2012

Joan Costa-Font[1]; Alistair McGuire[1]; Victoria Serra-Sastre[2*];

Abstract

The effect of insurance expansion on the diffusion of new technologies is not a well-understood phenomenon. Arguably, an expansion of insurance coverage provides a motivation for R&D investment in medical technologies. Although risk pooling through insurance gives rise to greater affordability for existing treatments and becomes a volume driver of new treatments, it may also influence provider reimbursement through a monopsony purchaser effect and related cost control measures. However the impact that insurance has on technology availability and R&D investment, and more generally on the adoption of new technologies remains an unexplored empirical question. This paper presents evidence of a link between insurance and technology diffusion using OECD panel data and taking advantage of a dynamic specification structure. Our empirical estimates indicate that higher degrees of private expenditure on health care correlate with higher levels of R&D in health care, consistent with the hypothesis forwarded by Weisbrod that increasing insurance coverage gives boosts technology adoption. However our findings also suggest that increasing public funding of health care appears to lower technological adoption, which is, of course, consistent with the exercising of monopsony power and an objective of cost containment.

Keywords: insurance, technology diffusion, health technologies.

JEL: I18.

[1]LSE Health and Social Care

[2] City University London and corresponding author. Email: v.serra-sastre@city.ac.uk

Introduction

In the last few decades, most western health systems have experienced a dramatic expansion of health expenditures together with a growth in the diffusion of new technologies. As a result, it appears to be a widely accepted notion that health care technology is a major driver of health care expenditure (Smith et al, 2010). At first glance this may appear at odds with commonly held views that technology supposedly produces a substitution effect that lowers unit costs and increases productivity. However as documented by Huckman and Cutler (2003), while a "substitution effect" does exist, a simultaneous "treatment expansion effect" might actually dominate, which essentially would lead us to conclude that technology adoption leads to demand shifting and subsequent expenditure increases. One has to be careful in making these conjectures however, as demand may also be shifting in response to quality improvements embedded in new technology (Enggleston et al (2011)[3].

A further nuance in this technology/expenditure relationship arises from the fact that health care demand is financed through insurance; whether this is privately or socially based. Consumer willingness to pay is of course liable to be higher under insurance than in its absence (Zweifel, 2003; Zweifel and Manning, 2000). Thus health care demand expansion is more easily assured when third-party payment is present. Insurance also exerts supply effects through increasing the contribution base to finance future innovations, while reducing fragmentation and uncertainty in the market from the innovators perspective. In the western world we have observed significant expansion of health care insurance converge, primarily through public insurance coverage. Hence, one might expect that following this expansion of insurance coverage, faster adoption of new technology would also be seen. There has however been limited empirical evidence to substantiate this behaviour.

It is plausible that new health care technology shifts demand through allowing more patients to benefit from treatment and/or through an increased quality embedded in new treatments. This increased demand is serviced through improved access, made possible by insurance. Rapidly the expectations associated with improved technology and increased access creates a self fulfilling cycle. Indeed, Weisbrod (1991) was among the first to suggest that growing health care insurance provides an incentive for the development and provision of new health care technology. Expanding health care coverage has a direct incentive impact through broader coverage of treatments and indirectly through enabling additional demand expansion by increasing insurance coverage of the population. Weisbrod (1991) further asserted that it was as a result of the expansion of health care insurance coverage that there has been a widespread development of cost-increasing technologies in the health care sector, and that this improved market access for consumers was the mechanism through which health care technology is quickly adopted and leads to growing health care expenditure. There is a small theoretical literature (Goddeeris, 1984; Zweifel, 2003; Zweifel and Manning, 2000) which

[3] Enggleston et al (2011) show for the case of diabetes care that once health expenditure is adjusted by quality, it is no longer true that health expenditures for diabetes care have expanded in the last decades.

support this supposition in suggesting that insurance imparts a bias in favour of cost-increasing (product) innovation rather than cost-reducing (process) innovation. Hence, health care expenditure growth can be partly explained by the interaction of growing insurance coverage and technology development.

On the other hand, the health care insurance sector, especially the development of universal and publicly integrated systems, has a tendency to promote monopsony purchasing. This is not only true of social insurance, but also of private insurance where common insurance pools tend to increase in efficiency as they enlarge. Such monopsony power allows greater control over treatment restrictions and cost containment, although with some potential detrimental effects on social welfare (Pauly, 1988). Bech et al (2010) provide evidence that systems with monopsony payers tend to have lower rates of technology adoption for heart disease, than systems which do not exhibit this characteristic. While some systems may have a tendency to monopsony, most health care systems are characterised by mixed purchasing of some kind, however. Either supplementary private insurance within a dominant social insurance setting or mixed insurance schemes tend to be the most prevalent form of health care system. Where the insurance market is more fragmented, the possibility that insurance firms compete on quality implies that the direct control of treatment costs, including those associated with the adoption of new technologies, may become more difficult.

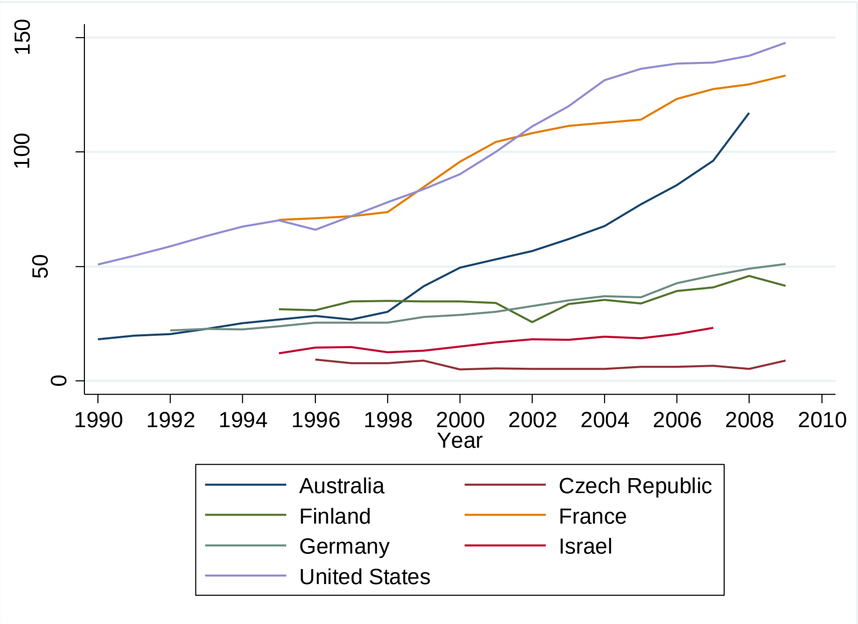
There is a growing literature on the determinants of health care expenditure with technology playing a central role (Newhouse (1992), Fuchs (1984), Okunade and Murthy (2002), Cutler (2004), Jones (2004)). Few have focussed on the role of insurance coverage, although Smith et al (2010) have estimated that greater insurance coverage accounts for approximately 10% of the per annum increase in health care expenditure growth, somewhat below the impact that technological factors per se have on per annum expenditure growth (somewhere between 27% and 48%). There has also been work on the return to health care technology that has focused on estimating quality adjusted price indexes, finding that the quality-adjusted price of health care over the recent decades has been roughly stable (Berndt et al (2000), Cutler et al (1998), Cutler and McClellan (2001); Egglestone et al (2011)). Examination of technology adoption trends in the treatment of heart attack finds different up-take rates across a range of systems (McClellan and Kessler (2002); TECH Research Network (2001); Bech et al (2010)).

There has been little explicit investigation of the relationship between health care technology adoption and insurance coverage. This paper is an attempt to give a first empirical take on this relationship using aggregate data on health care systems as the unit of analysis. We take advantage of the existing data available on both public and private insurance coverage, as well as on key new health care technologies for OECD countries.

We are concerned with the impact of insurance cover on investment in health care technologies and R&D volume to reflect this investment. Following Weisbrod (1991) we assume that R&D and the up-take of new technology are determined by the mechanisms expected to be used to finance health care. New technology is empirically defined by a diagnostic technology, MRI scanners, and a surgical intervention, Percutaneous Transluminal Angioplasty (PTCA). In particular, Weisbrod (1991) explicitly hypothesises that the effect of insurance on R&D, is not simply based on expected demand but the future form of insurance, which determines the strength of the market for new products. Thus, for example, public funding of health care may, through the pursuit of cost-containment dampen the market for new products. This gives a rationale for empirically investigating the dynamic process through which different forms of funding interacts with R&D and the diffusion of new products. Weisbrod (1991) argues there is a circularity in the relationship between insurance and R&D, and to a lesser extent the up-take of new technology. With increasing insurance coverage providing an incentive to invest in R&D, and the new health care technologies developed from this R&D investment providing the demand for greater insurance coverage. We exploit aggregate demand at the country level and dynamic relationships between these variables to assess one dimension of this process; namely the impact of insurance on R&D and health care technology. We therefore build on the earlier literature by providing some aggregate empirical estimates on these relationships to test whether there is support for this part of the Weisbrod hypothesis.

To further motivate our empirical investigation we outline the variation in trends across a number of OECD countries for a number of our principle variables. Figure 1 shows the evolution of R&D in health for few OECD countries during the time period 1990-2010. Some countries show a clear upward trend in R&D investment whereas others have a slight increase or even a flat trend. The issue that the paper explores is whether variation in insurance coverage has any significant effect on these trends.

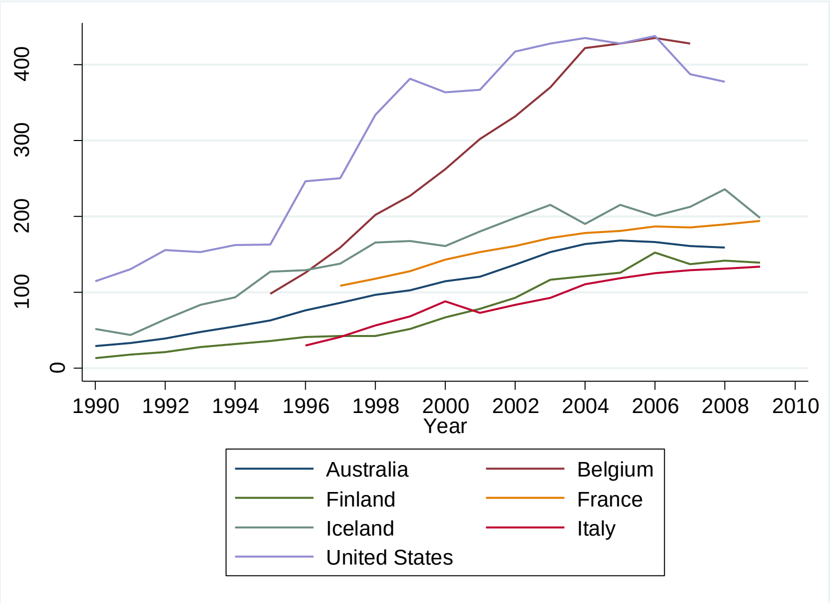
Figure 1. R&D in health (/per capita, $US purchasing power parity)



Source: OECD Health Data 2012

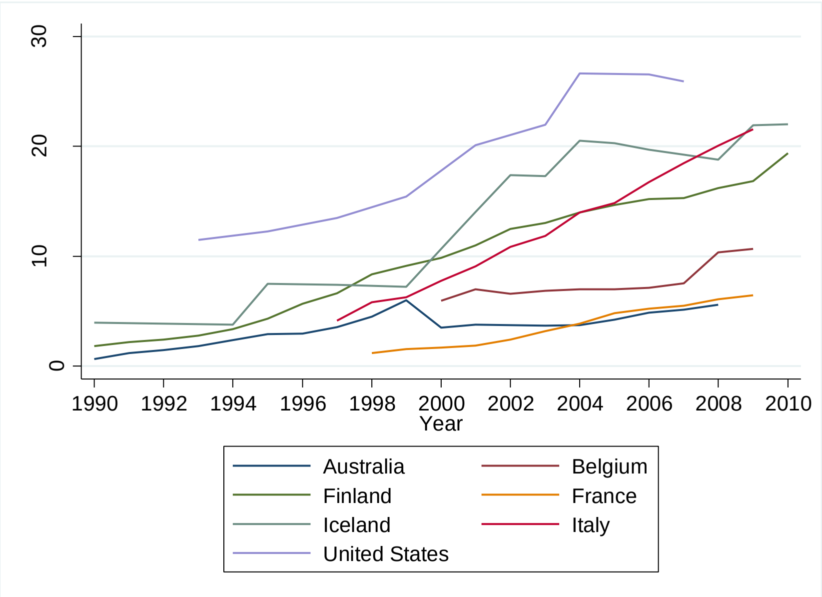
As technology is multivariate we consider specific examples. First, a diagnostic input, MRI scanners, which reflects Weisbrod's notion of a costly technology introduced through insurance coverage incentivizing an ever-widening concept of health care coverage. Second, a surgical procedure, PTCA, associated with demand shifting made possible by insurance coverage. We examine the volume of their use in different health care systems according to the variation in the form and coverage of health care insurance. Figures 2 and 3 display the patterns of such technologies over the last two decades 1990-2010 as an illustration of the remarkable differences in technology diffusion across countries, which appears to increase after the mid-1990s.

Figure 2. PTCA (per 100,000 population) for a selection of countries



Source: OECD Health Data 2012

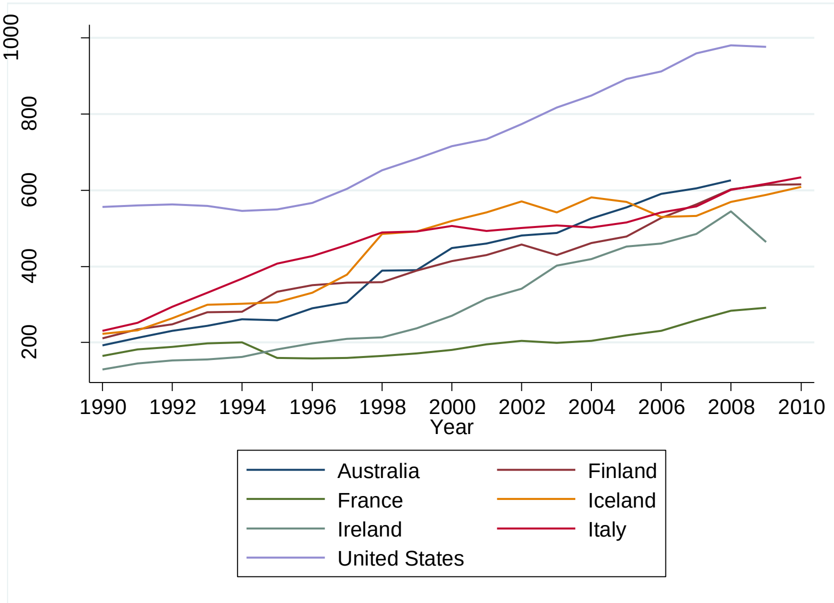
Figure 3. MRI (per million population) for a selection of countries



Source: OECD Health Data 2012

Following Comin and Hobjn (2010) we can define horizontal shifts to reflect differences in lags of new embodied technology across countries, while vertical shifts reflect, amongst other factors, the size of the treatment market and the overall productivity level. A steeper pathway implies later adoption and longer adoption lag relative to the initial adopter. We are particularly interested in whether or not different forms of health care insurance coverage can explain these differences. We would specifically expect that growth in private coverage would have a positive impact on health care technology investment and growth, while higher public sector coverage may counter this effect to the extent that regulations on cost containment are effective. Figure 4 shows the trends for private out-of-pocket expenditure on health (in per capita terms, US$ PPP). Although we can see there is a negligible upward trend, differences across countries may reflect differences in technology availability and R&D.

Figure 4. Private Out-of-Pocket Expenditure (/per capita, US$ PPP) for a selection of countries



Source: OECD Health Data 2012

Such variation across these variables supports further investigation and the paper continues as follows. The next section describes our data, empirical strategy and preliminary evidence. Section three reports the main results and section four concludes.

Data and methods

Data

As noted above we are interested in the impact that insurance coverage has on health care technology development and adoption. Specifically we wish to document the influence of different health care insurance systems on technology diffusion, assuming, in line with Weisbrod (1991) that greater coverage and higher private expenditure leads to increased diffusion. In addition, we also examine the relationship that Weisbrod (1991) suggested between R&D and insurance arrangements. The argument posed by Weisbrod (1991) being that investment in R&D is related to the expectation generated regarding the structure of the health insurance system.

We take advantage of the cross-country variability in R&D levels, technology up-take and insurance patterns, as well as the variation in institutional structures to identify these relationships. Specifically, we use aggregate OECD Health data[4] on different health care systems, which are available from 1980 to 2010. The main variables of interest are the technology variables, insurance variables and R&D in health. As technology variables we use the number of MRI scanners (per million population) and the number of PTCA (per 100,000 population), given that, though introduced relatively recently, there is adequate time series to assess diffusion. Our insurance variables include total private expenditure on health care, defined by the OECD as private insurance, private household out-of-pocket expenditure, non-profit institutions serving households and other corporations; total public expenditure from all public funds; and private out-of-pocket expenditure that is an aggregate of any out-of-pocket expenditure, cost sharing from government or social security funds, cost-sharing from private insurance (deductibles and coinsurance) and all other type of cost-sharing. As such the private out-of-pocket expenditure also contributes to the private expenditure variable. A number of control variables are also included in the estimation.

The data contain a large number of countries and cover a substantial time period (1980 -2010). There are differences in data availability for each of the variables used in the empirical analysis and consequently the panel we have is unbalanced. An additional data issue is that some countries did not provide data for all periods and there are data points with irregular time spans[5]. Therefore we use data for each country for which there were consecutive data points. A list of the variables included in the analysis and some descriptive statistics are shown in Table 1. Noting the estimated raw means and standard deviations displayed by the data, Table 1 reveals significant cross-country variability in technology adoption and in private insurance coverage, government funding of health

[4]OECD Countries included are Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom and United States.

[5] Data availability is limited for some countries and some cross-sections do not provide information in one or more of the relevant technology or R&D variables.

care and out-of pocket expenditure. It is this variability that we use to identify the relationships between health care insurance structures and R&D and technology up-take.

Table 1. Variables List and descriptive statistics.

Variable	Description	Mean	Std. Deviation	Min	Max
MRIs	MRIs (Per million population in logs)	6.16	5.42	0.04	22.01
PTCA	PTCA (Per 100,000 population in logs)	141.01	106.92	0.20	582.20
R&D	R&D on health (/per capita, US$ PPP in logs)	33.49	34.63	0.29	147.80
POut	Private households out-of-pocket expenditure (/per capita, US$ PPP in logs)	351.23	232.47	14.25	1649.97
Gov	Government total expenditure (/per capita, US$ PPP in logs)	1262.61	829.72	19.15	4501.06
Priv	Private total expenditure (/per capita, US$ PPP in logs)	491.51	498.86	14.25	4165.39
Female	Proportion of female population	0.51	0.01	0.49	0.54
Pop15to64	Proportion population aged between 15 and 64	0.67	0.02	0.57	0.73
Pop65over	Proportion population aged 65 and over	0.13	0.04	0.04	0.22
Beds	Hospital Beds (Per 1,000 population)	5.85	2.62	1.56	15.60
GDP	GDP (/capita, US$ PPP in logs)	21098.28	11124.10	2397.00	90539.60

Source: OECD Health Data 2012

Moreover, as displayed in Table 2, simple correlations across these aggregate variables suggests positive correlation between public and private insurance funding and R&D expenditures with, as hypothesised, private insurance exhibiting the strongest relationship. Both public and private insurance are also positively related to technology up-take. Private out of pocket expenditure, which essentially comprises co-payments and deductibles, are not surprisingly highly correlated with private insurance expenditures. As expected there is little correlation between R&D expenditure, and the technology variables, MRI scanners and PTCA rates.

Table 2. Correlation Matrix for MRIs, PTCA and R&D.

	MRIs	PTCA	R&D	POut	Gov	Priv
MRIs	1					
PTCA	0.0394	1				
R&D	-0.0239	0.09	1			
POut	0.516	0.2859	-0.0845	1		
Gov	0.501	0.3817	0.3813	0.3715	1	
Priv	0.3177	0.3672	0.5246	0.7299	0.5684	1

Empirical Strategy

To examine the relationship between technology and insurance a model is estimated in the following specification:

$$tech_{it} = \theta_t + c_i + \beta \cdot insurance_{it} + \gamma \cdot z_{it} + u_{it} \quad (1)$$

where the subscripts i and t index the individual country and time-period respectively in all cases. The dependent variable in equation (1), $tech_{it}$, captures the technology level for country i in year t. Two technologies are used: MRIs and PTCA. They are examples of diagnostic and surgical technologies respectively, and expressed in logarithms in the estimation given their skewed distribution across health care systems. The variable $insurance_{it}$ is our variable of interest and our parameter of interest is β. The various insurance variables private expenditure, government expenditure and out-of-pocket expenditure are all expressed in per capita terms. These insurance variables are used to examine if specific aspects of insurance coverage influence the level of technology adopted by different health care systems. The parameter θ_t is a time-varying intercept, c_i is a country fixed effect for unobservable heterogeneity and z_{it} is a vector of various confounding variables with associated parameter γ, and the final term is an error term u_{it}.

A further specification considers, of a similar manner and consistent with Weisbrod's (1991) explicit hypothesis that the impact of insurance is positive on R&D in health (in logs), and is given by:

$$R\&D_{it} = \theta_t + c_i + \beta \cdot insurance_{it} + \gamma \cdot z_{it} + u_{it} \quad (2)$$

Where $R\&D_{it}$ is the R&D expenditure on health care per capita. The controls and the fixed effects are the same as before. We not only test private insurance per capita as it affects R&D, but also examine the impact of government expenditure per capita, where we would expect the monopsony cost containment aspect to dominate, and the impact of private out-of-pocket expenditure where we are more agnostic a priori, as the strength of insurance effect is much diluted here and the monopsony purchasing effect is missing.

Methodological issues and preliminary testing

We use longitudinal data on 34 OECD countries with information on technology, insurance and R&D information. Given the time varying nature of our variables, and especially the trend components in technology diffusion we must examine whether the variables are stationary. Non-stationarity of variables may lead to spurious regressions. To test for the presence of unit roots we use the Im, Pesaran and Shin (2003) test which uses the average of the individual Dickey-Fuller t-statistics for each cross-section. The test is suitable for unbalanced panels (Breitung and Pesaran, 2005). Technology, R&D and insurance variables are tested individually for the presence of non-stationarity. In all cases we fail to reject the null of unit root. However, when taking first differences of the corresponding variables and testing for non-stationarity we reject the null of unit root. We therefore assume our series to be I(1) and all estimates presented here will be given in first-differences.

Following Weisbrod (1991) we expect that technology development, R&D, and the manner of technology adoption is a function of the mechanisms expected to finance future health care, while the form of insurance coverage is partly a function of previous R&D levels and adopted technology. We are therefore interested in an empirical strategy that allows a dynamic specification and deals with potential endogeneity. There is a potential source of endogeneity in the insurance variables employed. Simultaneity of insurance, and the technology and R&D variables could lead to biased estimates of the relevant coefficients. To test for endogeneity of the insurance variables, we obtained OECD data on general non-health insurance and used two non-health related insurance variables as instruments; the country specific total gross premiums (in million $US) and life insurance share (defined as the ratio between gross life insurance premium over the total gross premium). The rationale being that private health insurance coverage will be related to the general insurance preferences of any given population. A simple model based on estimating the effect of insurance on technology and R&D and using these two variables as instruments was then examined. A Hausman test failed to reject the null hypotheses of exogeneity and therefore the estimates presented below treat the insurance variables as exogenous.

In specifying a dynamic relationship we assume R&D, and the level of technology diffusion is dependent on the expected form of insurance prevailing in future periods. This gives us a means to identify whether the relationship between R&D and technology diffusion, and insurance is dynamic in nature. Thus, we use predicted values of the insurance variables, based on a simple autoregressive formulation, to capture the expectations of health care funding structure, consistent with the hypothesis suggested by Weisbrod (1991). We also use first differencing to exclude the country fixed effects and identify off this. We are primarily interested in picking up the impact of unobservables as social history and preferences obviously play a role here. We therefore estimate in differences, but still include country effects in differenced specifications.

Results

This section reports the econometric results. We first present results for the first-differenced variables in static models in Table 3. As the results presented are from first differences in log-log models, the coefficients of interest represent insurance elasticities in growth terms. As can be observed, without taking into account the expected, potential dynamic relationship as emphasised by Weisbrod (1991), in general there is no statistically significant relationship between the growth in technology diffusion or R&D expenditure and any of the insurance variables.

We therefore move to a dynamic specification. We assume that technology adoption is a function of future insurance coverage. Given the lead times required to develop new health care technology the suppliers of this technology will rely on predicted future insurance coverage to provide incentives. We assume a very simple model of predictions based on prior realisations of insurance coverage but one that, given that it is based on the level of per capita coverage, incorporates any increasing coverage. In this spirit we model the technology variable in the current period and regress it against the predicted value of the various insurance variables. We do so first by computing an AR(1) model of the type:

$$insurance_{it} = \alpha + \beta \cdot insurance_{it-1} + c_i + u_{it} \quad (3)$$

for each insurance variable. We also estimated the corresponding AR(2) and AR(5) models in order to check whether longer lags captured the insurance dynamics better for equation 3 [6] as follows:

$$insurance_{it} = \alpha + \beta_k \cdot \sum_{k=1}^{s} insurance_{it-s} + c_i + u_{it} \qquad (4)$$

for s=2,5. For each AR model and each insurance variable we computed the predicted values.

[6] When computing the AR(2) and AR(5) models, only the fist lag is statistically significant and longer lags are shown to be statistically insignificant.

Table 3. Static model. First-differenced estimates for various insurance variables.

VARIABLES	(1) MRIs	(2) PTCA	(3) R&D	(4) MRIs	(5) PTCA	(6) R&D	(7) MRIs	(8) PTCA	(9) R&D
Pout	0.182	0.427	0.798						
	(0.234)	(0.256)	(1.061)						
Gov				0.395**	0.545	0.0802			
				(0.184)	(0.450)	(1.038)			
Priv							0.192	0.496**	1.050
							(0.173)	(0.231)	(1.322)
Female	-19.50	50.52**	155.3*	-31.03	64.59**	118.9	-20.19	69.14***	165.6**
	(20.88)	(18.18)	(81.91)	(19.30)	(25.37)	(98.15)	(21.40)	(23.26)	(74.76)
Pop15to64	-1.093	33.20**	-41.15	1.235	36.03***	-37.49	-1.430	35.23***	-32.54
	(9.278)	(13.04)	(32.67)	(9.913)	(10.76)	(25.26)	(9.185)	(11.16)	(29.62)
Pop65over	-0.649	18.35	-40.69	-0.148	13.40	-33.59	-2.315	13.21	-33.71
	(8.553)	(12.48)	(29.47)	(7.509)	(10.90)	(31.55)	(7.382)	(11.21)	(29.32)
Beds	0.0638	0.0402	0.700	0.0439	0.0452	0.669	0.0627	0.0814	0.642
	(0.0455)	(0.0687)	(0.451)	(0.0472)	(0.0614)	(0.492)	(0.0457)	(0.0588)	(0.414)
GDP	0.384	-1.425***	-1.113	0.163	-1.752***	-0.760	0.367	-1.631***	-1.537
	(0.527)	(0.500)	(2.515)	(0.526)	(0.442)	(1.867)	(0.496)	(0.387)	(2.678)
Observations	221	199	171	241	232	191	241	232	191
R-squared	0.395	0.392	0.310	0.561	0.422	0.292	0.561	0.426	0.302

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Country and time dummies included but not reported

These predicted values were then used as a proxy for the suppliers' expected insurance coverage as it affects technology adoption in the forthcoming period, directly in line with this formulation of the Weisbrod (1991) hypothesis. Our new model specification is given by:

$$tech_{it} = \theta_t + c_i + \beta \cdot E(insurance)_{it-1} + \gamma \cdot z_{it} + u_{it} \qquad (5)$$

Tables 4, 5 and 6 show our main results where we include the lag expected value of the insurance variables, using the predicted values from the AR(1), AR(2) and AR(5). Tables 4 and 5 show the influence of out of pocket and private expenditure respectively. In Table 4 private total expenditure shows there is little of note other than the generally positive relationship between the growth of out-of-pocket expenditure and the growth in R&D expenditure levels. Given the correlation of these out-of-pocket expenditures with private insurance, the expectation that such demand-side risk sharing increases as private insurance coverage increases provides supportive, indicative evidence of the Weisbrod hypothesis.

Table 5, reporting the private insurance results, confirms this with strong direct positive, dynamic relationships between the growth in private coverage and the growth in R&D found. Indeed in both the cases of out-of-pocket expenditure and private insurance, the impact of expected future insurance coverage appears not to influence the up-take of new technologies. One inference is that it is the R&D process and the development of future technologies that is influenced by insurance coverage as hypothesised by Weisbrod, while the current level of funding alone affects the up-take of technology. Table 6 reports the results of the coverage of public insurance and here there is no significant relationship between technology and R&D and the expected level of public insurance. It is important to note that this lack of significance shall not be interepreted as reflecting the monopsony purchasing and cost-containment effects associated with public funding, as there is no correlation found between these variables.

Table 4. First-differences results. Private household out-of-pocket expenditure (/capita, US$ PPP)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
VARIABLES	MRIs	MRIs	MRIs	PTCA	PTCA	PTCA	R&D	R&D	R&D
AR(1) t-1	-0.186			0.0785			1.526***		
	(0.198)			(0.227)			(0.393)		
AR(2) t-1		-0.176			0.0983			1.388***	
		(0.198)			(0.225)			(0.340)	
AR(5) t-1			-0.136			-0.0373			1.060***
			(0.189)			(0.245)			(0.243)
Female	-32.07	-31.44	-22.31	52.85**	52.58**	38.52*	163.5	161.3	191.8
	(24.39)	(24.60)	(26.25)	(21.05)	(20.84)	(22.08)	(125.3)	(131.1)	(175.5)
Pop15to64	-3.380	-4.876	5.058	32.28**	31.88**	19.08	-62.85*	-74.29**	-39.19
	(9.523)	(10.06)	(12.60)	(12.53)	(12.53)	(11.21)	(33.02)	(31.02)	(36.93)
Pop65over	1.274	-3.098	4.766	15.94	14.72	2.328	-72.98**	-77.73**	-0.928
	(9.427)	(9.272)	(13.29)	(12.48)	(12.33)	(11.59)	(32.53)	(28.02)	(47.90)
Beds	0.0709	0.0575	0.00578	0.0441	0.0512	-0.0117	0.952	0.970	0.547*
	(0.0520)	(0.0549)	(0.0896)	(0.0663)	(0.0708)	(0.0613)	(0.555)	(0.694)	(0.269)
GDP	0.542	0.575	0.450	-1.362***	-1.334***	-0.929*	0.249	0.331	3.555***
	(0.493)	(0.496)	(0.596)	(0.435)	(0.436)	(0.516)	(1.726)	(1.788)	(1.195)
Observations	213	206	178	198	194	176	157	150	129
R-squared	0.397	0.405	0.425	0.370	0.366	0.458	0.353	0.337	0.539

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Country and time dummies included but not reported

Table 5. First-differences results. Insurance variable is Private total expenditure (/per capita, US$ PPP)

VARIABLES	(1) MRIs	(2) MRIs	(3) MRIs	(4) PTCA	(5) PTCA	(6) PTCA	(7) R&D	(8) R&D	(9) R&D
AR(1) t-1	-0.110			0.182			1.395**		
	(0.154)			(0.163)			(0.624)		
AR(2) t-1		-0.134			0.133			1.362**	
		(0.169)			(0.239)			(0.537)	
AR(5) t-1			-0.0794			0.146			0.712*
			(0.153)			(0.170)			(0.359)
Female	-39.11	-40.08	-33.55	65.20***	65.03***	56.53**	174.9	172.1	205.2
	(23.56)	(23.59)	(22.94)	(23.46)	(23.32)	(24.18)	(134.6)	(133.7)	(173.2)
Pop15to64	-0.909	-1.418	-0.0734	36.74***	36.47***	26.56**	-49.30	-54.51*	-23.85
	(9.408)	(9.164)	(9.310)	(11.42)	(11.63)	(12.17)	(30.96)	(28.13)	(35.50)
Pop65over	-0.834	-1.911	-3.066	10.57	11.06	-0.413	-50.02	-57.87**	3.473
	(8.066)	(7.482)	(7.405)	(11.28)	(11.37)	(10.92)	(33.19)	(27.46)	(38.47)
Beds	0.0572	0.0640	0.0285	0.0654	0.0663	0.0345	0.734	0.830	0.397*
	(0.0464)	(0.0467)	(0.0714)	(0.0574)	(0.0589)	(0.0515)	(0.482)	(0.626)	(0.218)
GDP	0.458	0.474	0.501	-1.562***	-1.551***	-1.370***	-0.987	-0.976	2.095
	(0.495)	(0.489)	(0.521)	(0.393)	(0.390)	(0.446)	(1.750)	(1.819)	(1.377)
Observations	237	234	217	230	229	220	181	176	160
R-squared	0.561	0.465	0.447	0.412	0.409	0.468	0.327	0.317	0.477

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Country and time dummies included but not reported

Table 6. First-difference results. Insurance variable is Government total expenditure (/per capita, US$ PPP)

VARIABLES	(1) MRIs	(2) MRIs	(3) MRIs	(4) PTCA	(5) PTCA	(6) PTCA	(7) R&D	(8) R&D	(9) R&D
AR(1) t-1	-0.0675			-0.392			-0.302		
	(0.239)			(0.298)			(1.146)		
AR(2) t-1		-0.0106			-0.182			-0.0527	
		(0.194)			(0.199)			(0.918)	
AR(5) t-1			-0.0371			-0.128			0.394
			(0.209)			(0.167)			(0.446)
Female	-33.97	-35.22	-30.32	71.69***	69.28***	59.83**	126.0	124.8	161.1
	(23.26)	(23.63)	(24.91)	(25.03)	(24.25)	(23.90)	(139.7)	(134.3)	(157.0)
Pop15to64	-0.639	-1.020	-0.140	36.10***	36.07***	25.96**	-46.29*	-51.65*	-15.29
	(9.680)	(9.624)	(9.267)	(11.20)	(11.44)	(11.83)	(26.76)	(26.32)	(34.93)
Pop65over	-1.536	-2.710	-3.361	10.86	11.38	0.146	-45.97*	-53.12*	15.08
	(8.120)	(7.519)	(7.423)	(11.49)	(11.35)	(10.91)	(22.94)	(26.00)	(37.44)
Beds	0.0544	0.0603	0.0268	0.0609	0.0631	0.0298	0.722	0.816	0.372
	(0.0469)	(0.0485)	(0.0701)	(0.0596)	(0.0612)	(0.0541)	(0.515)	(0.673)	(0.225)
GDP	0.414	0.428	0.487	-1.476***	-1.497***	-1.312***	-0.655	-0.715	2.372
	(0.503)	(0.499)	(0.523)	(0.393)	(0.392)	(0.425)	(1.827)	(1.923)	(1.406)
Observations	237	234	217	230	229	220	181	176	160
R-squared	0.558	0.461	0.445	0.418	0.411	0.468	0.294	0.293	0.466

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Country and time dummies included but not reported

The only other coefficients of note are those on the variables defining the proportion of females, the population aged between 15 and 65 and the GDP per capita. Generally in all sets of regressions these are always positive for the population variables and negative for GDP in the PTCA case. Noting that the equations are run in differences, the growth in PTCA surgery may partly reflect surgical intervention on less severe patients, consistent with the findings by Cutler and Huckman (2003). Coronary heart disease, which PTCA treats, may present as less severe in female and younger patients. With respect to GDP it is more difficult to find an explanation. However, given that we are estimating in differences, it may simply be that income growth slows technology uptake for PTCA as population could present better health status that do not require surgical intervention (but other type of treatment intervention), all other factors considered.

Conclusion

While it has long been believed that the Weisbrod (1991) propositions hold and that there is an inexorable link between the broadening and deepening of private health insurance coverage and the development of new health care technologies, there has been little explicit empirical examination of this thesis. In this study we have attempted to produce empirical tests of this thesis and find supportive evidence, at the aggregate level of a positive, dynamic relationship between private health care expenditure, including private insurance, and health care technology development. The mechanism for this relationship is consistent with the Weisbrod view that increasing coverage of health care insurance does lead to an incentive to provide new technology.

Moreover, although suggestive, while the results do support the Weisbrod hypothesis that insurance coverage leads to the development of new technologies through R&D, there is no support that insurance coverage in general leads to greater up-take of these technologies; at least as illustrated by MRI scanners and PTCA procedures. Moreover, the results do not support a cost-containing effect of governmental expenditures on health care R&D, as no statistical significant relationship was found to exist between these variables.

While an important step in attempting to pursue the Weisbrod hypothesis empirically, our results are indicative and better data, possibly on individual technologies would undoubtedly be worthwhile pursuing to produce a more substantive study. Given the many statistical difficulties in establishing causation, as associated with the dynamic nature of the relationship and issues of endogeneity, this study is a mere first step; but one that does at least provide partial, indicative support for the Weisbrod thesis as outlined some 20 years ago.

References

Bech, M., T. Christiansen, K. Dunham, J. Lauridsen, C. H. Lyttkens, K. McDonald, and A. McGuire (2009) The influence of economic incentives and regulatory factors on the adoption of treatment technologies: a case study of technologies used to treat heart attacks, Health Economics 18, 1114-1132.

Berndt, E.R., Bir,A., Busch, S.H., Frank, R.G. and Normand, S.L.T. (2002) The Medical Treatment Of Depression, 1991-1996: Productive Inefficiency, Expected Outcome Variations, And Price Indexes, Journal of Health Economics, 2002, v21(3,May), 373-396.

Breitung, J. and Pesaran, M.H. (2005) Unit roots and cointegration in panels. Deutsche Bundesbank Discussion paper, No. 42/2005.

Comin, D., and Hobjn, B. (2010) An exploration of technology diffusion, American Economic Review, 100, 2031-2059.

Cutler, D. (2004) Your Money or Your Life: Strong Medicine for America's Health Care System. New York, Oxford University Press.

Cutler,D., McClelan, M., Newhouse, J., Remler, D. (1998) Are medical prices declining? Evidence from heart attack treatments, Quarterly Journal of Economics, 113, 901-1024Cutler and McClellan 2001, Is technical change in medicine worth it? Health Affairs, 20, 11-29.

Cutler , D. M. and Huckman, R. S. (2003) Technological development and medical productivity: the diffusion of angioplasty in New York state. Journal of Health Economics, 22, 187-217.

Eggleston, K., Shah, N.D., Smith, S.A., Berndt, E.R., and Newhouse, J.P. (2011) Quality adjustment for health care spending on chronic diseases: Evidence from diabetes treatment, 1999-2001, American Economic Review, 101, 206-211.

Fuchs, V. (1984) Though Much is Taken : Reflections on Aging, Health and Medical Care, NBER Working Paper, No. 1269.

Goddeeris, J., (1984), Insurance and Incentives for Innovation in Medical Care, Southern Economic Journal, Vol. 51, 530-539

Im, K. S., Pesaran, M.H., and Shin, Y. (2003) Testing for unit roots in heterogeneous panels, Journal of Econometrics, 115, 53-74.

Jones, C. (2004) Why have health expenditure as a share of GDP risen so much?, U.C. Berkeley Working Paper.

OECD Health Data 2012, Paris, OECD.

Manning, W. (2000) Moral Hazard and Consumer Incentives in Health Care, in A. Cutler and J. Newhouse (eds) Handbook of Health Economics, Elsevier, Amsterdam.

McClellan, M., and Kessler, D. (2002) Technological Change in Health Care: A Global Analysis of Heart Attack Anne Arbor: The University of Michigan Press.

Newhouse, J. P. (1992) Medical Care Costs: How Much Welfare Loss? The Journal of Economic Perspectives, 6, 3-21.

Oukande, A. and Murthy, V. (2002) Technology as a major dirver of health care costs: a cointegration analysis of the Newhouse conjecture, Journal of Health Economics, 21, 147-159.

Pauly, M. (1988) Market power, monopsony and health insurance markets, Journal of Health Economics, 7, 111-118.

Smith, S., J. P. Newhouse, and M. S. Freeland (2009) Income, Insurance, And Technology: Why Does Health Spending Outpace Economic Growth? Health Affairs 28:1276-1284.

TECH Research Network (2001) Technological change around the world: Evidence from Heart Attack Care, Health Affairs, 20, 25-41.

Weisbrod, B. A. (1991) The health care quadrilemma: an essay on technological change, insurance, quality of care and cost containment, Journal of Economic Literature, 29, 523-522.

Weisbrod, B.A. and LaMay, C.L. (1999) Mixed signals: public policy and the future of health care R&D Health Affairs, 18, no.2 (1999):112-125.

Zweifel, P. (2003), "Medical innovation: A challenge to society", The Geneva Papers on Riks and Insurance - Issues and Practice, 28(2), 194-2002.

Zweifel P., Manning, W.G. (2000), "Moral Hazard and consumer incentives in health care", in Culyer and Newhouse (eds), Handbook of Health Economics, Boston, Chapter. 8.

Zweifel, P., Felder, S., and Werblow, A. (2004) Population ageing and health care expenditure: new evidence on the `red herring'. Geneva Papers on Risk and Insurance: Issues and Practice 29, 653--667.