

ESTIMATING EXPECTED HEALTH OPPORTUNITY COSTS IN THE NHS

(Analysis of 2009/10 Expenditure Data)

YORK TEAM

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Summary

This document comprises of two appendices:

Summary of Appendix 1: Outline of data update, estimation strategy, and results for outcome and expenditure models for 2009/10

Starting point: the 2008/09 specification

1. Identify the preferred specification for the PCT-level outcome and expenditure equations for each programme budget category (PBC) for 2008/09. The outcome and expenditure elasticities generated by these specifications, when re-estimated at LA-level with updated census data, are shown in Table 1.

Re-estimate the 2008/09 specifications using updated data

2. The 2008/09 specifications were derived using PCT-level data. Update PCT-level data to 2009/10 and put updated PCT-level data through the appropriate mapper to obtain LA-level data. This will include updating and mapping:

- the PB expenditure data from 2008/09 to 2009/10
- the raw population, unified weighted population, and MFF estimates used and implied from the 2009/10 DH resource allocation exposition book
- PB specific indices of need (eg infectious diseases, mental health, maternity) from the DH resource allocation exposition book
- PB specific disease prevalence rates as extracted from the HSCIC's QOF database

3. Obtain LA-level statistics for those variables that are reported at this unit of analysis. This will involve updating PCT-level data for 2008/09 and replacing it with LA-level data relevant to 2009/10. This will include updating and replacing:

- mortality data for 2008/9/10 with data for 2009/10/11
- census-based variables for 2001 with data for 2009 (by appropriate interpolation between 2001 and 2011)

Estimation strategy for 2009/10

4. Having updated all data, re-estimate each outcome and expenditure equation for 2009/10 using exactly the same specification as that employed for 2008/09 (this was the preferred PCT-level specification with 2001 Census data).

5. If this re-estimation produces a result which (a) passes the appropriate statistical tests and (b) generates coefficients in line with theoretical priors, use this result as our preferred result for 2009/10. This rule is applied to cases where the preferred specification for 2008/09 is either IV or OLS. If this re-estimation produces an acceptable result, the resulting elasticity shown in Table 1 has a '--' in the next column.

6. If the re-estimation produces a result which does not pass tests/have coefficients in line with priors, re-estimate the equation having adjusted the specification as suggested by the initial result.

So, for example, if the initial estimation implies the presence of weak instruments and one of the instruments is insignificant in the first-stage regression, try re-estimating the equation without the insignificant instrument. And if, for example, one of the regressors in the second-stage regression is insignificant, try re-estimating without it. If this re-estimation produces an acceptable result, the resulting elasticity shown in Table 1 has an 'A' in the next column.

7. If a relatively minor adjustment to the 2008/09 specification does not generate a statistically and theoretically acceptable result, re-derive the IV equation to be estimated (again, this applies to cases where the preferred specification for 2008/09 is either IV or OLS). That is, use OLS with backward stepwise regression to identify relevant covariates to be included in the second-stage regression having forced in the relevant variables throughout. For the outcome equation we force in own programme expenditure, and for the expenditure equation the other programme need variable and the total budget term are forced in throughout the stepwise procedure.

8. Having identified relevant covariates for the second-stage regression, again use stepwise backward regression to identify relevant instruments for the first-stage conditioning on the covariates for the second-stage identified above. In other words, these second-stage covariates are forced in throughout stepwise procedure to identify relevant instruments.

9. Having identified covariates for the second-stage (in 7 above) and instruments for the first-stage (in 8 above), re-estimate the IV specification equation using these two sets of variables. If the endogeneity test suggests that a variable (eg own programme expenditure in the outcome equation) is clearly not endogenous then re-estimate using OLS. If this re-estimation produces an acceptable result, the resulting elasticity shown in Table 1 has a 'B' in the next column.

10. If the above re-estimation approach produces a result which does not pass tests/have coefficients in line with priors, re-estimate the equation having adjusted the specification as suggested by the initial result (for example, if the result fails the misspecification test try adding the squared value of one of the regressors to the specification). If this re-estimation produces an acceptable result, the resulting elasticity shown in Table 1 has a 'C' in the next column.

11. If all of the above approaches fail to produce an acceptable result, consider excluding PCTs with extreme values of expenditure per person. Only explore this option for programmes with small amounts of expenditure and/or mortality. If this re-estimation approach produces an acceptable result, the resulting elasticity shown in Table 1 has a 'D' in the next column.

Results for 2009/10

12. The estimation strategy outlined above generated the outcome and expenditure elasticities for 2009/10 shown in Table 1.

13. The full result [IV (second-stage) or OLS] associated with each elasticity reported in Table 1 can be found in Table A3 (for the outcome equations) and Table A4 (for the expenditure equations) in the appendix.

14. The full estimation path for each result (starting with the re-estimation of the 2008/09 specification with updated data both) can be found in Table A5 (for the outcome equations) and Table A6 (for the expenditure equations) in the appendix.

Table 1 Outcome and expenditure elasticities for 2008/09 and 2009/10

PBC	PBC description	for 2008/09				for 2009/10				for 2010/11				for 2011/12				for 2012/13				
		Outcome	IV	Spend	OLS	Outcome	Re-estimation	Spend	Re-estimation													
#		elasticity	IV	elasticity	OLS	elasticity	Re-estimation	elasticity	Re-estimation													
1	Infectious diseases	-0.466**	IV	1471**	OLS	-0.310*	A	0.968***	—													
2	Cancers and tumours	-0.287***	IV	0.518*	IV	-0.345***	—	0.502**	A													
3	Diseases of the blood	n/a		1071*	OLS	n/a		1060***	B													
4	Endocrine, nutritional, metabolic	-0.746*	IV	0.367	IV	-1075**	A	0.708***	—													
5	Mental health disorders	n/a		0.995***	OLS	n/a		0.899***	—													
6	Learning disability	n/a		0.037	IV	n/a		0.647**	B													
7	Neurological problems	-0.304	IV	0.897***	IV	-1357	C	0.850***	—													
8	Vision problems	n/a		0.503	IV	n/a		0.934***	A													
9	Hearing problems	n/a		1223	OLS	n/a		1273***	C													
10	Circulatory problems	-1384***	IV	0.614	IV	-1842***	—	0.494*	—													
11	Respiratory problems	-1940***	IV	0.752**	IV	-2.103***	B	0.576***	—													
12	Dental problems	n/a		0.404**	OLS	n/a		0.765***	B													
13	Gastro-intestinal problems	-1553**	IV	0.520*	IV	-1989*	A	0.387*	—													
14	Skin problems	n/a		0.677**	IV	n/a		0.890***	D													
15	Musculo-skeletal problems	n/a		0.413	IV	n/a		0.295	B													
16	Trauma and injuries	0	n/a	1344***	OLS	0	B	1090***	—													
17	Genito-urinary problems	-0.346	IV	0.733***	OLS	-2.997	B	0.878***	—													
18	Maternity and reproductive health	0.043	IV	0.963***	IV	-0.166*	B	0.653***	—													
19	Neonates																					
20	Poisoning and adverse events	n/a		0.674*	IV	n/a		0.658**	—													
21	Healthy individuals	n/a		0.952	OLS	n/a		1246**	—													
22	Social care needs	n/a		0.830	OLS	n/a		0.844	B													
23	Other (includes GMS/PMS)	n/a		0.494***	OLS	n/a		0.564***	B													

Notes: (i) see pp12 of text for the meaning of the symbols in 're-estimation' columns;
(ii) there are no 're-estimation' columns for 2008/09 because these results were obtained by re-estimating preferred PCT-level specifications using LA-level data for this year (i.e., there were no changes to model specification).

Summary of Appendix 2: Expected health opportunity costs in the NHS (2009/10 results)

Overview

15. In the second appendix results are presented that reflect the available data for 2009/10 expenditure (this forms Appendix 2.1). In Appendix 2.2, the results are also analysed in terms of how sensitive the results are to two key inputs: i) each of the estimated elasticities and ii) assumptions made in order to overcome data limitations for each PBC (only have mortality outcome data and for only a portion of PBCs). Finally, Appendix 2.3 considers an update regarding data from ONS used to inform burden of disease.

Results

16. Results are presented in two ways as the point estimate of the cost per QALY of marginal activity in the NHS, or alternatively expressed as the expected QALY health opportunity cost for £10,000,000 expenditure. To highlight the contribution of each of the updated inputs, results are first presented where elasticities estimated from 2009/10 data and 2009/10 expenditure levels are applied to 2008-2010 burden and, secondly, with elasticities estimated from 2009/10 data and 2009/10 expenditure levels applied to 2009-2011 burden. In addition, we display the results with 2008-2010 burden in two ways, one with 2008-2010 burden as recorded in Claxton et al. (2015) and another where 2008-2010 burden inputs are re-calculated using the updated data presented in Appendix 2.3. These are shown in Table 2, which can also be found in Appendix 2.1.

Table 2 results for 2009/10 expenditure compared to previously generated results

2008/9 elasticities and expenditures with 2008-10 ONS data according to Claxton et al. (2015)

(1)	Point estimate	5th percentile	95th percentile
Cost per QALY	£13,227	£8,121	£34,069
Health opportunity costs of £10mn (QALYs)	756	294	1,231

2008/9 elasticities and expenditures with re-calculated 2008-10 ONS data

(2)	Point estimate	5th percentile	95th percentile
Cost per QALY	£13,095	£8,158	£38,652
Health opportunity costs of £10mn (QALYs)	764	259	1,226

2009/10 elasticities and expenditures with re-calculated 2008-10 ONS data

(3)	Point estimate	5th percentile	95th percentile
Cost per QALY	£9,655	£6,771	£17,012
Health opportunity costs of £10mn (QALYs)	1,036	588	1,477

2009/10 elasticities and expenditures with 2009-11 ONS data

(4)	Point estimate	5th percentile	95th percentile
Cost per QALY	£9,662	£6,650	£16,784
Health opportunity costs of £10mn (QALYs)	1,035	596	1,504

It can be seen from Table 2 that the expected health opportunity costs of a change in expenditure have increased between 2008/09 and 2009/10 and so the cost per QALY ratio has fallen. In this table, the uncertainty associated with these estimates is shown and it can be judged to what extent any changes in the point estimate between years should be interpreted as a signal of any trend. From Table 2 it is hard to conclude that there is a significant fall in the health opportunity costs of £10mn expenditure, since there is a great deal of overlap between the 90% confidence intervals.

Figure 1 Results illustrating uncertainty for 2009/10 and previously generated results – cost per QALY

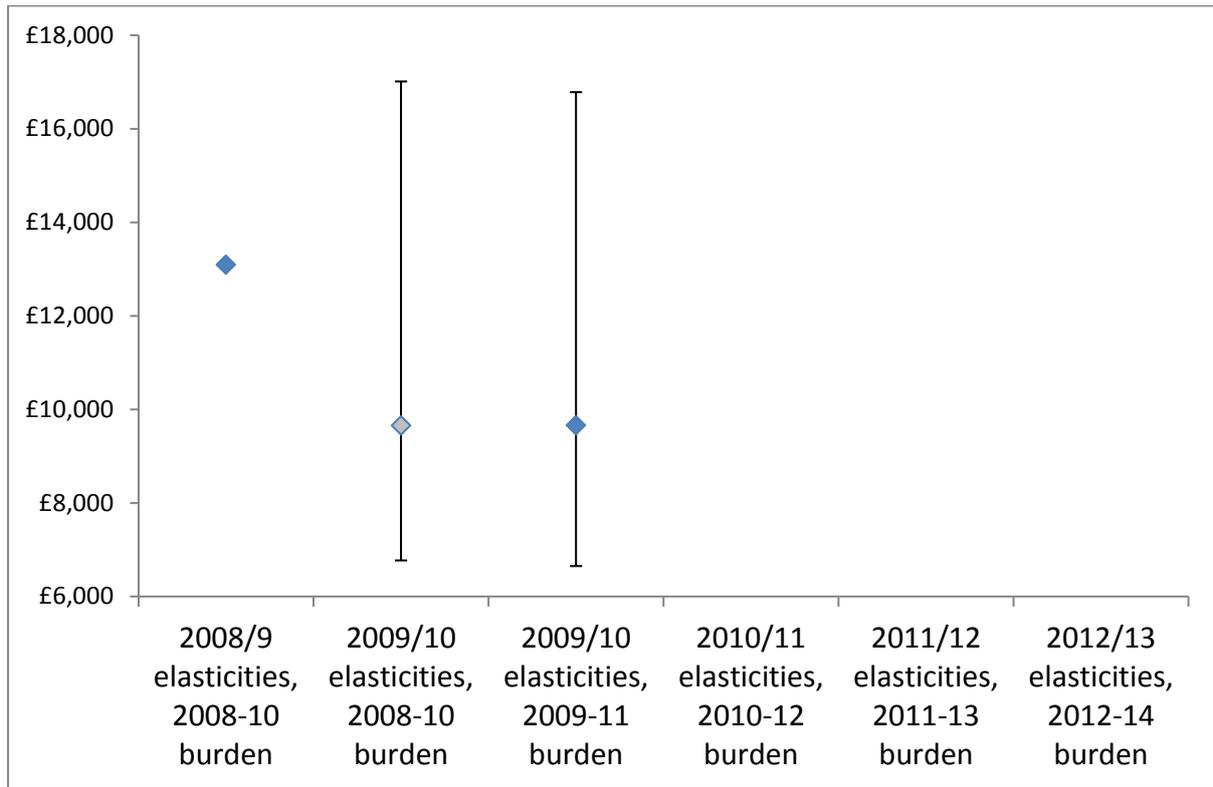
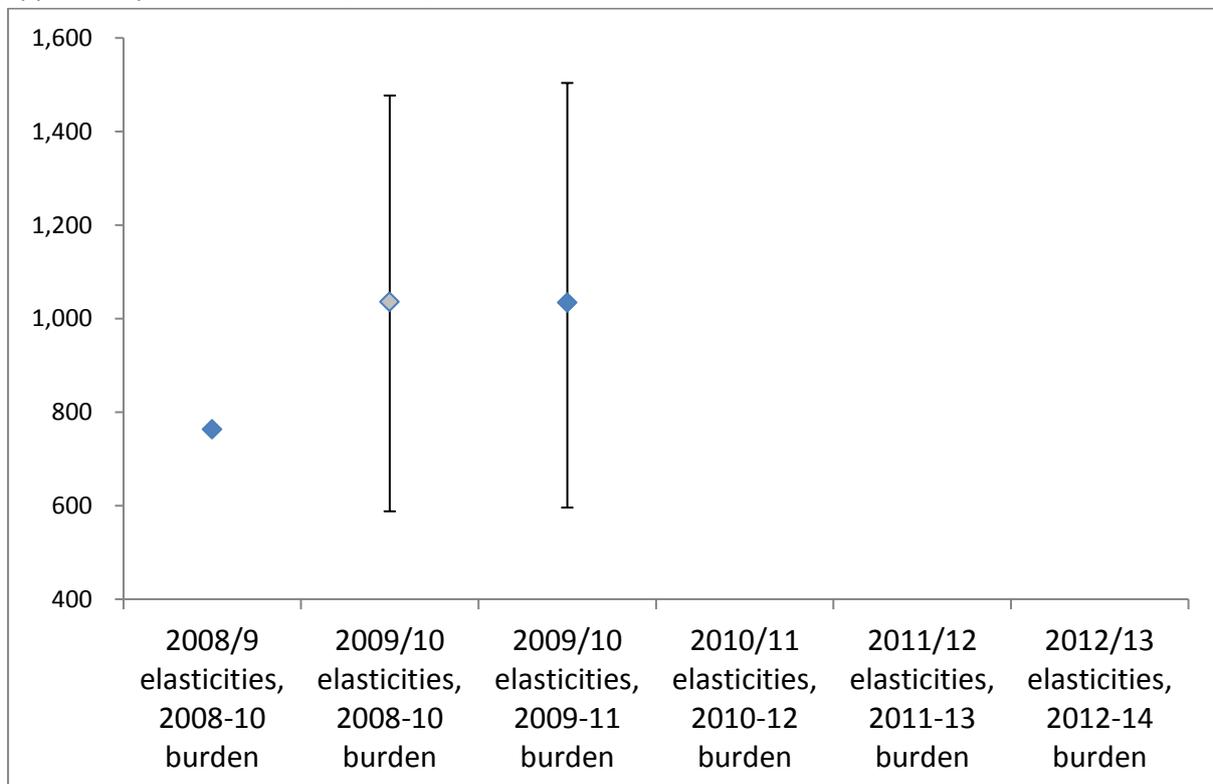


Figure 2 Results illustrating uncertainty for 2009/10 and previously generated results – Health opportunity costs of £10mn (QALYs)



17. The results contained within Table 2 are also represented graphically in Figures 1 and 2. The confidence intervals are presented for results pertaining to 2009/10 elasticities, but not for 2008/9 elasticities. The reason for this is that the specifications used for 2009/10 equations were adjusted if a re-application of 2008/9 specifications resulted in poor statistical performance (see Appendix 1). The specification of the 2008/9 models, however, were directly taken from Claxton et al. (2015) where there were two key differences: analysis was at PCT and not LA level and census variables used 2001 values not 2009 values (calculated by interpolation between 2001 and 2011 census data). As such, the specification in the 2008/9 models may not have passed all statistical performance tests once moved to LA level and the instruments were updated to 2009 values (e.g 2008/9 specification may possess weak instruments that lead to imprecise coefficient estimation).

18. It can also be seen from Figures 1 and 2 that while the confidence interval is far from symmetrically distributed around the point estimate of the cost per QALY ratio in Figure 1 (where uncertainty is reflected in the denominator), when expressed as health opportunity costs per £10mn then the distribution of uncertainty is much more symmetric in Figure 2 (uncertainty is reflected in the numerator).

Sensitivity analysis

19. Appendix 2.2 details three sensitivity analyses that were performed. The first two concerned the elasticities that were econometrically estimated for each of the PBCs. In the first case each of the estimated PBC outcome elasticities are varied by +/- 1 standard error. Then, the difference between the two resulting opportunity costs is presented. When this is larger, this implies that the overall resulting estimate of health opportunity costs is more sensitive to the outcome elasticity under consideration. The same procedure is then carried out for each of the PBC expenditure elasticities. The results of these sensitivity analyses are reported in Tables 3 and 4, with analysis and interpretation found in Appendix 2.2.

Table 3 Sensitivity of results to estimated outcome elasticities

	Change in spend	Change in QALY death + QALY alive	Implied PBC cost per QALY (£)	Difference in health opportunity costs between +1 SE and -1 SE in PBC outcome elasticity	% difference in health opportunity costs between +1 SE and -1 SE in PBC outcome elasticity	Importance of PBC (rank)
2 Cancer	£457,412.96	28	£16,523.87	25	2.44%	7
10 Circulatory	£579,645.11	105	£5,544.45	62	5.96%	6
11 Respiratory	£411,572.52	218	£1,889.33	192	18.55%	2
13 Gastro-intestinal	£283,693.87	51	£5,583.95	83	8.05%	4
1 Infectious diseases	£221,354.67	5	£41,541.64	9	0.87%	8
4 Endocrine	£295,384.86	73	£4,056.79	74	7.16%	5
7 Neurological	£545,689.03	292	£1,866.46	403	38.93%	1
17 Genito-urinary	£627,621.24	22	£28,904.12	136	13.11%	3
16 Trauma & injuries* Maternity & neonates*	£657,736.33	0	-	-	-	-
18+19	£501,566.02	0	£2,765,793.49	4	0.39%	9
3 Disorders of Blood	£205,789.96	31	£6,617.68	-	-	-
5 Mental Health	£1,561,506.83	130	£12,006.32	-	-	-
6 Learning Disability	£319,501.78	3	£93,016.80	-	-	-
8 Problems of Vision Problems of	£302,392.67	10	£31,719.56	-	-	-
9 Hearing	£103,679.04	24	£4,401.21	-	-	-
12 Dental problems	£435,457.38	16	£27,304.33	-	-	-
14 Skin	£284,676.08	4	£70,447.88	-	-	-
15 Musculo skeletal	£222,739.45	21	£10,443.12	-	-	-
20 Poisoning and AE	£113,531.55	2	£75,437.15	-	-	-
21 Healthy Individuals	£410,002.60	1	£341,922.60	-	-	-
22 Social Care Needs	£285,440.64	0	-	-	-	-
23 Other	£1,173,605.40	0	-	-	-	-

Total: 1,035

Table 4 Sensitivity of overall results to estimated spend elasticities

	Change in spend	Change in QALY death + QALY alive	Implied PBC cost per QALY (£)	Difference in health opportunity costs between +1 SE and -1 SE in PBC spend elasticity	% difference in health opportunity costs between +1 SE and -1 SE in PBC spend elasticity	Importance of PBC (rank)
2 Cancer	£457,412.96	28	£16,523.87	36	3.51%	8
10 Circulatory	£579,645.11	105	£5,544.45	71	6.86%	3
11 Respiratory	£411,572.52	218	£1,889.33	144	13.90%	1
13 Gastro-intestinal	£283,693.87	51	£5,583.95	36	3.49%	9
1 Infectious diseases	£221,354.67	5	£41,541.64	16	1.52%	14
4 Endocrine	£295,384.86	73	£4,056.79	24	2.34%	12
7 Neurological	£545,689.03	292	£1,866.46	126	12.19%	2
17 Genito-urinary	£627,621.24	22	£28,904.12	1	0.13%	22
16 Trauma & injuries* Maternity & neonates*	£657,736.33	0	-	41	3.92%	5
18+19	£501,566.02	0	£2,765,793.49	53	5.15%	4
3 Disorders of Blood	£205,789.96	31	£6,617.68	5	0.49%	20
5 Mental Health	£1,561,506.83	130	£12,006.32	16	1.53%	13
6 Learning Disability	£319,501.78	3	£93,016.80	27	2.61%	11
8 Problems of Vision Problems of Hearing	£302,392.67	10	£31,719.56	12	1.16%	16
9	£103,679.04	24	£4,401.21	7	0.70%	19
12 Dental problems	£435,457.38	16	£27,304.33	14	1.38%	15
14 Skin	£284,676.08	4	£70,447.88	11	1.06%	17
15 Musculo skeletal	£222,739.45	21	£10,443.12	3	0.30%	21
20 Poisoning and AE	£113,531.55	2	£75,437.15	9	0.91%	18
21 Healthy Individuals	£410,002.60	1	£341,922.60	34	3.24%	10
22 Social Care Needs	£285,440.64	0	-	39	3.81%	6
23 Other	£1,173,605.40	0	-	37	3.54%	7

Total: 1,035

20. Following these two sensitivity analyses, a third is performed with a different emphasis, which analyses the sensitivity of the overall health opportunity cost estimate to two key assumptions:

Surrogacy- we are required to make an assumption about how the effect on mortality for PBCs with a mortality indicator can be used as a *surrogate* for the effect that expenditure has on morbidity (or health-related quality of life) in those PBCs.

Extrapolation- We are required to make an assumption about how the estimated effects on mortality found for PBCs with a mortality indicator can be *extrapolated* to the effect that expenditure has on mortality for those PBCs that do not have a mortality indicator.

In order to assess the impact of these assumptions on the overall results for the NHS, we evaluate the health effects of £10mn spending at the margin in the NHS when either:

- a) For PBCs with a mortality indicator: no surrogacy assumption, therefore expenditure has no effect on morbidity
- b) For PBCs without a mortality indicator: assume no health effects at all, neither on mortality (extrapolation assumption) nor morbidity (surrogacy assumption)

The results are found here in Table 5. Interpretation and analysis is found in Appendix 2.2.

Table 5 Sensitivity of overall results to surrogacy and extrapolation assumptions

	Change in spend	Change in QALY death	Change in QALY alive	Health opportunity costs sensitivity to mortality/morbidity assumption (%)	Importance of PBC (rank)
2 Cancer	£457,412.96	26	2	-0.19%	16
10 Circulatory	£579,645.11	73	32	-3.07%	5
11 Respiratory	£411,572.52	13	205	-19.82%	2
13 Gastro-intestinal	£283,693.87	19	31	-3.03%	6
1 Infectious diseases	£221,354.67	1	4	-0.39%	14
4 Endocrine	£295,384.86	4	69	-6.63%	4
7 Neurological	£545,689.03	12	281	-27.13%	1
17 Genito-urinary	£627,621.24	4	17	-1.67%	10
16 Trauma & injuries*	£657,736.33	0	0	0.00%	-
18+19 Maternity & neonates*	£501,566.02	0	0	-0.01%	19
3 Disorders of Blood	£205,789.96	2	29	-3.00%	7
5 Mental Health	£1,561,506.83	11	119	-12.57%	3
6 Learning Disability	£319,501.78	1	3	-0.33%	15
8 Problems of Vision	£302,392.67	0	9	-0.92%	12
9 Problems of Hearing	£103,679.04	0	23	-2.28%	8
12 Dental problems	£435,457.38	0	16	-1.54%	11
14 Skin	£284,676.08	1	3	-0.39%	13
15 Musculo skeletal	£222,739.45	1	20	-2.06%	9
20 Poisoning and AE	£113,531.55	0	1	-0.15%	17
21 Healthy Individuals	£410,002.60	0	1	-0.12%	18
22 Social Care Needs	£285,440.64	0	0	0.00%	-
23 Other	£1,173,605.40	0	0	0.00%	-
Total:		169	866		
Total change in QALY death + QALY alive			1,035		

Outline of ONS data update for 2009/10

21. Appendix 2.3 considers an update regarding data from ONS used to inform burden of disease. This is important, because in order to generate final results two steps are necessary. The first is the estimation of elasticities given the appropriate waves of expenditure and outcome data (detailed in Appendix 1). The second step (detailed in Appendix 2.3) is to update the data surrounding burden of disease to which the elasticities are applied in order to estimate the implication for elasticities in terms of the resulting cost per QALY of marginal NHS expenditure.

Further work

22. Further work will consider the implied overall NHS mortality estimate in order to compare with results from the wider literature including the analysis by Gallet and Doucouliagos (2016).

Appendix 1: Outline of data update, estimation strategy, and results for outcome and expenditure models for 2009/10

Starting point: the 2008/09 specification

23. Identify the preferred specification for the PCT-level outcome and expenditure equations for each programme budget category (PBC) for 2008/09. The outcome and expenditure elasticities generated by these specifications, when re-estimated at LA-level with updated census data, are shown in Table 1.

Re-estimate the 2008/09 specifications using updated data

24. The 2008/09 specifications were derived using PCT-level data. Update PCT-level data to 2009/10 and put updated PCT-level data through the appropriate mapper to obtain LA-level data. This will include updating and mapping:

- the PB expenditure data from 2008/09 to 2009/10
- the raw population, unified weighted population, and MFF estimates used and implied from the 2009/10 DH resource allocation exposition book
- PB specific indices of need (eg infectious diseases, mental health, maternity) from the DH resource allocation exposition book
- PB specific disease prevalence rates as extracted from the HSCIC's QOF database

25. Obtain LA-level statistics for those variables that are reported at this unit of analysis. This will involve updating PCT-level data for 2008/09 and replacing it with LA-level data relevant to 2009/10. This will include updating and replacing:

- mortality data for 2008/9/10 with data for 2009/10/11
- census-based variables for 2001 with data for 2009 (by appropriate interpolation between 2001 and 2011)

Estimation strategy for 2009/10

26. Having updated all data, re-estimate each outcome and expenditure equation for 2009/10 using exactly the same specification as that employed for 2008/09 (this was the preferred PCT-level specification with 2001 Census data).

27. If this re-estimation produces a result which (a) passes the appropriate statistical tests and (b) generates coefficients in line with theoretical priors, use this result as our preferred result for 2009/10. This rule is applied to cases where the preferred specification for 2008/09 is either IV or OLS. If this re-estimation produces an acceptable result, the resulting elasticity shown in Table A1 has a '--' in the next column.

28. If the re-estimation produces a result which does not pass tests/have coefficients in line with priors, re-estimate the equation having adjusted the specification as suggested by the initial result. So, for example, if the initial estimation implies the presence of weak instruments and one of the instruments is insignificant in the first-stage regression, try re-estimating the equation without the

insignificant instrument. And if, for example, one of the regressors in the second-stage regression is insignificant, try re-estimating without it. If this re-estimation produces an acceptable result, the resulting elasticity shown in Table A1 has an 'A' in the next column.

29. If a relatively minor adjustment to the 2008/09 specification does not generate a statistically and theoretically acceptable result, re-derive the IV equation to be estimated (again, this applies to cases where the preferred specification for 2008/09 is either IV or OLS). That is, use OLS with backward stepwise regression to identify relevant covariates to be included in the second-stage regression having forced in the relevant variables throughout. For the outcome equation we force in own programme expenditure, and for the expenditure equation the other programme need variable and the total budget term are forced in throughout the stepwise procedure.

30. Having identified relevant covariates for the second-stage regression, again use stepwise backward regression to identify relevant instruments for the first-stage conditioning on the covariates for the second-stage identified above. In other words, these second-stage covariates are forced in throughout stepwise procedure to identify relevant instruments.

31. Having identified covariates for the second-stage (in 7 above) and instruments for the first-stage (in 8 above), re-estimate the IV specification equation using these two sets of variables. If the endogeneity test suggests that a variable (eg own programme expenditure in the outcome equation) is clearly not endogenous then re-estimate using OLS. If this re-estimation produces an acceptable result, the resulting elasticity shown in Table A1 has a 'B' in the next column.

32. If the above re-estimation approach produces a result which does not pass tests/have coefficients in line with priors, re-estimate the equation having adjusted the specification as suggested by the initial result (for example, if the result fails the misspecification test try adding the squared value of one of the regressors to the specification). If this re-estimation produces an acceptable result, the resulting elasticity shown in Table A1 has a 'C' in the next column.

33. If all of the above approaches fail to produce an acceptable result, consider excluding PCTs with extreme values of expenditure per person. Only explore this option for programmes with small amounts of expenditure and/or mortality. If this re-estimation approach produces an acceptable result, the resulting elasticity shown in Table A1 has a 'D' in the next column.

Results for 2009/10

34. The estimation strategy outlined above generated the outcome and expenditure elasticities for 2009/10 shown in Table A1.

35. The full result [IV (second-stage) or OLS] associated with each elasticity reported in Table A1 can be found in Table A4 (for the outcome equations) and Table A5 (for the expenditure equations).

36. The full estimation path for each result (starting with the re-estimation of the 2008/09 specification with updated data both) can be found in Table A6 (for the outcome equations) and Table A7 (for the expenditure equations).

Table A1 Outcome and expenditure elasticities for 2008/09 and 2009/10

PBC	PBC description	for 2008/09				for 2009/10				for 2010/11				for 2011/12				for 2012/13				
		Outcome		Spend		Outcome		Spend		Outcome		Spend		Outcome		Spend		Outcome		Spend		
		elasticity	IV or OLS	elasticity	IV or OLS	elasticity	Re-estimation	elasticity	Re-estimation													
1	Infectious diseases	-0.466**	IV	1471**	OLS	-0.310*	A	0.968***	-													
2	Cancers and tumours	-0.287***	IV	0.518*	IV	-0.345***	-	0.502**	A													
3	Diseases of the blood	n/a		1071*	OLS	n/a		1060***	B													
4	Endocrine, nutritional, metabolic	-0.746*	IV	0.367	IV	-1075**	A	0.708***	-													
5	Mental health disorders	n/a		0.995***	OLS	n/a		0.899***	-													
6	Learning disability	n/a		0.037	IV	n/a		0.647**	B													
7	Neurological problems	-0.304	IV	0.897***	IV	-1357	C	0.850***	-													
8	Vision problems	n/a		0.503	IV	n/a		0.934***	A													
9	Hearing problems	n/a		1223	OLS	n/a		1273***	C													
10	Circulatory problems	-1384***	IV	0.614	IV	-1842***	-	0.494*	-													
11	Respiratory problems	-1940***	IV	0.752**	IV	-2.103***	B	0.576***	-													
12	Dental problems	n/a		0.404**	OLS	n/a		0.765***	B													
13	Gastro-intestinal problems	-1553**	IV	0.520*	IV	-1989*	A	0.387*	-													
14	Skin problems	n/a		0.677**	IV	n/a		0.890***	D													
15	Musculo-skeletal problems	n/a		0.413	IV	n/a		0.295	B													
16	Trauma and injuries	0	n/a	1344***	OLS	0	B	1090***	-													
17	Genito-urinary problems	-0.346	IV	0.733***	OLS	-2.997	B	0.878***	-													
18	Maternity and reproductive health	0.043	IV	0.963***	IV	-0.166*	B	0.653***	-													
19	Neonates																					
20	Poisoning and adverse events	n/a		0.674*	IV	n/a		0.658**	-													
21	Healthy individuals	n/a		0.952	OLS	n/a		1246**	-													
22	Social care needs	n/a		0.830	OLS	n/a		0.844	B													
23	Other (includes GMS/PMS)	n/a		0.494***	OLS	n/a		0.564***	B													

Notes: (i) see pp12 of text for the meaning of the symbols in 're-estimation' columns;
(ii) there are no 're-estimation' columns for 2008/09 because these results were obtained by re-estimating preferred PCT-level specifications using LA-level data for this year (i.e., there were no changes to model specification).

Overview of results by PBC

Infectious diseases

37. Outcome: Re-estimation of the 2008/09 specification using updated data suggests that the instrument set is not valid (see Table A6). Re-derivation of the specification generates the same second-stage set of regressors but with a different and now valid instrument set (see Table A4 and Table A6).

38. Expenditure: Re-estimation of the 2008/09 specification generates an acceptable result, both statistically and in line with priors (see Table A5 and Table A7).

Cancer and tumours

39. Outcome: Re-estimation of the 2008/09 specification generates an acceptable result (see Table A4 and Table A6).

40. Expenditure: Re-estimation of the 2008/09 specification generates an acceptable result but the coefficient on the budget term is insignificant (see Table A7). The addition of an extra regressor generates a significant coefficient on the budget term (see Table A5 and Table A7).

Blood disorders

41. Expenditure: Re-estimation of the 2008/09 specification generates an acceptable result but the coefficient on the budget term is insignificant (see Table A7). Re-derivation of the IV specification suggests that the 'other programme need' term is not endogenous (Table A7). The OLS version of this IV specification is acceptable (see Table A5 and Table A7).

Endocrine, nutritional and metabolic

42. Outcome: The 2008/09 specification suggests weak instruments (Table A6). Elimination of two of the three instruments generates an acceptable result but there is a little evidence of misspecification (Table A6). The replacement of the diabetes prevalence rate with the proportion of the population in professional occupations as a regressor generates an acceptable result (Table A4 and Table A6).

43. Expenditure: The 2008/09 specification generates an acceptable result (Table A5 and Table A7).

Mental health disorders

44. Expenditure: The 2008/09 specification generates an acceptable result (Table A5 and Table A7).

Learning disability

45. Expenditure: The 2008/09 specification generates a poor result including weak instruments (Table A7). Re-derivation of the IV specification for 2009/10 generates an acceptable result but the 'other programme need' variable is clearly not endogenous (Table A7). Re-estimation using OLS generates an acceptable result (Table A5 and Table A7).

Neurological problems

46. Outcome: The 2008/09 specification generates a poor result (see Table A6). Re-derivation generates a better result (see Table A6) and a slight adjustment to the re-derived specification generates an acceptable result (see Table A4 and Table A6).

47. Expenditure: The 2008/09 specification generates an acceptable result (Table A5 and Table A7).

Problems of vision

48. Expenditure: The 2008/09 specification generates an OK result but the 'need' variable is not statistically significant (see Table A7). Re-estimation of the equation without the insignificant 'need' variable generates an acceptable result (Table A5 and Table A7).

Problems of hearing

49. Expenditure: The 2008/09 specification generates a poor result eg all coefficients are insignificant (see Table A7). Re-derivation of an IV specification suggests that the 'other need' variable is not endogenous and OLS estimation of this specification, with a slight adjustment, generates the result shown in Table A5 and Table A7.

Circulatory problems

50. Outcome: The 2008/09 specification generates an acceptable result (Table A4 and Table A6).

51. Expenditure: The 2008/09 specification generates an acceptable result (Table A5 and Table A7).

Respiratory problems

52. Outcome: The 2008/09 specification generates a poor result (see Table A6). Re-derivation of the IV specification generates an acceptable result (see Table A4 and Table A6).

53. Expenditure: The 2008/09 specification generates an acceptable result (Table A5 and Table A7).

Dental problems

54. Expenditure: The 2008/09 specification generates a poor result (see Table A7). Re-derivation of an IV specification generates an acceptable result but 'other need' is not endogenous (see Table A7). The OLS version of this re-derived specification is OK (see Table A5).

Gastro-intestinal problems

55. Outcome: The 2008/09 specification fails the reset test but this can be remedied with the addition of the CARAN need squared term. However, this specification still suffers from a weak instrument set (see Table A6) but the removal of one instrument largely ameliorates this problem (see Table A4 and Table A6).

56. Expenditure: The 2008/09 specification generates an acceptable result (Table A5 and Table A7).

Skin problems

57. Expenditure: The 2008/09 specification is OK but 'other need' is not endogenous (see Table A7). Re-estimation of this specification using OLS reveals some evidence of mis-specification (see Table A7). Re-derivation of the IV model suggests that 'other need' is not endogenous (see Table A7). The OLS version of the re-derived specification also reveals some evidence of mis-specification (see Table A7) and this can be corrected by the omission of two large spending outliers – Liverpool and Wolverhampton – from the sample (see Table A5 and Table A7).

Musculo-Skeletal system

58. Expenditure: The coefficient on budget is very close to zero when the 2008/09 specification is used to re-estimate with updated data for 2009/10 (Table A7). Re-derivation of the IV specification for 2009/10 is OK but it appears that the 'other need' variable is not endogenous (Table A7). Estimation of an OLS specification generates the result shown in Table A5 and Table A7.

Trauma and injuries

59. Outcome: We had been unable to obtain a plausible specification/result using the 2008/09 expenditure and associated outcome data. For 2009/10, we have SMR<75 for skull fractures and SMR<75 for femur fractures as potential outcome measures. However, many of the femur fracture observations are missing at LA-level so we use the skull fracture data as our outcome measure. We derived an IV specification but this was problematic (positive coefficient on expenditure, weak instruments, expenditure not endogenous). We therefore reverted to the derived OLS specification which has a very small and statistically insignificant positive coefficient on expenditure (Table A4 and Table A6).

60. Expenditure: The 2008/09 specification generates an acceptable result (Table A5 and Table A7).

Genito-urinary system

61. Outcome: The 2008/09 specification generates a poor result (see Table A4). Re-derivation of an IV specification generates an acceptable result (see Table A4 and Table A6).

62. Expenditure: The 2008/09 specification generates an acceptable result (Table A5 and Table A7).

Maternity/Neonates

63. Outcome: The 2008/09 specification generates a mis-specified result (see Table A6). Re-derivation of the IV specification generates an acceptable result (see Table A6) but suggests that 'other need' is not endogenous. The OLS equivalent of this IV specification is OK (see Table A4 and Table A6).

64. Expenditure: The 2008/09 specification generates an acceptable result (Table A5 and Table A7).

Poisoning

65. Expenditure: The 2008/09 specification generates an acceptable result (Table A5 and Table A7).

Healthy Individuals

66. Expenditure: The 2008/09 specification generates an acceptable result (Table A5 and Table A7).

Social Care

67. Expenditure: The 2008/09 specification generates a poor result in the sense that all regressors are insignificant (see Table A7). Re-derivation of the IV specification generates an OK result (see Table A7) but 'other need' is not endogenous. The OLS equivalent of this IV specification generates an OK result (see Table A4 and Appendix 3). [Note that the sample restriction to LAs with a spend per head of between £15 and £75 is the same as that employed for 2008/09. This is necessary because there is a large number of 'outliers'].

GMS/PMS

68. Expenditure: The 2008/09 specification generates a poor result in the sense that three of the regressors are insignificant (see Table A7). Re-derivation of the IV specification generates an OK result (see Table A7) but 'other need' is not endogenous. The OLS equivalent of this IV specification generates an OK result (see Table A5 and Table A7).

All PBCs

69. Table A2 summarises whether the preferred specification for each equation is the same as for the previous year (indicated by a blank cell) or, if not, why the previous year's specification is not suitable. For example, this might be because the previous specification does not 'pass' the appropriate statistical tests when estimated on updated data (indicated by "Tests"). It could also be because the estimated coefficients are incompatible with our prior beliefs about their sign and significance. For example, one of our priors is that, for the outcome equation, health care expenditure should not have a negative marginal effect on mortality and another is that ("Prior"), in the expenditure equation, budget should have a positive marginal effect on PBC expenditure ("Prior (A)"). In a small number of cases, the previous specification might 'fail' on both statistical tests and on priors.

70. Finally, Table A3 reports the number times where the preferred specification for 2009/10 is OLS and this is the same/similar specification as was preferred for the previous year (i.e., we do not re-derive specification starting with IV model).

Notes:

(i) This estimation round involved both the usual updating of the expenditure and mortality data as well as (i) the shift from PCTs to LAs as the unit of analysis and (ii) the updating of the census-based data from 2001 to 2009. For the 2010/11 expenditure data the re-estimation will only involve the usual updates of spend and mortality together with the update of the census data from 2009 to 2010...so we might expect this to be more straightforward.

(ii) There are 152 upper tier local authorities. Most of our sample sizes are either 150 (where mortality rates for Cornwall and the Isles of Scilly are not reported) or 148 (where mortality rates for Cornwall, the Isles of Scilly, Rutland and the City of London are not reported). These are not reported by HSCIC so as to avoid potentially identifying an individual.

Table A2 Whether the preferred specification for each equation is the same as for the previous year

PBC #	PBC Title	2009/10 Outcome	2009/10 Expenditure	2010/11 Outcome	2010/11 Expenditure	2011/12 Outcome	2011/12 Expenditure	2012/13 Outcome	2012/13 Expenditure
1	Infectious diseases	Tests							
2	Cancers and tumours		Prior (A)						
3	Diseases of the blood	n/a	Prior (A)						
4	Endocrine, nutritional, metabolic	Tests							
5	Mental health disorders	n/a							
6	Learning disability	n/a	Tests						
7	Neurological problems	Prior							
8	Vision problems	n/a	Priors (A, C)						
9	Hearing problems	n/a	Priors (A, C)						
10	Circulatory problems								
11	Respiratory problems	Tests							
12	Dental problems	n/a	Tests						
13	Gastro-intestinal problems	Tests							
14	Skin problems	n/a	Tests						
15	Musculo-skeletal problems	n/a	Prior (A)						
16	Trauma and injuries	n/a*							
17	Genito-urinary problems	Prior							
18	Maternity and reproductive health								
19	Neonates	Tests							
20	Poisoning and adverse events	n/a							
21	Healthy individuals	n/a							
22	Social care needs	n/a	Prior (C)						
23	Other (includes GMS/PMS)	n/a	Priors (B, C)						
	*no preferred specification from previous year								
Totals	Pass (= blank cell)	n=2	n=12						
	Tests	n=5	n=3						
	Prior (negative coefficient on expenditure)	n=2							
	Tests and priors	n=0	n=0						
	Prior (A: 'significant', +ve coefficient on budget)		n=3						
	Prior (B: no significant +ve coefficient on o/need)		n=0						
	Prior (C: other coefficients significant)		n=1						
	Priors (A, C)		n=2						
	Priors (B, C)		n=1						

Table A3 OLS specification for previous year and current year

Number of times preferred specification is OLS and the same/similar OLS specification as in the previous year		2009/10	2010/11	2011/12	2012/13
Outcome equation	(maximum n=10)	n=0			
Expenditure equation	(maximum n=23)	n=5			

In this section, Tables A4 and A5 provide details of our preferred specification for each outcome and expenditure model by PBC for 2009/10.

Table A4 Preferred outcome specifications for 2009/10

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	PBC 1	PBC 2	PBC 04	PBC 07	PBC 10	PBC 11	PBC 13	PBC 17	PBC 1819	PBC 16
	infectious diseases	cancer	endocrine etc	neurological	circulatory	respiratory	gastro-intestinal	genito-urinary	mat/neonates	trauma/injuries
	2009/10 spend SYLLR	2009/10 spend SYLLR	2009/10 spend SYLLR	2009/10 spend SYLLR	2008/9 spend SYLLR	2009/10 spend SYLLR	2009/10 spend SYLLR	2009/10 spend SYLLR	2009/10 spend infant mort rate	2009/10 spend SMR<75 skull
	2009/10/11	2009/10/11	2009/10/11	2009/10/11	2008/9/10	2009/10/11	2009/10/11	2009/10/11	2009/10/11	fracture9/10/11
	outcome model	outcome model	outcome model	outcome model	outcome model	outcome model	outcome model	outcome model	outcome model	outcome model
	instrument spend	instrument spend	instrument spend	instrument spend	instrument spend	instrument spend	instrument spend	instrument spend	o/need exogenous	spend exogenous
	weighted	weighted	weighted	weighted	weighted	weighted	weighted	weighted	weighted	weighted
	IV second stage	IV second stage	IV second stage	IV second stage	IV second stage	IV second stage	IV second stage	IV second stage	OLS	OLS
	GMM2S	GMM2S	GMM2S	GMM2S	GMM2S	GMM2S	GMM2S	GMM2S		
	LA-level	LA-level	LA-level	LA-level	LA-level	LA-level	LA-level	LA-level	LA-level	LA-level
	actual mortality actual census 09	actual mortality actual census09	actual mortality actual census 09							
VARIABLES	Re-derived	08/09 version	08/09 revised v2(SI)	Re-derived(SI)+	08/09 version	Re-derived	revised(SI)	Re-derived	Re-derived, OLS	Re-derived, OLS
ILAg1_0910pheadOHP	-0.310* [0.169]									
ILAhivneedph	0.362*** [0.071]									
ILAhivneedphSQ	0.123*** [0.037]									
ILAIMD2010	0.478*** [0.079]		0.658*** [0.149]							
ILAg2_0910pheadOHP		-0.345*** [0.127]								
ILACARANneed910		0.881*** [0.113]		1.191 [0.812]	3.041*** [0.392]	1.433** [0.728]	4.291*** [1.178]		2.019*** [0.287]	1.163*** [0.329]
ILAg4_0910pheadOHP			-1.075** [0.462]							
LPROFOCCU09			-0.462*** [0.178]							
ILAg7_0910pheadOHP				-1.357 [0.845]						
ILAepiprev0910				1.413*** [0.384]						
LBORNEXEU09				0.187*** [0.065]					0.319*** [0.055]	
ILAg10_0910pheadOHP					-1.842***					

Table A5 Preferred expenditure specifications for 2009/10

	(1) PBC 1 infectious 2009/10 spend SYLLR 2009/10/11 spend model instrument n/a weighted OLS LA-level actual mortality actual census 09 08/09 version	(2) PBC 2 cancer 2009/10 spend SYLLR 2009/10/11 spend model instrument other needs weighted IV second stage GMM2S LA-level actual mortality actual census09 revised(XR)	(3) PBC 3 Blood disorders 2009/10 spend SYLLR 2009/10/11 spend model instrument n/a weighted OLS LA-level actual mortality actual census 09 Re-derived, OLS	(4) PBC 4 diabetes 2009/10 spend all causeSYLLR 2009/10/11 spend model instrument o/need weighted IV second stage GMM2S LA-level actual mortality actual census 09 08/09 version	(5) PBC 5 Mental health 2009/10 spend SYLLR 2009/10/11 spend model instrument n/a weighted OLS LA-level actual mortality actual census 09 08/09 version	(6) PBC 6 LDisability 2009/10 spend SYLLR 2009/10/11 spend model instrument n/a weighted OLS LA-level actual mortality actual census 09 Re-derived, OLS	(7) PBC 7 epilepsy 2009/10 spend all causeSYLLR 2009/10/11 spend model instrument o/need weighted IV second stage GMM2S LA-level actual mortality actual census 09 08/09 version	(8) PBC 8 Vision 2009/10 spend SYLLR 2009/10/11 spend model instrument o/need weighted GMM2S LA-level actual mortality actual census 09 08/09 revised	(9) PBC 9 hearing problems 2009/10 spend SYLLR 2009/10/11 spend model instrument n/a weighted OLS LA-level actual mortality actual census 09 Re-derived, OLS
ILAgall_0910pheadOHP	0.968*** [0.288]	0.502** [0.245]	1.060*** [0.277]	0.708*** [0.214]	0.899*** [0.225]	0.647** [0.295]	0.850*** [0.225]	0.934*** [0.258]	1.273*** [0.359]
ILAhivneedph	0.413*** [0.022]								
lacsyllrexIP0911	-0.169 [0.229]								
ILAhivneedphSQ	0.147*** [0.026]								
lacsyllrexcancer911		-1.040*** [0.173]							
ILACARANneed910		1.446*** [0.288]		0.445 [0.335]					
LPROFOCCU09		-0.152 [0.098]					-0.338** [0.139]		
lacsYLLR0911			-0.850*** [0.239]		-0.107 [0.138]		-0.577** [0.284]	-0.482* [0.275]	0.310 [0.288]
LLONEPARH09			0.703*** [0.132]						
lacsyllrexDIAB0911				-0.167 [0.258]					
ILACARANneed910SQ				1.248** [0.522]			3.985*** [1.155]		
ILAdiaprev0910				0.189* [0.103]					
ILAmhneedindexpp					0.510*** [0.170]				
LPOPPUCAR09					-0.465*** [0.104]				

lacsyllrexEPI0911								-0.080		
								[0.212]		
ILAepiprev0910								0.394***		
								[0.074]		
LNQUAL17409									0.489***	
									[0.086]	
LOWNOCC09										0.297*
										[0.168]
Constant	-2.991**	6.566***	2.197	0.164	-1.794	2.204	0.406	0.262		-8.969***
	[1.338]	[1.661]	[1.634]	[1.976]	[2.060]	[1.477]	[0.977]	[0.967]		[1.774]
Observations	147	150	150	148	150	150	140	150		150
R-squared	0.752		0.270		0.765	0.139				0.256
Ramsey reset F statistic	0.970		0.592		0.345	1.023				0.479
Probability > F	0.409		0.621		0.793	0.385				0.698
Endogeneity test statistic		17.406		1.531			2.882	3.238		
Endogeneity p-value		0.000		0.216			0.090	0.072		
Hansen-Sargan test statistic		1.235		0.171			0.785	0.736		
Hansen-Sargan p-value		0.267		0.679			0.376	0.391		
Kleibergen-Paap LM test statistic		25.606		27.318			30.560	23.051		
Kleibergen-Paap p-value		0.000		0.000			0.000	0.000		
Kleibergen-Paap F statistic		27.743		23.097			55.103	17.739		
Pesaran-Taylor reset statistic		0.042		0.832			0.073	0.028		
Pesaran-Taylor p-value		0.838		0.362			0.787	0.866		

Robust standard errors in brackets

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

Table A5 continued Preferred expenditure specifications for 2009/10

	(1) PBC 10 circulatory 2009/10 spend SYLLR 2009/10/11 spend model instrument o/need weighted IV second stage GMM2S LA-level actual mortality actual census09 08/09 version	(2) PBC 11 respiratory 2009/10 spend SYLLR 2009/10/11 spend model instrument other needs weighted IV second stage GMM2S LA-level actual mortality actual census09 08/09 version	(3) PBC 12 dental problems 2009/10 spend SYLLR 2009/10/11 spend model instrument n/a weighted OLS LA-level actual mortality actual census 09 Re-derived, OLS	(4) PBC 13 gastro 2009/10 spend SYLLR 2009/10/11 spend model instrument other needs weighted IV second stage GMM2S LA-level actual mortality actual census09 08/09 version	(5) PBC 14 skin problems 2009/10 spend SYLLR 2009/10/11 spend model instrument n/a weighted OLS LA-level actual mortality actual census 09 Re-derived, OLS	(6) PBC 15 musculo-skeletal 2009/10 spend SYLLR 2009/10/11 spend model instrument n/a weighted OLS LA-level actual mortality actual census 09 Re-derived, OLS	(7) PBC 16 trauma/injuries 2009/10 spend SYLLR 2009/10/11 spend model instrument n/a weighted OLS LA-level actual mortality actual census 09 08/09 version	(8) PBC 17 renal 2009/10 spend SYLLR 2009/10/11 spend model instrument n/a weighted OLS LA-level actual mortality actual census 09 08/09 version	(9) PBC 1819 maternity/neonates 2009/10 spend all causeSYLLR 2009/10/11 spend model instrument o/need weighted IV second stage GMM2S LA-level actual mortality actual census 09 08/09 version
lacsyllrexresp911		-0.565** [0.273]							
ILAgall_0910pheadOHP	0.494* [0.267]	0.576*** [0.218]	0.765*** [0.188]	0.387* [0.231]	0.890*** [0.192]	0.295 [0.263]	1.090*** [0.215]	0.878*** [0.207]	0.653*** [0.233]
ILACARANneed910	2.458*** [0.502]	1.252*** [0.309]		1.292*** [0.319]		0.965*** [0.340]		0.218 [0.265]	
ILACARANneed910SQ		1.323*** [0.472]	-1.905*** [0.538]						
lacsyllrexcirc911	-1.965*** [0.460]								
lacmSYLLR0911			0.167 [0.131]		-0.046 [0.208]	0.180 [0.185]	-0.219 [0.150]		-0.405* [0.246]
LWORKAGRI09			-0.039** [0.018]				0.069*** [0.016]		
LLONEPENH09			0.190* [0.107]			0.341*** [0.119]			
lacsyllrexgast911				-0.612*** [0.211]					
ILAIMD2010					0.278** [0.133]				
LHHNOCAR09					-0.176** [0.074]				
LPC74LTUN09						-0.317*** [0.077]			
LBORNEXEU09								0.051*** [0.017]	
lacsyllrexrenal0911								-0.171 [0.124]	

ILAmatneedindexpp										
Constant	12.640*** [3.154]	3.491 [2.136]	-2.268** [0.977]	5.218** [2.254]	-3.817** [1.517]	0.574 [2.551]	-2.171* [1.157]	-0.939 [1.794]		0.963*** [0.088] 2.072*** [0.704]
Observations	150	148	150	148	148	150	150	150		150
Endogeneity test statistic	23.688	7.777		9.122						1.253
Endogeneity p-value	0.000	0.005		0.003						0.263
Hansen-Sargan test statistic	0.267	0.024		0.389						0.212
Hansen-Sargan p-value	0.606	0.877		0.533						0.899
Kleibergen-Paap LM test statistic	16.668	26.156		32.784						35.340
Kleibergen-Paap p-value	0.000	0.000		0.000						0.000
Kleibergen-Paap F statistic	11.755	22.221		29.989						69.224
Pesaran-Taylor reset statistic	0.022	0.171		2.482						0.050
Pesaran-Taylor p-value	0.883	0.679		0.115						0.822
R-squared			0.482		0.496	0.564	0.236	0.487		
Ramsey reset F statistic			1.405		1.358	1.392	0.948	1.995		
Probability > F			0.244		0.258	0.248	0.419	0.117		

Robust standard errors in brackets

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

Table A5 continued Preferred expenditure specifications for 2009/10

	(1)	(2)	(3)	(4)
	PBC 20	PBC 21	PBC 22	PBC 23a
	poisoning	HI	social care	GMS
	2009/10 spend	2009/10 spend	2009/10 spend	2009/10 spend
	SYLLR	SYLLR	SYLLR	SYLLR
	2009/10/11	2009/10/11	2009/10/11	2009/10/11
	spend model	spend model	spend model	spend model
	instrument	instrument n/a	instrument n/a	instrument n/a
	o/need	weighted	weighted	weighted
	GMM2S	OLS	OLS	OLS
	LA-level	LA-level	LA-level	LA-level
	actual mortality	actual mortality	actual mortality	actual mortality
	actual census 09	actual census 09	actual census 09	actual census 09
VARIABLES	08/09 version	08/09 version	Re-derived, OLS	Re-derived, OLS
lacmSYLLR0911	-0.816***	0.232	-0.177	0.010
	[0.302]	[0.323]	[0.432]	[0.071]
ILAgall_0910pheadOHP	0.658**	1.246**	0.844	0.564***
	[0.304]	[0.506]	[0.563]	[0.085]
ILACARANneed910	1.110***	0.939		
	[0.390]	[0.570]		
Constant	3.017	-7.085*	-1.640	0.751**
	[2.692]	[4.068]	[2.855]	[0.369]
Observations	150	150	97	148
R-squared		0.385	0.035	0.463
Endogeneity test statistic	12.352			
Endogeneity p-value	0.000			
Hansen-Sargan test statistic	0.078			
Hansen-Sargan p-value	0.781			
Kleibergen-Paap LM test statistic	25.438			
Kleibergen-Paap p-value	0.000			
Kleibergen-Paap F statistic	21.297			
Pesaran-Taylor reset statistic	0.008			
Pesaran-Taylor p-value	0.928			
Ramsey reset F statistic		0.507	1.066	0.112
Probability > F		0.678	0.368	0.953

Robust standard errors in brackets

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

In this section, Tables A6 and A7 provide details of the estimation path to our preferred specifications for each outcome and expenditure model by PBC for 2009/10. For each PBC, we first estimate the model for 2009/10 using our specification for 2008/9. If this specification fails to meet either the necessary statistical tests or our prior beliefs about the sign/size/significance of coefficients, then the specification is adjusted in line with our estimation strategy outlined on pp14-15 and the model is re-estimated. This process continues until we identify a specification that meets our priors and passes the relevant statistical tests. The final, preferred specification for each PBC for 2009/10 is also shown here, along with the results associated with the estimation of selected intermediate specifications.

Table A6 Estimation path to preferred outcome specifications for 2009/10

	(1) PBC 1 infectious diseases 2009/10 spend SYLLR 2009/10/11 outcome model instrument spend weighted IV second stage GMM2S LA-level actual mortality actual census 09 08/09 version	(2) PBC 1 infectious diseases 2009/10 spend SYLLR 2009/10/11 outcome model instrument spend weighted IV second stage GMM2S LA-level actual mortality actual census 09 Re-derived	(3) PBC 2 cancer 2009/10 spend SYLLR 2009/10/11 outcome model instrument spend weighted IV second stage GMM2S LA-level actual mortality actual census09 08/09 version	(4) PBC 04 endocrine etc 2009/10 spend SYLLR 2009/10/11 outcome model instrument spend weighted IV second stage GMM2S LA-level actual mortality actual census 09 08/09 version	(5) PBC 04 endocrine etc 2009/10 spend SYLLR 2009/10/11 outcome model instrument spend weighted IV second stage GMM2S LA-level actual mortality actual census 09 revised(SI)	(6) PBC 04 endocrine etc 2009/10 spend SYLLR 2009/10/11 outcome model instrument spend weighted IV second stage GMM2S LA-level actual mortality actual census 09 revised v2(SI)	(7) PBC 07 neurological etc 2009/10 spend SYLLR 2009/10/11 outcome model instrument spend weighted IV second stage GMM2S LA-level actual mortality actual census 09 08/09 version	(8) PBC 07 neurological 2009/10 spend SYLLR 2009/10/11 outcome model instrument spend weighted IV second stage GMM2S LA-level actual mortality actual census 09 Re-derived	(9) PBC 07 neurological 2009/10 spend SYLLR 2009/10/11 outcome model instrument spend weighted IV second stage GMM2S LA-level actual mortality actual census 09 Re-derived(SI)+
VARIABLES									
ILAg1_0910pheadOHP	-0.387* [0.234]	-0.310* [0.169]							
ILAhivneedph	0.393*** [0.097]	0.362*** [0.071]							
ILAhivneedphSQ	0.137*** [0.042]	0.123*** [0.037]							
ILAIMD2010	0.520*** [0.084]	0.478*** [0.079]		0.667*** [0.132]	0.676*** [0.137]	0.658*** [0.149]			
ILAg2_0910pheadOHP			-0.345*** [0.127]						
ILACARANneed910			0.881*** [0.113]				0.456 [0.647]		1.191 [0.812]
ILAg4_0910pheadOHP				-0.735* [0.431]	-0.766* [0.448]	-1.075** [0.462]			
ILAdiaprev0910				0.377*	0.384*				

				[0.214]	[0.218]				
LPROFOCCU09						-0.462***			
						[0.178]			
ILAg7_0910pheadOHP							0.249	-0.230	-1.357
							[0.545]	[0.320]	[0.845]
ILAepiprev0910								1.265***	1.413***
								[0.365]	[0.384]
LBORNEXEU09								0.178***	0.187***
								[0.060]	[0.065]
Constant	1.531**	1.418***	6.559***	3.149*	3.267*	2.834**	0.314	8.997***	14.608***
	[0.684]	[0.505]	[0.594]	[1.776]	[1.836]	[1.404]	[2.354]	[3.095]	[5.131]
Observations	147	147	150	148	148	148	140	140	140
Endogeneity test statistic	2.578	1.862	5.166	2.928	2.925	6.368	0.018	0.922	3.034
Endogeneity p-value	0.108	0.172	0.023	0.087	0.087	0.012	0.894	0.337	0.082
Hansen-Sargan test statistic	8.443	5.056	0.020	0.175			3.569	0.225	
Hansen-Sargan p-value	0.038	0.168	0.888	0.916			0.168	0.635	
Kleibergen-Paap LM test statistic	18.948	25.041	23.944	13.257	12.801	13.637	19.197	25.571	7.203
Kleibergen-Paap p-value	0.001	0.000	0.000	0.004	0.000	0.000	0.000	0.000	0.007
Kleibergen-Paap F statistic	8.636	8.698	17.787	5.766	17.099	17.223	9.044	29.408	10.204
Pesaran-Taylor reset statistic	0.798	1.073	0.329	2.481	2.766	2.068	0.243	0.000	0.575
Pesaran-Taylor p-value	0.372	0.300	0.566	0.115	0.096	0.150	0.622	0.991	0.448

Robust standard errors in brackets

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

Table A6 continued Estimation path to preferred outcome specifications for 2009/10

	(1) PBC 10 circulatory 2008/9 spend	(2) PBC 11 respiratory 2009/10 spend	(3) PBC 11 respiratory 2009/10 spend	(4) PBC 13 gastro-intestinal 2009/10 spend	(5) PBC 13 gastro-intestinal 2009/10 spend	(6) PBC 17 genito-urinary 2009/10 spend	(7) PBC 17 genito-urinary 2009/10 spend	(8) PBC 1819 mat/neonates 2009/10 spend	(9) PBC 1819 mat/neonates 2009/10 spend infant mort rate 2009/10/11 outcome model instrument spend weighted IV second stage GMM2S LA-level actual mortality actual census 09 08/09 version	(10) PBC 1819 mat/neonates 2009/10 spend infant mort rate 2009/10/11 outcome model o/need exogenous weighted OLS actual mortality actual census 09 Re-derived, OLS	(11) PBC 16 trauma/injuries 2009/10 spend SMR<75 skull fracture outcome model spend exogenous weighted OLS actual mortality actual census 09 Re-derived, OLS
VARIABLES											
ILAg11_0910pheadOHP		-3.948 [2.681]	-2.103*** [0.794]								
ILACARANneed910	3.041*** [0.392]	6.687** [3.244]	1.433** [0.728]	3.863*** [1.152]	4.291*** [1.178]			0.829*** [0.284]	2.057*** [0.292]	2.019*** [0.287]	1.163*** [0.329]
LPERMSICK09			4.493*** [1.676]								
LPERMSICK09SQ			0.508** [0.239]								
ILAg10_0910pheadOHP	-1.842*** [0.380]										
ILAg13_0910pheadOHP				-1.558 [1.073]	-1.989* [1.111]						
ILACARANneed910SQ		5.600 [3.947]			3.833*** [1.473]						
ILAg17_0910pheadOHP						4.949 [3.167]	-2.997 [2.017]				
LLONEPARH09						-1.911 [1.361]					
ILACKDprev18							2.662*** [0.791]				
LOWNOCC09							-4.052*** [1.354]				
LWHITEG09							-3.945*** [1.170]				
LWORKAGRI09							0.522** [0.205]				
ILAg1819_0910phOHP								-0.220 [0.188]	-0.201 [0.172]	-0.166* [0.092]	
LBORNEXEU09								0.242*** [0.043]	0.327*** [0.056]	0.319*** [0.055]	
LNQUAL17409								0.426*** [0.152]			
LHHNOCAR09									-0.344*** [0.095]	-0.340*** [0.099]	

ILAg16_0910pheadOHP												0.041
LPC74LTUN09												[0.141]
Constant	13.415*** [1.873]	21.403 [14.603]	21.341*** [6.014]	10.022** [4.773]	11.868** [4.923]	-28.812* [17.312]	20.235** [9.485]	3.261*** [0.899]	2.325*** [0.843]	2.152*** [0.462]		-0.259** [0.123]
Observations	150	148	148	148	148	150	150	149	149	149		143
R-squared											0.413	0.141
Endogeneity test statistic	34.858	8.292	13.820	5.295	8.584	2.187	2.256	0.392	0.031			
Endogeneity p-value	0.000	0.004	0.000	0.021	0.003	0.139	0.133	0.531	0.861			
Hansen-Sargan test statistic	0.877	2.378	0.766	2.232		0.174	2.729	2.190	1.040			
Hansen-Sargan p-value	0.349	0.123	0.381	0.135		0.677	0.099	0.139	0.595			
Kleibergen-Paap LM test statistic	14.621	2.534	11.432	7.323	6.617	13.132	26.731	20.409	22.973			
Kleibergen-Paap p-value	0.001	0.282	0.003	0.026	0.010	0.001	0.000	0.000	0.000			
Kleibergen-Paap F statistic	10.903	1.363	9.051	4.916	8.446	9.957	19.945	17.777	13.250			
Pesaran-Taylor reset statistic	0.000	3.045	1.083	7.024	0.251	0.183	1.449	4.674	0.300			
Pesaran-Taylor p-value	0.995	0.081	0.298	0.008	0.616	0.669	0.229	0.031	0.584			
Ramsey reset F statistic											1.439	0.050
Probability > F											0.234	0.985

Robust standard errors in brackets

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

Table A7 Estimation path to preferred expenditure specifications for 2009/10

	(1) PBC 1 infectious 2009/10 spend SYLLR 2009/10/11 spend model instrument n/a weighted OLS LA-level actual mortality actual census 09 08/09 version	(2) PBC 2 cancer 2009/10 spend SYLLR 2009/10/11 spend model instrument other needs weighted IV second stage GMM2S LA-level actual mortality actual census09 08/09 version	(3) PBC 2 cancer 2009/10 spend SYLLR 2009/10/11 spend model instrument other needs weighted IV second stage GMM2S LA-level actual mortality actual census09 revised(XR)	(4) PBC 3 Blood disorders 2009/10 spend SYLLR 2009/10/11 spend model instrument n/a weighted OLS LA-level actual mortality actual census 09 08/09 version	(5) PBC 03 Blood disorders 2009/10 spend SYLLR 2009/10/11 spend model instrument other needs weighted IV second stage GMM2S LA-level actual mortality actual census09 Re-derived	(6) PBC 3 Blood disorders 2009/10 spend SYLLR 2009/10/11 spend model instrument n/a weighted OLS LA-level actual mortality actual census 09 Re-derived, OLS	(7) PBC 4 diabetes 2009/10 spend all causeSYLLR 2009/10/11 spend model instrument o/need weighted IV second stage GMM2S LA-level actual mortality actual census 09 08/09 version	(8) PBC 5 Mental health 2009/10 spend SYLLR 2009/10/11 spend model instrument n/a weighted OLS LA-level actual mortality actual census 09 08/09 version	(9) PBC 6 LDisability 2009/10 spend SYLLR 2009/10/11 spend model instrument o/need weighted GMM2S LA-level actual mortality actual census 09 08/09 version	(10) PBC 6 LDisability 2009/10 spend SYLLR 2009/10/11 spend model instrument o/need weighted GMM2S LA-level actual mortality actual census 09 Re-derived IV	(11) PBC 6 LDisability 2009/10 spend SYLLR 2009/10/11 spend model instrument n/a weighted OLS LA-level actual mortality actual census 09 Re-derived, OLS
ILAgall_0910pheadOHP	0.968*** [0.288]	0.321 [0.199]	0.502** [0.245]	0.784 [0.525]	1.347*** [0.418]	1.060*** [0.277]	0.708*** [0.214]	0.899*** [0.225]	0.600 [0.625]	0.775** [0.370]	0.647** [0.295]
ILAhivneedph	0.413*** [0.022]										
lacsyllrexIP0911	-0.169 [0.229]										
ILAhivneedphSQ	0.147*** [0.026]										
lacsyllrexcancer911		-1.006*** [0.164]	-1.040*** [0.173]								
ILACARANneed910		1.751*** [0.237]	1.446*** [0.288]	0.886 [0.726]			0.445 [0.335]		0.225 [2.047]		
LPROFOCCU09			-0.152 [0.098]							-0.432*** [0.163]	-0.338** [0.139]
ILACARANneed910SQ				0.207 [1.154]			1.248** [0.522]			3.969*** [1.102]	3.985*** [1.155]
LPOPPUCAR09				-0.945*** [0.260]				-0.465*** [0.104]	0.204 [0.657]		
lacmSYLLR0911				-0.482* [0.273]	-1.263*** [0.487]	-0.850*** [0.239]		-0.107 [0.138]	-0.426 [1.399]	-0.791* [0.406]	-0.577** [0.284]
LLONEPARH09					0.792*** [0.174]	0.703*** [0.132]					
lacsyllrexDIAB0911							-0.167 [0.258]				
ILAdiaprev0910							0.189* [0.103]				

ILAmhneedindexpp								0.510*** [0.170]			
Constant	-2.991** [1.338]	7.901*** [1.466]	6.566*** [1.661]	-2.014 [4.215]	2.800* [1.694]	2.197 [1.634]	0.164 [1.976]	-1.794 [2.060]	2.593 [9.966]	2.434* [1.449]	2.204 [1.477]
Observations	147	150	150	150	150	150	148	150	150	150	150
R-squared	0.752			0.231		0.270		0.765			0.139
Ramsey reset F statistic	0.970			1.342		0.592		0.345			1.023
Probability > F	0.409			0.263		0.621		0.793			0.385
Endogeneity test statistic		17.485	17.406		0.595		1.531		0.020	0.852	
Endogeneity p-value		0.000	0.000		0.441		0.216		0.887	0.356	
Hansen-Sargan test statistic		1.129	1.235		3.751		0.171		0.349	1.882	
Hansen-Sargan p-value		0.288	0.267		0.153		0.679		0.554	0.390	
Kleibergen-Paap LM test statistic		28.185	25.606		37.287		27.318		5.191	31.854	
Kleibergen-Paap p-value		0.000	0.000		0.000		0.000		0.075	0.000	
Kleibergen-Paap F statistic		25.698	27.743		37.953		23.097		2.855	42.930	
Pesaran-Taylor reset statistic		0.135	0.042		0.033		0.832		0.001	0.419	
Pesaran-Taylor p-value		0.714	0.838		0.857		0.362		0.969	0.517	

Robust standard errors in brackets
 *** p<0.01, ** p<0.05, * p<0.1

Table A7 continued Estimation path to preferred expenditure specifications for 2009/10

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	
	PBC 7 epilepsy	PBC 8	PBC 8	PBC 9 hearing problems	PBC 9 hearing problems	PBC 10 circulatory	PBC 11 respiratory	PBC 12	PBC 12	PBC 12	
	2009/10 spend all causeSYLLR 2009/10/11	Vision 2009/10 spend SYLLR 2009/10/11	Vision 2009/10 spend SYLLR 2009/10/11	2009/10 spend SYLLR 2009/10/11	2009/10 spend SYLLR 2009/10/11	2009/10 spend SYLLR 2009/10/11	2009/10 spend SYLLR 2009/10/11	2009/10 spend SYLLR 2009/10/11	2009/10 spend SYLLR 2009/10/11	2009/10 spend SYLLR 2009/10/11	2009/10 spend SYLLR 2009/10/11
	spend model instrument o/need	spend model instrument o/need	spend model instrument o/need	spend model	spend model	spend model instrument o/need	spend model instrument other needs	spend model	spend model instrument o/need	spend model	
	weighted IV second stage GMM2S LA-level	weighted GMM2S LA-level	weighted GMM2S LA-level	instrument n/a weighted OLS LA-level	instrument n/a weighted OLS LA-level	weighted IV second stage GMM2S LA-level	weighted IV second stage GMM2S LA-level	instrument n/a weighted OLS LA-level	instrument n/a weighted GMM2S LA-level	instrument n/a weighted OLS LA-level	
	actual mortality actual census 09 08/09 version	actual mortality actual census 09 08/09 version	actual mortality actual census 09 revised 08/09	actual mortality actual census 09 08/09 version	actual mortality actual census 09 Re-derived, OLS	actual mortality actual census09 08/09 version	actual mortality actual census09 08/09 version	actual mortality actual census 09 08/09 version	actual mortality actual census 09 Re-derived	actual mortality actual census 09 OLS version	
VARIABLES											
lacmSYLLR0911		-0.501* [0.263]	-0.482* [0.275]	0.051 [0.334]	0.310 [0.288]			-0.060 [0.173]	0.206 [0.160]	0.167 [0.131]	
lAgall_0910pheadOHP	0.850*** [0.225]	0.356 [0.287]	0.934*** [0.258]	0.587 [0.586]	1.273*** [0.359]	0.494* [0.267]	0.576*** [0.218]	0.717*** [0.193]	0.723*** [0.201]	0.765*** [0.188]	
lACARANneed910		0.837 [0.520]		0.776 [0.679]		2.458*** [0.502]	1.252*** [0.309]				
LNQUAL17409		0.278** [0.137]	0.489*** [0.086]								
lacsyllrexEPI0911	-0.080 [0.212]										
lAepiprev0910	0.394*** [0.074]										
LOWNOCC09					0.297* [0.168]			0.106 [0.099]			
lacsyllrexcirc911						-1.965*** [0.460]					
lacsyllrexcresp911							-0.565** [0.273]				
lACARANneed910SQ							1.323*** [0.472]		-1.923*** [0.508]	-1.905*** [0.538]	
lLAIMD2010								0.180* [0.096]			
LWORKAGRI09									-0.039** [0.018]	-0.039** [0.018]	
LLONEPENH09									0.192* [0.105]	0.190* [0.107]	

Constant	0.406 [0.977]	4.382* [2.607]	0.262 [0.967]	-2.454 [4.857]	-8.969*** [1.774]	12.640*** [3.154]	3.491 [2.136]	-1.264 [1.281]	-2.186** [0.956]	-2.268** [0.977]
Observations	140	150	150	150	150	150	148	150	150	150
R-squared				0.248	0.256			0.454		0.482
Endogeneity test statistic	2.882	3.165	3.238			23.688	7.777		0.169	
Endogeneity p-value	0.090	0.075	0.072			0.000	0.005		0.681	
Hansen-Sargan test statistic	0.785	0.304	0.736			0.267	0.024		0.083	
Hansen-Sargan p-value	0.376	0.581	0.391			0.606	0.877		0.959	
Kleibergen-Paap LM test statistic	30.560	27.166	23.051			16.668	26.156		41.796	
Kleibergen-Paap p-value	0.000	0.000	0.000			0.000	0.000		0.000	
Kleibergen-Paap F statistic	55.103	22.508	17.739			11.755	22.221		99.691	
Pesaran-Taylor reset statistic	0.073	0.287	0.028			0.022	0.171		0.100	
Pesaran-Taylor p-value	0.787	0.592	0.866			0.883	0.679		0.752	
Ramsey reset F statistic				0.270	0.479			3.203		1.405
Probability > F				0.847	0.698			0.025		0.244

Robust standard errors in brackets

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

Table A7 continued Estimation path to preferred expenditure specifications for 2009/10

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	PBC 13 gastro	PBC 14	PBC 14	PBC 14	PBC 14	PBC 14	PBC 15 musculo- skeletal	PBC 15 musculo- skeletal	PBC 15 musculo- skeletal	PBC 16
	2009/10 spend SYLLR	skin problems	skin problems	skin problems	skin problems	skin problems	skin problems	skin problems	skin problems	trauma/injuries
	2009/10/11	2009/10 spend SYLLR	2009/10 spend SYLLR	2009/10 spend SYLLR	2009/10 spend SYLLR	2009/10 spend SYLLR	2009/10 spend SYLLR	2009/10 spend SYLLR	2009/10 spend SYLLR	2009/10 spend SYLLR
	spend model instrument other needs	2009/10/11	2009/10/11	2009/10/11	2009/10/11	2009/10/11	2009/10/11	2009/10/11	2009/10/11	2009/10/11
	weighted IV second stage GMM2S LA-level	spend model instrument o/need weighted GMM2S LA-level	spend model instrument n/a weighted OLS	spend model instrument o/need weighted GMM2S LA-level	spend model instrument n/a weighted OLS	spend model instrument n/a weighted OLS	spend model instrument o/need weighted GMM2S LA-level	spend model instrument o/need weighted GMM2S LA-level	spend model instrument n/a weighted OLS	spend model instrument n/a weighted OLS
	actual mortality actual census09 08/09 version	actual mortality actual census 09 08/09 version	actual mortality actual census 09 OLS version	actual mortality actual census 09 Re-derived	actual mortality actual census 09 OLS	actual mortality actual census 09 OLS v2	actual mortality actual census 09 08/09 version	actual mortality actual census 09 Re-derived IV	actual mortality actual census 09 OLS	actual mortality actual census 09 08/09 version
VARIABLES										
lacsyllrexgast911	-0.612*** [0.211]									
lAgall_0910pheadOHP	0.387* [0.231]	0.791*** [0.267]	0.758*** [0.264]	1.025*** [0.216]	0.972*** [0.202]	0.890*** [0.192]	0.013 (0.316)	0.288 (0.257)	0.295 [0.263]	1.090*** [0.215]
lACARANneed910	1.292*** [0.319]	0.600* [0.346]	0.494* [0.291]				2.869*** (0.445)	1.259*** (0.416)	0.965*** [0.340]	
lacmSYLLR0911		-0.065 [0.291]	0.064 [0.148]	-0.248 [0.333]	-0.073 [0.211]	-0.046 [0.208]	-1.850*** (0.370)	-0.129 (0.321)	0.180 [0.185]	-0.219 [0.150]
lLAIMD2010				0.355** [0.168]	0.297** [0.134]	0.278** [0.133]				
LHHNOCAR09				-0.197** [0.080]	-0.185** [0.074]	-0.176** [0.074]				
LPC74LTUN09								-0.299*** (0.079)	-0.317*** [0.077]	
LLONEPENH09								0.257** (0.117)	0.341*** [0.119]	
LWORKAGRI09										0.069*** [0.016]
Constant	5.218** [2.254]	-1.875 [2.268]	-2.401 [2.040]	-3.864** [1.730]	-4.332*** [1.595]	-3.817** [1.517]	15.495*** (2.795)	2.387 (3.052)	0.574 [2.551]	-2.171* [1.157]
Observations	148	150	150	150	150	148	150	150	150	150
R-squared			0.510		0.521	0.496			0.564	0.236
Endogeneity test statistic	9.122	0.229		0.318			18.408	1.663		
Endogeneity p-value	0.003	0.632		0.573			0.000	0.197		
Hansen-Sargan test statistic	0.389	0.000		1.073			0.518	1.206		

Hansen-Sargan p-value	0.533	0.996		0.585			0.472	0.752		
Kleibergen-Paap LM test statistic	32.784	25.438		25.102			25.438	27.193		
Kleibergen-Paap p-value	0.000	0.000		0.000			0.000	0.000		
Kleibergen-Paap F statistic	29.989	21.297		30.806			21.297	19.406		
Pesaran-Taylor reset statistic	2.482	0.185		0.396			0.048	0.493		
Pesaran-Taylor p-value	0.115	0.667		0.529			0.826	0.483		
Ramsey reset F statistic			2.778		2.281	1.358			1.392	0.948
Probability > F			0.043		0.082	0.258			0.248	0.419

Robust standard errors in brackets

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

Table A7 continued Estimation path to preferred expenditure specifications for 2009/10

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	PBC 17 renal 2009/10 spend SYLLR 2009/10/11 spend model instrument n/a	PBC 1819 maternity/neonates 2009/10 spend all causeSYLLR 2009/10/11 spend model instrument o/need	PBC 20 poisoning 2009/10 spend SYLLR 2009/10/11 spend model instrument o/need	PBC 21 HI 2009/10 spend SYLLR 2009/10/11 spend model instrument n/a	PBC 22 social care 2009/10 spend SYLLR 2009/10/11 spend model instrument n/a	PBC 22 social care 2009/10 spend SYLLR 2009/10/11 spend model instrument o/need	PBC 22 social care 2009/10 spend SYLLR 2009/10/11 spend model instrument n/a	PBC 23a GMS 2009/10 spend SYLLR 2009/10/11 spend model instrument n/a	PBC 23a GMS/PMS 2009/10 spend SYLLR 2009/10/11 spend model instrument o/need	PBC 23a GMS 2009/10 spend SYLLR 2009/10/11 spend model instrument n/a
	weighted OLS LA-level actual mortality actual census 09 08/09 version	weighted IV second stage GMM2S LA-level actual mortality actual census 09 08/09 version	weighted GMM2S LA-level actual mortality actual census 09 08/09 version	weighted OLS LA-level actual mortality actual census 09 08/09 version	weighted OLS LA-level actual mortality actual census 09 08/09 version	weighted GMM2S LA-level actual mortality actual census 09 08/09 version Re-derived IV	weighted OLS LA-level actual mortality actual census 09 08/09 version OLS	weighted OLS LA-level actual mortality actual census 09 08/09 version	weighted GMM2S LA-level actual mortality actual census 09 08/09 version Re-derived IV	weighted OLS LA-level actual mortality actual census 09 08/09 version Re-derived, OLS
LBORNEXEU09	0.051*** [0.017]									
ILACARANneed910	0.218 [0.265]		1.110*** [0.390]	0.939 [0.570]	0.060 [1.073]			0.305 [0.208]		
lacsyllrexrenal0911	-0.171 [0.124]									
ILAgall_0910pheadOHP	0.878*** [0.207]	0.653*** [0.233]	0.658** [0.304]	1.246** [0.506]	0.801 [0.926]	1.029* [0.623]	0.844 [0.563]	0.485*** [0.173]	0.589*** [0.114]	0.564*** [0.085]
lacmSYLLR0911		-0.405* [0.246]	-0.816*** [0.302]	0.232 [0.323]	-0.191 [0.532]	-0.218 [0.461]	-0.177 [0.432]	0.050 [0.112]	-0.015 [0.102]	0.010 [0.071]
ILAmatneedindexpp		0.963*** [0.088]								
LLONEPENH09								0.026 [0.059]		
LPERMSICK09								-0.155** [0.068]		
LPROFOCCU09								0.015 [0.084]		
Constant	-0.939 [1.794]	2.072*** [0.704]	3.017 [2.692]	-7.085* [4.068]	-1.234 [7.870]	-2.780 [2.884]	-1.640 [2.855]	-6.231*** [1.541]	0.718* [0.387]	0.751** [0.369]
Observations	150	150	150	150	97	97	97	148	148	148
R-squared	0.487			0.385	0.035		0.035	0.364		0.463
Ramsey reset F statistic	1.995			0.507	1.305		1.066	0.036		0.112
Probability > F	0.117			0.678	0.278		0.368	0.991		0.953
Endogeneity test statistic		1.253	12.352			0.317			0.078	
Endogeneity p-value		0.263	0.000			0.573			0.780	
Hansen-Sargan test statistic		0.212	0.078			2.047			1.357	

Hansen-Sargan p-value	0.899	0.781	0.563	0.507
Kleibergen-Paap LM test statistic	35.340	25.438	27.420	34.081
Kleibergen-Paap p-value	0.000	0.000	0.000	0.000
Kleibergen-Paap F statistic	69.224	21.297	53.616	60.202
Pesaran-Taylor reset statistic	0.050	0.008	0.885	0.169
Pesaran-Taylor p-value	0.822	0.928	0.347	0.681

Robust standard errors in brackets
*** p<0.01, ** p<0.05, * p<0.1

Appendix 2: Expected health opportunity costs in the NHS (2009/10 results)

Overview

71. In the second appendix results are presented that reflect the available data for 2009/10 expenditure (this forms Appendix 2.1). In Appendix 2.2, the results are also analysed in terms of how sensitive the results are to two key inputs: i) each of the estimated elasticities and ii) assumptions made in order to overcome data limitations for each PBC (only have mortality outcome data and for only a portion of PBCs). Finally, Appendix 2.3 considers an update regarding data from ONS used to inform burden of disease.

Appendix 2.1 Results

72. Results are presented in two ways, in table A8, as the point estimate of the cost per QALY of marginal activity in the NHS, or alternatively expressed as the expected QALY health opportunity cost for £10,000,000 expenditure. To highlight the contribution of each of the updated inputs, results are first presented where elasticities estimated from 2009/10 data and 2009/10 expenditure levels are applied to 2008-2010 burden (3) and, secondly, with elasticities estimated from 2009/10 data and 2009/10 expenditure levels applied to 2009-2011 burden (4). In addition, we display the results using 2008/9 elasticities in two ways, one with 2008-2010 burden as recorded in Claxton et al. (2015) (1) and another where 2008-2010 burden inputs are re-calculated using the updated data presented in Appendix 2.3 (2).

Table A8 Results for 2009/10 compared to previously generated results

	<i>(1)</i>	<i>(2)</i>	<i>(3)</i>	<i>(4)</i>
Elasticities and expenditures	<i>2008/09</i>	<i>2008/09</i>	<i>2009/10</i>	<i>2009/10</i>
Burden	<i>2008-10 Claxton et al. (2015)</i>	<i>2008-10</i>	<i>2008-10</i>	<i>2009-11</i>
Cost per QALY	£13,227	£13,095	£9,655	£9,662
Health opportunity costs of £10mn (QALYs)	756	764	1,036	1,035

73. It can be seen from Table A8 that the expected health opportunity costs of a given level of expenditure have increased between 2008/09 and 2009/10 and so the cost per QALY ratio has fallen. In addition, changes to burden make only a modest difference to these point estimates. The associated uncertainty with each of these results is presented in Table A9 and figures A1 and A2 below.

Table A9 results for 2009/10 expenditure compared to previously generated results

2008/9 elasticities and expenditures with 2008-10 ONS data according to Claxton et al. (2015)

(1)	Point estimate	5th percentile	95th percentile
Cost per QALY	£13,227	£8,121	£34,069
Health opportunity costs of £10mn (QALYs)	756	294	1,231

2008/9 elasticities and expenditures with re-calculated 2008-10 ONS data

(2)	Point estimate	5th percentile	95th percentile
Cost per QALY	£13,095	£8,158	£38,652
Health opportunity costs of £10mn (QALYs)	764	259	1,226

2009/10 elasticities and expenditures with re-calculated 2008-10 ONS data

(3)	Point estimate	5th percentile	95th percentile
Cost per QALY	£9,655	£6,771	£17,012
Health opportunity costs of £10mn (QALYs)	1,036	588	1,477

2009/10 elasticities and expenditures with 2009-11 ONS data

(4)	Point estimate	5th percentile	95th percentile
Cost per QALY	£9,662	£6,650	£16,784
Health opportunity costs of £10mn (QALYs)	1,035	596	1,504

It can be seen from Table A9 that the expected health opportunity costs of a change in expenditure have increased between 2008/09 and 2009/10 and so the cost per QALY ratio has fallen. In this table, the uncertainty associated with these estimates is shown and it can be judged to what extent any changes in the point estimate between years should be interpreted as a signal of any trend. From Table A9 it is hard to conclude that there is a significant fall in the health opportunity costs of £10mn expenditure, since there is a great deal of overlap between the 90% confidence intervals.

Figure A1 Results illustrating uncertainty for 2009/10 and previously generated results – cost per QALY

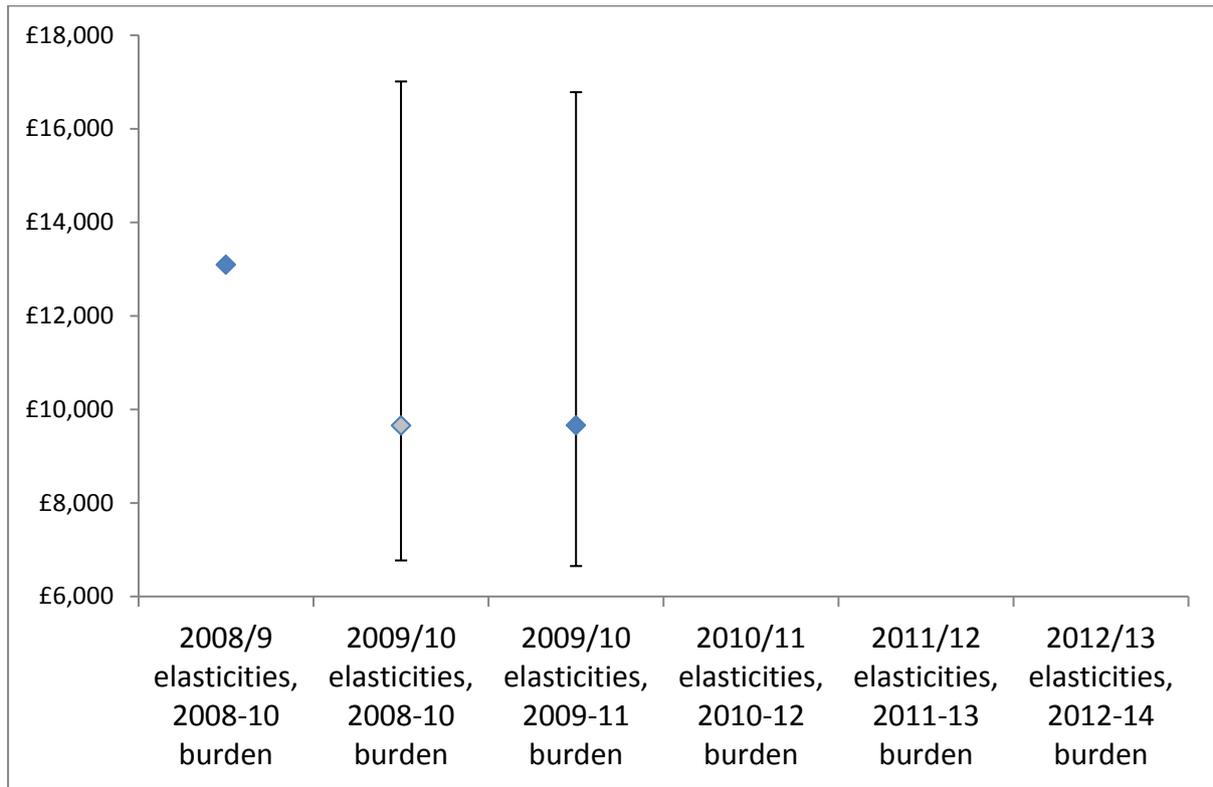
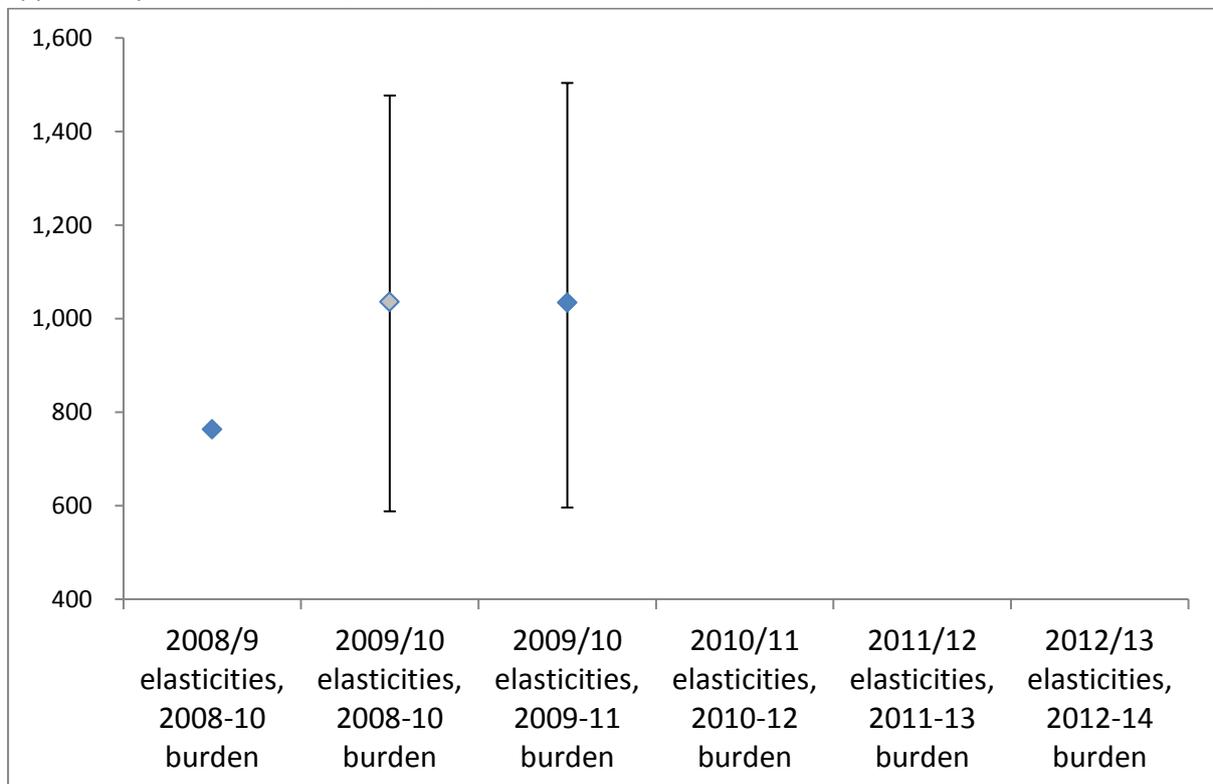


Figure A2 Results illustrating uncertainty for 2009/10 and previously generated results – Health opportunity costs of £10mn (QALYs)



74. The results contained within Table A9 are also represented graphically in Figures A1 and A2. The confidence intervals are presented for results pertaining to 2009/10 elasticities, but not for 2008/9 elasticities. The reason for this is that the specifications used for 2009/10 equations were adjusted if a re-application of 2008/9 specifications resulted in poor statistical performance (see Appendix 1). The specification of the 2008/9 models, however, were directly taken from Claxton et al. (2015) where there were two key differences: analysis was at PCT and not LA level and census variables used 2001 values not 2008 values (calculated by interpolation between 2001 and 2011 census data). As such, the specification in the 2008/9 models may not have passed all statistical performance tests once moved to LA level and the instruments were updated to 2008 values (e.g 2008/9 specification may possess weak instruments that lead to imprecise coefficient estimation).

75. It can also be seen from Figures A1 and A2 that while the confidence interval is far from symmetrically distributed around the point estimate of the cost per QALY ratio in Figure A1 (where uncertainty is reflected in the denominator), when expressed as health opportunity costs per £10mn then the distribution of uncertainty is much more symmetric in Figure A2 (uncertainty is reflected in the numerator).

Appendix 2.2 Sensitivity analysis

76. Appendix 2.2 details three sensitivity analyses that were performed. The first two concerned the elasticities that were econometrically estimated for each of the PBCs. In the first case each of the estimated PBC outcome elasticities are varied by +/- 1 standard error. Then, the difference between the two resulting opportunity costs is presented. When this is larger, this implies that the overall resulting estimate of health opportunity costs is more sensitive to the outcome elasticity under consideration (Table A10). The same procedure is then carried out for each of the PBC expenditure elasticities (Table A11).

Table A10 Sensitivity of results to estimated outcome elasticities

	Change in spend	Change in QALY death + QALY alive	Implied PBC cost per QALY (£)	Difference in health opportunity costs between +1 SE and -1 SE in PBC outcome elasticity	% difference in health opportunity costs between +1 SE and -1 SE in PBC outcome elasticity	Importance of PBC (rank)
2 Cancer	£457,412.96	28	£16,523.87	25	2.44%	7
10 Circulatory	£579,645.11	105	£5,544.45	62	5.96%	6
11 Respiratory	£411,572.52	218	£1,889.33	192	18.55%	2
13 Gastro-intestinal	£283,693.87	51	£5,583.95	83	8.05%	4
1 Infectious diseases	£221,354.67	5	£41,541.64	9	0.87%	8
4 Endocrine	£295,384.86	73	£4,056.79	74	7.16%	5
7 Neurological	£545,689.03	292	£1,866.46	403	38.93%	1
17 Genito-urinary	£627,621.24	22	£28,904.12	136	13.11%	3
16 Trauma & injuries* Maternity & neonates*	£657,736.33	0	-	-	-	-
18+19	£501,566.02	0	£2,765,793.49	4	0.39%	9
3 Disorders of Blood	£205,789.96	31	£6,617.68	-	-	-
5 Mental Health	£1,561,506.83	130	£12,006.32	-	-	-
6 Learning Disability	£319,501.78	3	£93,016.80	-	-	-
8 Problems of Vision Problems of	£302,392.67	10	£31,719.56	-	-	-
9 Hearing	£103,679.04	24	£4,401.21	-	-	-
12 Dental problems	£435,457.38	16	£27,304.33	-	-	-
14 Skin	£284,676.08	4	£70,447.88	-	-	-
15 Musculo skeletal	£222,739.45	21	£10,443.12	-	-	-
20 Poisoning and AE	£113,531.55	2	£75,437.15	-	-	-
21 Healthy Individuals	£410,002.60	1	£341,922.60	-	-	-
22 Social Care Needs	£285,440.64	0	-	-	-	-
23 Other	£1,173,605.40	0	-	-	-	-

Total: 1,035

Table A11 Sensitivity of overall results to estimated spend elasticities

	Change in spend	Change in QALY death + QALY alive	Implied PBC cost per QALY (£)	Difference in health opportunity costs between +1 SE and -1 SE in PBC spend elasticity	% difference in health opportunity costs between +1 SE and -1 SE in PBC spend elasticity	Importance of PBC (rank)
2 Cancer	£457,412.96	28	£16,523.87	36	3.51%	8
10 Circulatory	£579,645.11	105	£5,544.45	71	6.86%	3
11 Respiratory	£411,572.52	218	£1,889.33	144	13.90%	1
13 Gastro-intestinal	£283,693.87	51	£5,583.95	36	3.49%	9
1 Infectious diseases	£221,354.67	5	£41,541.64	16	1.52%	14
4 Endocrine	£295,384.86	73	£4,056.79	24	2.34%	12
7 Neurological	£545,689.03	292	£1,866.46	126	12.19%	2
17 Genito-urinary	£627,621.24	22	£28,904.12	1	0.13%	22
16 Trauma & injuries* Maternity & neonates*	£657,736.33	0	-	41	3.92%	5
18+19	£501,566.02	0	£2,765,793.49	53	5.15%	4
3 Disorders of Blood	£205,789.96	31	£6,617.68	5	0.49%	20
5 Mental Health	£1,561,506.83	130	£12,006.32	16	1.53%	13
6 Learning Disability	£319,501.78	3	£93,016.80	27	2.61%	11
8 Problems of Vision Problems of Hearing	£302,392.67	10	£31,719.56	12	1.16%	16
9	£103,679.04	24	£4,401.21	7	0.70%	19
12 Dental problems	£435,457.38	16	£27,304.33	14	1.38%	15
14 Skin	£284,676.08	4	£70,447.88	11	1.06%	17
15 Musculo skeletal	£222,739.45	21	£10,443.12	3	0.30%	21
20 Poisoning and AE	£113,531.55	2	£75,437.15	9	0.91%	18
21 Healthy Individuals	£410,002.60	1	£341,922.60	34	3.24%	10
22 Social Care Needs	£285,440.64	0	-	39	3.81%	6
23 Other	£1,173,605.40	0	-	37	3.54%	7
Total:		1,035				

77. The results display varying degrees of sensitivity to estimated elasticities depending upon the PBC under consideration. In general, but not always, the results are more sensitive to specific PBC outcome elasticities than to specific PBC spend elasticities. Looking first at Table A11, for many PBCs, the difference between the overall health opportunity cost when the spend elasticity is increased by one standard error compared to the result when the standard error is reduced by one standard error represents less than 1% of the overall point estimate of health opportunity costs (PBCs 17, 3, 9, 15 and 20). In only 2 PBCs is this difference more than 10%: PBCs 11 and 7 (respiratory and neurological). Switching to look at Table A10 it can be seen that the same two PBCs are the most important when outcome elasticity is under consideration, as when spend elasticity is considered: PBCs 11 and 7 (respiratory and neurological). However, sensitivity between the two types of elasticity do not always associate so closely, for example the third most sensitive PBC in terms of outcome elasticity is PBC 17, genito-urinary, owing to its highly imprecise outcome elasticity - whose sensitivity to spend elasticity is practically negligible.

78. Following these two sensitivity analyses, a third is performed (Table A12) with a different emphasis, which analyses the sensitivity of the overall health opportunity cost estimate to two key assumptions:

Surrogacy- we are required to make an assumption about how the effect on mortality for PBCs with a mortality indicator can be used as a *surrogate* for the effect that expenditure has on morbidity (or health-related quality of life) in those PBCs.

Extrapolation- We are required to make an assumption about how the estimated effects on mortality found for PBCs with a mortality indicator can be *extrapolated* to the effect that expenditure has on mortality for those PBCs that do not have a mortality indicator.

In order to assess the impact of these assumptions on the overall results for the NHS, we evaluate the health effects of £10mn spending at the margin in the NHS when either:

- a) For PBCs with a mortality indicator: no surrogacy assumption, therefore expenditure has no effect on morbidity
- b) For PBCs without a mortality indicator: assume no health effects at all, neither on mortality (extrapolation assumption) nor morbidity (surrogacy assumption)

Table A12 Sensitivity of overall results to surrogacy and extrapolation assumptions

	Change in spend	Change in QALY death	Change in QALY alive	Health opportunity costs sensitivity to mortality/morbidity assumption (%)	Importance of PBC (rank)
2 Cancer	£457,412.96	26	2	-0.19%	16
10 Circulatory	£579,645.11	73	32	-3.07%	5
11 Respiratory	£411,572.52	13	205	-19.82%	2
13 Gastro-intestinal	£283,693.87	19	31	-3.03%	6
1 Infectious diseases	£221,354.67	1	4	-0.39%	14
4 Endocrine	£295,384.86	4	69	-6.63%	4
7 Neurological	£545,689.03	12	281	-27.13%	1
17 Genito-urinary	£627,621.24	4	17	-1.67%	10
16 Trauma & injuries*	£657,736.33	0	0	0.00%	-
18+19 Maternity & neonates*	£501,566.02	0	0	-0.01%	19
3 Disorders of Blood	£205,789.96	2	29	-3.00%	7
5 Mental Health	£1,561,506.83	11	119	-12.57%	3
6 Learning Disability	£319,501.78	1	3	-0.33%	15
8 Problems of Vision	£302,392.67	0	9	-0.92%	12
9 Problems of Hearing	£103,679.04	0	23	-2.28%	8
12 Dental problems	£435,457.38	0	16	-1.54%	11
14 Skin	£284,676.08	1	3	-0.39%	13
15 Musculo skeletal	£222,739.45	1	20	-2.06%	9
20 Poisoning and AE	£113,531.55	0	1	-0.15%	17
21 Healthy Individuals	£410,002.60	0	1	-0.12%	18
22 Social Care Needs	£285,440.64	0	0	0.00%	-
23 Other	£1,173,605.40	0	0	0.00%	-
Total:		169	866		
Total change in QALY death + QALY alive			1,035		

79. It can be seen that the surrogacy assumption is especially impactful for PBCs 7 and 11 (neurological and respiratory) while the assumption is only of negligible (<1%) importance for PBCs 2 and 18+19 (cancer and maternity & neonates). Extrapolation and surrogacy is particularly important for PBC 5 (mental health) and only negligibly important for PBCs 6, 8, 14, 20 and 21 (learning disability, problems of vision, skin, poisoning and AE and healthy individuals).

Appendix 2.3 Outline of ONS data update for 2009/10

Sources of data

80. The following types of data were obtained from the ONS either by personal communication or from the ONS websites.

“National life tables, England” – available at

<http://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/lifeexpectancies/datasets/nationallifetablesenglandreferencetables>

“VS3 MORTALITY BY CAUSE” – obtained through personal communication with ONS vital statistics team

“Population Estimates by single year of age and sex for local authorities in the UK (mid-year estimates)” – available at

<https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/datasets/populationestimatesforukenglandandwalesscotlandandnorthernireland>

The last of these, “Population Estimates by single year of age and sex for local authorities in the UK (mid-year estimates)”, was required for updating net YLL based on general population life expectancy. It is not used when life expectancy is PBC-specific, which is an input into the calculation of net YLL for generating results presented in the third note.

Calculation of PBC net YLL

81. The calculation of net YLL by PBC relies on two crucial inputs. The first is data on deaths within each PBC and the age of death, which is then compared to the benchmark of the second input, PBC life expectancy. Each death can then be translated into a number of years of life lost (YLL) if death occurred before the life expectancy and years of life gained (YLG) when the death occurred after the life expectancy. The difference between YLL and YLG gives net YLL, which is an input into the calculation of results. PBC life expectancy itself has to be calculated and relies on data provided by national life tables.

82. Table A13 displays net YLL and total number of deaths derived from ONS data for 2006-2008, 2007-2009, 2008-2010 and 2009-2011. It is worth noting that the net YLL calculated for 2006-2008, 2007-2009 and 2008-2010 below do not correspond exactly to the equivalent tables in Claxton et al. (2015): Tables 10 and 12 (2006-2008); 159 (2008-2010) and 186 (2007-2009). This is for two reasons. First, a correction was made to the data entry for ONS deaths by age, gender and ICD code data for years 2008, 2009 and 2010, affecting net YLL, but not all deaths, for all of the tables below. Second, for 2007-2009 and 2008-2010 the PBC life expectancy was re-calculated, while in Claxton et al. (2015) 2006-2008 PBC life expectancy was used for all years.

Table A13 Net YLL for 2006-08, 2007-09, 2008-10 and 2009-2011 using LE for each PBC

2006-2008

PBC	GP LE (M)	GP LE (F)	PBC LE (M)	PBC LE (F)	All deaths	Net YLL	Claxton et al net YLL
1	80.7	84.4	79.6	83.6	6,958	36,379	36,962
2	80.7	84.4	83.0	84.7	130,810	1,347,324	1,347,184
4	80.7	84.4	81.0	84.7	6,765	50,933	51,225
7	80.7	84.4	79.6	83.3	15,353	92,710	93,917
10	80.7	84.4	83.0	86.5	159,852	808,850	823,768
11	80.7	84.4	80.3	84.0	65,446	61,007	68,030
13	80.7	84.4	80.6	84.5	24,147	226,380	227,703
17	80.7	84.4	83.5	85.6	10,624	16,669	18,127
18+19	80.7	84.4	78.7	83.1	226	16,801	16,801

2007-2009

PBC	GP LE (M)	GP LE (F)	PBC LE (M)	PBC LE (F)	All deaths	Net YLL	Claxton et al net YLL
1	80.9	84.6	79.8	83.8	6,288	38,835	38,629
2	80.9	84.6	83.2	84.9	131,372	1,355,804	1,334,916
4	80.9	84.6	81.2	84.9	6,762	51,857	51,189
7	80.9	84.6	79.9	83.5	16,076	91,442	90,835
10	80.9	84.6	83.2	86.6	155,222	785,989	793,264
11	80.9	84.6	80.5	84.2	65,026	73,441	73,922
13	80.9	84.6	80.8	84.7	23,920	227,224	225,593
17	80.9	84.6	83.7	85.7	11,015	15,310	16,725
18+19	80.9	84.6	79.0	83.2	255	18,899	18,843

2008-2010

PBC	GP LE (M)	GP LE (F)	PBC LE (M)	PBC LE (F)	All deaths	Net YLL	Claxton et al net YLL
1	81.2	84.8	80.1	84.0	5,262	39,656	38,794
2	81.2	84.8	83.4	85.1	131,945	1,369,741	1,322,166
4	81.2	84.8	81.4	85.1	6,763	51,348	49,817
7	81.2	84.8	80.1	83.7	16,771	93,096	90,069
10	81.2	84.8	83.4	86.8	151,443	778,237	771,038
11	81.2	84.8	80.7	84.4	64,449	85,785	77,434
13	81.2	84.8	81.0	84.9	23,898	230,841	225,254
17	81.2	84.8	83.9	85.9	11,345	15,635	16,508
18+19	81.2	84.8	79.3	83.5	265	19,907	19,781

2009-2011

PBC	GP LE (M)	GP LE (F)	PBC LE (M)	PBC LE (F)	All deaths	Net YLL
1	81.5	85.1	80.5	84.3	4,907	38,814
2	81.5	85.1	83.7	85.4	132,656	1,395,819
4	81.5	85.1	81.7	85.4	6,477	51,079
7	81.5	85.1	80.5	84.0	17,113	93,164
10	81.5	85.1	83.6	87.1	142,567	768,320
11	81.5	85.1	81.1	84.7	63,088	101,927
13	81.5	85.1	81.4	85.2	23,499	235,041
17	81.5	85.1	84.1	86.2	10,600	16,230
18+19	81.5	85.1	79.7	83.8	252	18,895

83. From Table A13 it is clear that changes made to Claxton et al. (2015) make only a small difference to the calculated net YLLs. It is less easy to see from the table above, that there are some more significant changes to the number of deaths and net YLL within certain PBCs than others. This is more clearly expressed in Tables A14, A15 and A16 below.

Table A14 General population and PBC life expectancy over time

PBC	Sex	2006-2008	2007-2009	2008-2010	2009-2011
GP	M	80.7	80.9	81.2	81.5
	F	84.4	84.6	84.8	85.1
1	M	79.6	79.8	80.1	80.5
	F	83.6	83.8	84.0	84.3
2	M	83.0	83.2	83.4	83.7
	F	84.7	84.9	85.1	85.4
4	M	81.0	81.2	81.4	81.7
	F	84.7	84.9	85.1	85.4
7	M	79.6	79.9	80.1	80.5
	F	83.3	83.5	83.7	84.0
10	M	83.0	83.2	83.4	83.6
	F	86.5	86.6	86.8	87.1
11	M	80.3	80.5	80.7	81.1
	F	84.0	84.2	84.4	84.7
13	M	80.6	80.8	81.0	81.4
	F	84.5	84.7	84.9	85.2
17	M	83.5	83.7	83.9	84.1
	F	85.6	85.7	85.9	86.2
18+19	M	78.7	79.0	79.3	79.7
	F	83.1	83.2	83.5	83.8

Table A15 Net YLL by PBC over time

PBC	2006-2008	2007-2009	2008-2010	2009-2011
1	36,379	38,835	39,656	38,814
2	1,347,324	1,355,804	1,369,741	1,395,819
4	50,933	51,857	51,348	51,079
7	92,710	91,442	93,096	93,164
10	808,850	785,989	778,237	768,320
11	61,007	73,441	85,785	101,927
13	226,380	227,224	230,841	235,041
17	16,669	15,310	15,635	16,230
18+19	16,801	18,899	19,907	18,895

Table A16 Total deaths by PBC over time

PBC	2006-2008	2007-2009	2008-2010	2009-2011
1	6,958	6,288	5,262	4,907
2	130,810	131,372	131,945	132,656
4	6,765	6,762	6,763	6,477
7	15,353	16,076	16,771	17,113
10	159,852	155,222	151,443	142,567
11	65,446	65,026	64,449	63,088
13	24,147	23,920	23,898	23,499
17	10,624	11,015	11,345	10,600
18+19	226	255	265	252
Total	420,180	415,936	412,141	401,157

There are modest variations in general population and PBC-specific life expectancy over time (Table A14) and variations are modest between different PBC's number of deaths and net YLL values in most cases. It is clear that mortality was low over the period 2009-11 compared to other three year periods in Table A16. This is observed for all causes of death and not just those captured in the PBCs included here. In particular the PBC 1 (infectious diseases) number of deaths was 42% higher in 2006-08 compared to 2009-11 while PBC 10 (circulatory problems) the corresponding figure was 12%. In PBC 7 (neurological problems), the number of deaths was higher in 2009-11 compared to 2006-08 by 12%. In Table A15, the most striking change in net YLL by PBC over time is found in PBC 11 (respiratory problems) where the value was 67.1% higher in 2009-11 compared to 2006-08. Despite the variations over time observed here, the impact on results found in Appendix 2.1 is relatively modest (see Table A8).