Hybrid Risk Adjustment for Total Health Expenditures

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AIES. Firenze, October 19, 2007

Hybrid Risk Adjustment for Total Health Expenditures

1. Introduction
2. Data and Methodology
3. Hybrid Risk Adjustment
4. Conclusions

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Introduction

Motivation:

- Large increase in Health care costs in last years.
- But the increase is not equal for everyone.
- It becomes important to predict cost for each group of individuals
  - Dependence of clinical characteristics (CRG classification system)
  - Knowledge of individual total health expenditures (inpatient and outpatient care, drugs,…)

Usually, **Risk Adjustment** is used to control the cost: Reimbursement to plans based on capitated payment

Consequences: tradeoff between selection and efficiency

\+ Efficiency incentives: benefit from savings

\- Selection incentives: avoid unprofitable enrollees. Origin: better predictions

However, Risk Adjustment does not solve the selection problem. Alternatives:

RISK SHARING

- Payment based on *ex post* information on costs. Used to reduce selection while preserving incentives for efficiency
- Newhouse (1996): mixed payment system (prospective and retrospective) permits tradeoff between selection and efficiency in production. Hybrid system:
  - Only prospective: (+) efficiency (-) selection
  - Only retrospective: (-) efficiency (+) selection

- Earlier analysis using only drug expenditures

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Data and Methodology

- Baix Empordà (Girona, Spain)
  - integrated healthcare management organization, Serveis de Salut Integrats Baix Empordà (SSIBE):121,720 inhabitants in 2004.
    - Only one hospital: Palamós.
    - Five areas of Primary Care: Palamós, Torroella, la Bisbal, Palafrugell, and Sant Feliu de Guíxols. Estimation for all except for Sant Feliu de Guixols (incomplete data).
    - Individual data for years 2004 and 2005 with N=92273 (N=89722 in 2004 and N=90849 in 2005).
  - Information system:
    - Identify all the activity (primary care, hospital, or specialist) for each patient
    - All the activity is codified in ICD9-CM
    - Total health expenditures included pharmaceutical expenditures.

Data and Methodology

- Clinical Risk Group (CRG) classification system:
  - classifies individuals in mutually exclusive categories from the clinical perspective using information from contacts between the health system and the patient.
  - The CRG software reads the codes for the different contacts,
    - assigns a diagnosis category group (CRG)
    - then it groups by health status (acute or chronic) defined within a CRG.
    - Finally, if the patient is chronic, the system assigns a level of severity.
  - There are different aggregation levels
  - We use the ACRG2: 55 categories with 176 mutually exclusive clinical risk groups. However, in order to capture better predictions we aggregate some CRG categories (following compatible criteria to the CRG classification) so that the number of individuals in each group is large enough to obtain consistent estimators:
    - 95 mutually exclusive CRG categories.

Data and Methodology

$$HealthExpenditures_{i,t} = f(age_{i,t-1}, sex_i, HealthStatus_{i,t-1,t}, \varepsilon_{i,t})$$

- where
  - Annual health expenditures for individual i,
  - Demographic characteristics (i)
  - Health Status (i)

- Different models (specification is the linear regression model):
  - Model 1: only demographic information
  - Model 2: prospective models
  - Model 3: concurrent models

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Hybrid Risk Adjustment

- Following Newhouse (1996), we propose to use a hybrid system. We apply the methodology used by:
  - R. Adams Dudley, Harold Luft et al.The best of both worlds? Potential of hybrid prospective/concurrent risk adjustment. Medical Care 2003;41:56-59
    - Prospective payment for low expected cost patients (90,7% population – 51,5 % expenditure) (they do not include > 65 years old belonging to Medicare)
    - Concurrent payment for high expected cost patient (with a diagnostic of expected high cost (9,3% population – 48,5 % expenditures)
    - They construct the division high-low expected cost through an study of the 100 highest cost conditions in the ICD9-CM classification.
    - They are named the VEP100 conditions: Verifiable, Expensive, Predictive conditions. Patients suffering those conditions are presumably those towards risk selection can be addressed.
  - We utilize the same classification proposed by Dudley et al. With the VEP100 conditions.
    - However, we use it under a different classification system (CRGs)
    - In order to provide a sensitivity analysis we also try with the 50 VEP of highest cost.
    - Thus:
      - prospective payment for individuals not suffering the set of VEP conditions
      - Concurrent payment for individuals suffering any VEP condition

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Table 1: Descriptive statistics of the sample.

	Average	Std. Deviation		
Age in 2004	40.20	23.17		
	2004		2005	
Average pharmacy cost	191,33		207,86	
Total health expenditures	513,2		559,68	
	N	%	N	%
Gender				
Males	45339	50.56	44643	50.55
Females	44328	49.44	43655	49.45
All patients with zero total health expenditure	20904	22.40	19020	20.93
All patients with zero drug expenditure	33669	37.54	32071	35.30
Patients by health conditions				
Healthy with zero total health expenditure	20035	22.34	19014	20.92
Healthy with non-zero drug expenditure	43539	48.55	43054	47.40
History Of Significant Acute Disease	8398	9.37	8332	9.17
Single Minor Chronic Disease	4776	5.33	5200	5.72
Minor Chronic Disease In Multiple Organ Systems	522	0.58	772	0.85
Single Dominant Or Moderate Chronic Disease	8475	9.45	9754	10.74
Significant Chronic Disease In Multiple Organ Systems	3050	3.40	3942	4.34
Dominant Chronic Disease In Three Or More Organ Systems	258	0.29	309	0.34
Dominant. Metastatic. And Complicated Malignancies	444	0.50	302	0.33
Catastrophic Conditions	170	0.19	170	0.19

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Is that set of VEP conditions valid in our sample?

Table 2: Relative cost weights by the presence of VEP conditions.

	2004			2005		
Presence of VEP100 Conditions	**Mean Annual Cost**	**Mean Annual Relative Cost Weight**	**Sum patients**	**Mean Annual Cost**	**Mean Annual Relative Cost Weight**	**Sum patients**
Patients with no VEP100 conditions	310.17	0.60	77767 (86.73%)	331.07	0.59	78058 (85.90%)
Patients with at least one VEP100 condition	1840.05	3.58	11900 (13.27%)	1954.78	3.49	12791 (14.10%)
Patients with no VEP50 conditions	329.76	0.64	80320 (89.57%)	374.03	0.66	82663 (90.99%)
Patients with at least one VEP50 condition	2089.53	4.07	9347 (10.43%)	2434.41	4.34	8186 (9.01%)
all patients	513.20	1.00	89667 (100%)	559.68	1.00	90849 (100%)

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Is that set of VEP conditions valid in our sample?

Table 3: Distribution of health conditions and presence of VEP100 in patients.

Health conditions by Clinical Risk Groups (highest level of aggregation)	Patients with no VEP100 in 2004		Patients with at least one VEP100 in 2004		Patients with no VEP100 in 2005		Patients with at least one VEP100 in 2005	
	N	% by CRG	N	% by CRG	N	% by CRG	N	% by CRG
Healthy	60882	95.76	2692	4.24	59411	95.71	2657	4.29
History Of Significant Acute Disease	6481	77.18	1917	22.82	6383	76.61	1949	23.39
Single Minor Chronic Disease	4216	88.27	560	11.73	4536	87.23	664	12.77
Minor Chronic Disease In Multiple Organ Systems	436	83.53	86	16.47	625	80.96	147	19.04
Single Dominant Or Moderate Chronic Disease	4770	56.28	3705	43.72	5688	58.31	4066	41.69
Significant Chronic Disease In Multiple Organ Systems	964	31.61	2086	68.39	1382	35.05	2560	64.95
Dominant Chronic Disease In Three Or More Organ Systems	10	3.87	248	96.13	26	8.42	283	91.58
Dominant, Metastatic, And Complicated Malignancies	5	1.12	439	98.88	6	1.98	296	98.02
Catastrophic Conditions	3	1.76	167	98.24	1	0.005	169	99.99

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Is that set of VEP conditions valid in our sample?

Table 4: Distribution of health conditions and presence of VEP50 in patients.

Health conditions by Clinical Risk Groups (highest level of aggregation)	Patients with no VEP50 in 2004		Patients with at least one VEP50 in 2004		Patients with no VEP50 in 2005		Patients with at least one VEP50 in 2005	
	N	% by CRG	N	% by CRG	N	% by CRG	N	% by CRG
Healthy	61763	97.15	1811	2.85	60702	97.79	1366	2.21
History Of Significant Acute Disease	6995	83.30	1403	16.70	7201	86.43	1131	13.57
Single Minor Chronic Disease	4430	92.75	346	7.25	4903	94.28	297	5.72
Minor Chronic Disease In Multiple Organ Systems	476	91.19	46	8.81	699	90.55	73	9.45
Single Dominant Or Moderate Chronic Disease	5417	63.91	3058	36.09	7145	73.25	2609	26.75
Significant Chronic Disease In Multiple Organ Systems	1155	37.87	1895	62.13	1932	49.02	2010	50.98
Dominant Chronic Disease In Three Or More Organ Systems	14	5.42	244	94.58	42	13.59	267	86.41
Dominant, Metastatic, And Complicated Malignancies	65	14.64	379	85.36	37	12.26	265	87.74
Catastrophic Conditions	5	2.94	165	97.06	2	1.17	168	98.83

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Table 5: R-squared of the different risk adjustment models

Predictors	R-squared total health expenditures	R-squared drug expenditures	Percentage of patients	Timing	N	Number of parameters
Model using only demographic information						
M1: Only demographic information	0.0728	0.0501	100.00%	Prospective	90849	12
Prospective models including diagnostic and procedures information						
M2a: Only information on CRG conditions	0.1995	0.1281	100.00%	Prospective	90849	82
M2b: Demographic and CRG conditions information	0.2187	0.1429	100.00%	Prospective	90849	94
M2c: Demographic, CRG and existence of VEP100 information	0.2473	0.1605	100.00%	Prospective	88298	194
Concurrent models including diagnostic and procedures information						
M3a: Only information on CRG conditions	0.3259	0.1544	100.00%	Concurrent	90849	82
M3b: Demographic and CRG conditions information	0.3336	0.1640	100.00%	Concurrent	90849	94
M3c: Demographic, CRG and existence of VEP100 information	0.4614	0.3393	100.00%	Concurrent	90849	194
Dividing the sample between those with and without VEP100 in 2003						
M4a: Only information on CRG conditions	0.2211	0.1089	14.07%	Concurrent	12791	82
M4b: Demographic and CRG conditions information	0.2300	0.1151	14.07%	Concurrent	12791	94
M4c: Demographic, CRG and VEP information	0.4614	0.3393	14.45%	Concurrent	12791	194
M5a: Only information on CRG conditions	0.1322	0.0861	85.93%	Prospective	78058	82
M5b: Demographic and CRG conditions information	0.1603	0.1213	85.93%	Prospective	78058	94
M5c: Demographic, CRG and VEP information	0.1685	0.1313	85.55%	Prospective	75717	194
M6a: Hybrid Model (concurrent m4a for 14.07 and prospective m5a for 85.93%)	0.2006	0.1040	85.93%+14.07%	Hybrid	90849	82
M6b: Hybrid Model (concurrent m4b for 14.07% and prospective m5b for 85.93%)	0.2140	0.1164	85.93%+14.07%	Hybrid	90849	94
M6c: Hybrid Model (concurrent m4c for 14.45% and prospective m5c for 85.55%)	0.3571	0.3018	85.55%+14.45%	Hybrid	88508	194
Dividing the sample between those with at least one of the 50 VEP100 more expensive conditions in 2005						
M7a: Only information on CRG conditions	0.2003	0.0984	9.01%	Concurrent	8186	82
M7b: Demographic and CRG conditions information	0.2079	0.1026	9.01%	Concurrent	8186	94
M7c: Demographic, CRG and VEP information	0.4618	0.4432	9.26%	Concurrent	8186	194
M8a: Only information on CRG conditions	0.1481	0.1017	90.99%	Prospective	82663	82
M8b: Demographic and CRG conditions information	0.1761	0.1387	90.99%	Prospective	82663	94
M8c: Demographic, CRG and VEP information	0.1855	0.1475	90.74%	Prospective	80201	194
M9a: Hybrid Model (concurrent m7a for 9.01% and prospective m8a for 90.99%)	0.1849	0.0992	90.99%+9.01%	Hybrid	90849	82
M9b: Hybrid Model (concurrent m7b for 9.01% and prospective m8b for 90.99%)	0.1985	0.1115	90.99%+9.01%	Hybrid	90849	94
M9c: Hybrid Model (concurrent m7c for 9.26% and prospective m8c for 90.74%)	0.3800	0.3704	90.74%+9.26%	Hybrid	88387	194

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		Prospective models				Concurrent models			Hybrid model dividing population by appearance of at least one VEP100 condition in 2005			Hybrid model dividing population by appearance of at least one VEP50 condition in 2005		
	N from validating sample of 45142	M1: Only dem.Info	M2a: Only info on CRGs	M2b: Dem. and CRGs info	M2c: Dem. CRG and VEP100 info	M3a: Only info on CRGs	M3b: Dem. and CRGs info	M3c: Dem. CRG and VEP100 info	M6a: Hybrid Model. Only info on CRGs	M6b: Hybrid Model, Dem. and CRGs info	M6c: Hybrid Model, Dem. CRG and VEP100 info	M9a: Hybrid Model. Only info on CRGs	M9b: Hybrid Model, Demo and CRGs info	M9c: Hybrid Model, Demo, CRG and VEP100 info
total	45142	1,0431	1,0509	1,0525	1,0669	1,0223	1,0520	1,0218	1,0311	1,0312	1,0491	1,0343	1,0356	1,0433
Predictive Ratios by health conditions in 2005														
Healthy	30941	2,3963	1,9527	1,8239	1,8187	1,0492	1,0469	1,0419	1,5259	1,4763	1,4898	1,6145	1,5529	1,5563
History Of Significant Acute Disease	4101	0,6037	0,6617	0,6669	0,6610	1,0267	1,0304	1,0601	0,7663	0,7662	0,8084	0,7311	0,7352	0,7276
Single Minor Chronic Disease	2533	0,9438	0,9282	0,9743	0,9732	1,0118	1,0138	1,0021	0,7866	0,8193	0,8184	0,7996	0,8379	0,8289
Minor Chronic Disease In Multiple Organ Systems	381	0,7600	0,7549	0,8374	0,8376	1,0302	1,0493	1,0452	0,7100	0,7612	0,7437	0,6943	0,7518	0,7368
Single Dominant Or Moderate Chronic Disease	4807	0,7253	0,8583	0,9173	0,9294	0,9618	0,9602	0,9993	0,8312	0,8522	0,9046	0,8135	0,8425	0,8914
Significant Chronic Disease In Multiple Organ Systems	1987	0,5038	0,6834	0,7395	0,7504	1,0625	1,0653	1,0012	0,9548	0,9699	0,9061	0,9039	0,9243	0,8643
Dominant Chronic Disease In Three Or More Organ Systems	162	0,2682	0,4425	0,4694	0,5110	0,9399	0,9410	0,9301	0,9119	0,9144	0,9041	0,8741	0,8776	0,8704
Dominant, Metastatic, And Complicated Malignancies	147	0,2594	0,4040	0,4324	0,4432	1,1500	1,1490	1,1685	1,1435	1,1434	1,1676	1,0929	1,0950	1,1543
Catastrophic Conditions	83	0,0603	0,8028	0,7990	0,7295	1,2804	1,2779	1,1780	1,2656	1,2627	1,1611	1,2758	1,2753	1,1551
Predictive Ratios by deciles of drug expenditures in 2005														
decile 1 to 5	22628	9,0129	6,5030	5,8186	5,7242	3,6334	3,3458	3,2141	5,0562	4,6936	4,6816	5,3498	4,9659	4,9058
decile 6	4592	2,1210	2,2266	2,0557	2,0338	1,9852	1,9067	2,0293	1,9067	1,8019	2,0018	1,9256	1,8250	1,8172
decile 7	4455	1,5788	1,7229	1,6818	1,6405	1,6514	1,6250	1,5466	1,4896	1,4554	1,4446	1,4875	1,4641	1,4681
decile 8	4530	1,1627	1,2732	1,3030	1,2944	1,3354	1,3506	1,2813	1,1910	1,2028	1,1766	1,1726	1,1910	1,1657
decile 9	4411	0,8480	0,9130	1,0007	1,0156	1,0528	1,0945	1,1137	0,9394	0,9889	1,0196	0,9076	0,9636	1,0038
decile 10	4574	0,3101	0,4367	0,4714	0,4911	0,5604	0,6190	0,6448	0,5506	0,5696	0,5656	0,5460	0,5644	0,5597
Predictive Ratios by appearance of VEP procedures in 2005														
no VEP100 in 2005	38901	1,5849	1,4093	1,3785	1,3595	1,1249	1,1735	0,9832	1,0276	1,0307	1,0473	1,1102	1,1107	1,1142
at least one VEP100 in 2005	6241	0,4652	0,6728	0,7097	0,7556	0,9227	0,9321	1,0633	1,0473	1,0441	1,0413	0,9639	0,9661	0,9653
no VEP50 in 2005	41140	1,4306	1,3123	1,2883	1,2727	1,1071	1,1457	1,0025	1,0640	1,0553	1,0471	1,0269	1,0298	1,0412
at least one VEP50 in 2005	4002	0,4212	0,6356	0,6792	0,7344	0,8960	0,9115	1,0534	0,9900	1,0045	1,0426	1,0591	1,0578	1,0355

Table 6: Predictive Ratios for the different risk adjustment models

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Conclusions

- Prospective models explain around 24% of the variance in the total health expenditures using information of CRG categories and VEP conditions.
- Concurrent models increases the predictive power up to 33% (CRGs) y 46% (CRGs+VEP) for total health expenditures
- Dividing population into groups with or without VEP100 (VEP50) conditions through the hybrid model, the predictive power of the prospective model is reduced. As a consequence, ***for patients at risk of suffering risk selection*** (around 12%):
  - Efficiency incentives are reduced
  - But risk selection incentives are eliminated
- There are no negative effects for the rest of the population
- Using the Predictive Ratios, we observe how the hybrid risk adjustment model obtain better estimations for individuals suffering VEP conditions and similar estimations for the rest of the population.
- Integrated healthcare management organizations can benefit from Hybrid Risk Adjustment Models that would allow to set better and more realistic budget constraint for total health expenditures depending on the morbility,
  - Providing incentives for efficiency.
  - Reducing incentives for risk selection
- More research is needed in the refinement of the definition of high cost conditions (even with VEP50, still too much concurrent reimbursement: near 50% with VEP100 and near 40% with VEP50)