Methodology Appendix – Hypothetical Calculation of Sources of Cost Differences

As in footnote 6, the formula for per capita costs for condition j in plan P is $x_j^P = q_j^P \cdot \sum_{i=1}^{N} \left(d_{ij}^P \cdot \sum_{k=1}^{K} t_{ijk}^P \cdot r_{ijk}^P \right)$.

Let $P \in \{I, H\}$, $N = 2$, and $K = 2$; we can suppress subscript j for considering one hypothetical condition.
Let $q^I = 0.2$ and $q^H = 0.1$ be the incidence rates in the two plans.
Let the demographic distributions conditional on contracting the condition be $d^I = [0.4 \quad 0.6]$ in the indemnity plan and $d^H = [0.3 \quad 0.7]$ in the HMOs.

Let the distributions of treatments conditional on demographics and on contracting the condition be $t^I = \begin{bmatrix} 0.6 & 0.8 \\ 0.4 & 0.2 \end{bmatrix}$ in the indemnity plan and $t^H = \begin{bmatrix} 0.5 & 0.7 \\ 0.5 & 0.3 \end{bmatrix}$ in the HMOs.

Let mean payments conditional on treatments, demographics, and contracting the condition be $r^I = \begin{bmatrix} 2 & 6 \\ 4 & 8 \end{bmatrix}$ in the indemnity plan and $r^H = \begin{bmatrix} 1 & 5 \\ 3 & 7 \end{bmatrix}$ in the HMOs.

Then $x^I = 0.99$ and $x^H = 0.45$, and $\Delta x^{I\text{-}H} = 0.54$, the per capita cost difference between plans.

If we only replace q^I with q^H, then the value of x^I changes to 0.50, which accounts for (0.99-0.50)/(0.99-0.45) = 91 percent of $\Delta x^{I\text{-}H}$.
If we only replace d^I with d^H, then the value of x^I changes to 1.06, which accounts for (0.99-1.06)/(0.99-0.45) = -13 percent of $\Delta x^{I\text{-}H}$.
If we only replace t^I with t^H, then the value of x^I changes to 1.03 which accounts for (0.99-1.03)/(0.99-0.45) = -7 percent of $\Delta x^{I\text{-}H}$.
If we only replace r^I with r^H, then the value of x^I changes to 0.79, which accounts for (0.99-0.79)/(0.99-0.45) = 37 percent of $\Delta x^{I\text{-}H}$.
(If we standardize to fractions of cost differences accounted for by first-order effects, we find that incidence accounts for 84 percent of costs differences, demographic mix accounts for –12 percent, treatments account for –6 percent, and prices account for 37 percent.)
Replacing two or more of the terms that compose x^I with the corresponding terms from x^H will produce the 11 interactions as listed in Appendix Table I. Note that the terms differ if we use x^H as the base and substitute terms from x^I.

Results Appendix

In the data appendix, we discuss the sampling issues in identifying people with the different conditions, present results controlling for hospital and zip code effects, and show the interaction terms for one of our conditions (AMI). We begin with the sampling issues

Sampling Issues

Birth

Our baseline measure of birth costs includes costs in the 9 months before birth, and costs in the 7 days after birth. One issue raised by this choice is the possibility of long-term complications in the HMOs leading to higher costs down the road. To address this, we calculated an alternative measure of costs including all spending on the infant in the 180 days following birth. Appendix table A shows a comparison of overall costs and costs by treatment path using the two definitions. There is little substantive difference in the results. Indeed, indemnity plan costs are relatively higher with the 180-day definition than with the 7-day definition.

APPENDIX TABLE A – COMPARISON OF BIRTH COSTS USING DIFFERENT INTERVALS AFTER BIRTH

Plan	**7-Days After Birth**			**180-Days After Birth**		
	Indemnity	**HMO**	**Ratio**	**Indemnity**	**HMO**	**Ratio**
Incidence of live birth	6.80%	4.82%				
Average cost per birth	$9,624	$8,446	1.14	$10,349	$8,554	1.21
Caesarian section share (Intense path)	25.5%	19.6%				
Payments, pregnancy episodes						
with caesarian	$14,964	$10,103	1.48	$16,752	$10,958	1.53
no caesarian	7,728	$7,707	1.00	8,279	8,019	1.03

Note: All figures above the dotted line are demographically adjusted for the age and sex composition of the total insurance pool using ordinary least squares regression. This analysis includes only women between the ages of 15 and 44 classified as heads-of-household or heads' spouses. Payments refer to all services and prescription drugs. All pregnancies resulting in births between 4/1/94 and 6/31/95 are included.

Diabetes

We code as diabetic anyone with two or more ICD-9 diagnoses of diabetes at any time over the sample. For type I diabetes, we use ICD-9 code 250.X1 or 250.X3. For type 2 diabetes, we use ICD-9 code 250.X0 or 250.X2. These codes exclude women with gestational diabetes (ICD-9 code 648.0). The limitation to two or more ICD-9 diagnoses is to limit rule-outs of diabetes and miscoding. Appendix table B shows a comparison of the number of visits with a diabetes diagnosis by type and plan.

APPENDIX TABLE B – COMPARISON OF DIABETES CODES IN HMO AND INDEMNITY PLAN

Plan	Indemnity		HMOs	
Visits	**Type I**	**Type II**	**Type I**	**Type II**
1	95	1,001	104	1,008
2	61	339	74	269
3	68	204	48	186
4	66	196	50	132
5+	696	763	473	633

Type I diabetes is juvenile, insulin-dependent diabetes; type II is adult-onset, non-insulin-dependent diabetes.

The results are consistent with our expectations. Type I diabetes is diagnosed well. A majority of people have five or more diagnoses of type I diabetes in the two year period. That is true in both the indemnity plan (71 percent) and the HMOs (63 percent). Among type II diabetics, there are many more people with just one visit. Still, these shares are similar in the two plans: 40 percent of indemnity patients have one diagnosis for type II diabetes, as do 45 percent of HMO patients. If anything, HMOs are diagnosing more patients with fewer diabetes visits than is the indemnity plan, suggesting that HMO incidence might be too high. But this is not major. In both plans, the number of people with type II diabetes does not drop off greatly after two diagnoses. This suggests that the two diagnosis rule is accurately capturing diabetics.

We tested the sensitivity of our diabetes results to using 3 diagnosis rule instead of two. Appendix table C shows the results. The results are very similar using the 3 diagnosis rule to the 2 diagnosis rule.

APPENDIX TABLE C – COMPARISON OF DIABETES INCIDENCE AND COSTS WITH DIFFERING NUMBER OF DIAGNOSES

Plan		2 or More Diagnoses			3 or More Diagnoses		
		Indemnity	**HMO**	**Ratio**	**Indemnity**	**HMO**	**Ratio**
Incidence	type I	1.16%	0.66%	1.76	1.08%	0.60%	1.80
	type II	1.71	1.36	1.26	1.31	1.08	1.21
Payment	type I	$11,023	$7,748	1.42	$11,479	$7,722	1.49
	type II	6,898	4,479	1.54	7,352	4,564	1.61

Note: All figures above the dotted line are demographically adjusted for the age and sex composition of the total insurance pool using ordinary least squares regression. This analysis includes individuals between the ages of 0 and 64.

The overall share of people with type I diabetes is higher in these data than in the population as a whole. Using our two-diagnosis rule, 59 percent in the indemnity plan have type I diabetes, versus 53 percent in the HMOs. Nationally, about 10 percent of diabetics have type I diabetes, and 90 percent have type II. The difference here is likely due to incomplete coding by physicians. Still, it is unlikely to affect our results greatly.

The shares of type I and type II diabetics is so similar in the two plans that the average payments still differ by 50 percent ($8,434 in the indemnity plan versus $5,610 in the HMOs)

Additional Results

The following tables present our treatment and payment results controlling for three-digit zip code of residence, Metropolitan Statistical Area of residence, and treatment at any of 10 major Massachusetts hospitals

APPENDIX TABLE D – FREQUENCY OF TREATMENTS AND PAYMENTS FOR ACUTE MYOCARDIAL INFARCTION (AMI) BY PLAN, ADJUSTED FOR AREA OF RESIDENCE AND HOSPITAL OF TREATMENT, FY94-95

Plan		Indemnity	HMOs
Two-year incidence of AMI		0.54%*****	0.40%*****
Average cost per episode		$30,060	$18,440*****
Share by treatment path			
	Null	52.6%	52.3%
	catheterization	21.7	13.9*****
	PTCA	13.4	20.5*****
	CABG	12.4	13.3
Payments, AMI episodes			
treatment path:	null	$18,315	$8,242*****
	catheterization	27,044	18,892
	PTCA	42,348	23,355*****
	CABG	75,854	47,273*****
Weighted by treatment path		30,487	17,961*****

* Denotes that means are significantly different at the five percent level.
Note: All figures are demographically adjusted for the age and sex composition of the total insurance pool. Additional fixed effects are included for three-digit zip code of residence, Metropolitan Statistical Area of residence, and treatment at any of 10 major Massachusetts hospitals. This analysis includes only individuals between the ages of 30 and 64. Payments refer to all services and prescription drugs within 90 days from the date of diagnosis of the AMI. CABG is coronary artery bypass graft surgery. PTCA is percutaneous transluminal coronary angioplasty. Catheterization refers to instances in which the patient underwent a cardiac catheterization but not CABG or PTCA. The null path indicates none of the three major surgical treatments were undertaken. Nine cases in which patients underwent both PTCA and CABG were classified as CABG.

APPENDIX TABLE E – FREQUENCY OF TREATMENTS AND PAYMENTS FOR LIVE BIRTHS BY PLAN, ADJUSTED FOR AREA OF RESIDENCE AND HOSPITAL OF TREATMENT, FY94-95

Plan	Indemnity	HMOs
Incidence of live birth	6.84%	4.77%*****
Average cost per birth	$10,050	$9,307
Caesarian sections/live births	25.7%	22.9%
Payments, pregnancy episodes		
with caesarian	$14,879	$10,438*****
no caesarian	8,203	9,159
Weighted by treatment path	9,976	9,320

* Denotes that means are significantly different at the five percent level.
Note: All figures are demographically adjusted for the age composition of the total insurance pool. Additional fixed effects are included for three-digit zip code of residence, Metropolitan Statistical Area of residence, and treatment at any of 10 major Massachusetts hospitals. This analysis includes only women between the ages of 15 and 44 classified as heads-of-household or heads' spouses. Payments refer to all services and prescription drugs from nine months before a normal birth through seven days after the birth. Only pregnancies resulting in births between 4/1/94 and 6/31/95 are included.

APPENDIX TABLE F – FREQUENCY OF TREATMENTS AND PAYMENTS FOR FOUR CANCERS BY PLAN, ADJUSTED FOR AREA OF RESIDENCE, FY94-95

Cancer	Breast		Cervix		Colon		Prostate	
Plan	**Indemnity**	**HMOs**	**Indemnity**	**HMOs**	**Indemnity**	**HMOs**	**Indemnity**	**HMOs**
Incidence	1.12%	0.72%*	0.13%	0.13%	0.16%	0.10%*	0.53%	0.37%*
Average cost per episode	$26,011	$11,410*	$15,492	$8,486	$35,636	$4,932*	$18,098	$10,109*
Share by treatment path								
RO/C	3.7%	2.9%	0.0%	1.8%	5.3%	0.6%#	8.0%	6.7%
Surgery	64.3	62.6	92.5	96.4	76.0	66.6	81.7	82.5
surgery-RO/C	32.0	34.4	7.5	1.8	18.7	32.8	10.3	10.8
Share with treatment								
patient management	99.2	96.8*	96.1	90.8	96.9	79.1*	98.7	95.6
diagnostic radiology	95.5	92.7	79.6	69.3	84.1	71.0	81.9	74.9
Payments by episode								
by path: RO/C	$15,494	$7,906	—	—+	$25,953	—+	$21,230	$14,354
Surgery	18,803	6,851*	12,116	7,458	30,232	-2,546*	15,785	7,398*
surgery-RO/C	38,911	23,205*	47,851	53,058*	63,083	15,983*	40,291	18,402
weighted by treatment path	26,425	11,374*	14,165	8,944	37,157	2,268*	18,261	10,245*

# Denotes that means are significantly different at the 10 percent level.

* Denotes that means are significantly different at the five percent level.

+ Denotes that the figures in this line are computed using insufficient observations to test confidence.

Note: All figures are demographically adjusted for the age and sex composition of the total insurance pool. Additional fixed effects are included for three-digit zip code of residence and Metropolitan Statistical Area of residence. This analysis includes only individuals between the ages of 30 and 64—women only for breast and cervical cancer, men only for prostate cancer, and both men and women for colon cancer. Payments include all services and prescription drugs within six-months from the first date of a service with a relevant cancer diagnosis and a surgery, radioactive oncology, or chemotherapy treatment. RO/C is radioactive oncology or chemotherapy. Some figures are negative as a result of small sample sizes where regression estimation with so few degrees of freedom is less precise. The lack of degrees of freedom also results in some perfectly-specified regressions.

APPENDIX TABLE G – INCIDENCE AND PAYMENTS FOR DIABETICS BY PLAN, ADJUSTED FOR AREA OF RESIDENCE, FY94-95

Plan		Indemnity	HMOs
Incidence:	type I	1.18%	0.65%*
	type II	1.73	1.34*
Payments:	type I	$10,915	$7,858*
	type II	6,911	4,417*

* Denotes that means are significantly different at five percent level.
Note: All figures are demographically adjusted for the age and sex composition of the total insurance pool. Additional fixed effects are included for three-digit zip code of residence and Metropolitan Statistical Area of residence. This analysis includes only individuals between the ages of 0 and 64. Payments include all services and prescription drugs within the two fiscal years of data. Patients were marked as diabetics if they had two services with diabetes-related diagnoses within the two-year period. Type I diabetes is juvenile, insulin-dependent diabetes; type II is adult-onset, non-insulin-dependent diabetes.

APPENDIX TABLE H — DECOMPOSITION OF COST DIFFERENCES BETWEEN PLANS AMONG SUFFERERS, ACTUAL FIRST-ORDER TERMS, FY94-95

Condition	Difference in Per Capita Plan Costs, Indemnity – HMO*	Percent of Difference from Incidence Mix	Percent of Difference from Within-Condition Mix	Percent of Difference from Treatment Intensity	Percent of Difference from Price or Unobserved Selection
average	$106.9	83.3%	7.1%	7.0%	73.2%
acute myocardial infaction	143.4	77.0	6.0	1.3	49.4
live birth	151.7	65.5	0.5	14.4	47.1
breast cancer	272.6	69.7	-9.0	1.6	71.9
cervical cancer	9.8	-14.5	33.3	19.7	98.0
colon cancer	55.7	73.5	-8.0	8.4	85.5
prostate cancer	100.1	83.8	9.0	-3.6	54.7
type I diabetes	52.6	181.3	11.6	—	88.9
type II diabetes	69.5	129.8	13.1	—	89.8

Note: Sum of components of differences may exceed 100 percent since second-order and third-order terms are omitted. Appendix Table F lists all terms for acute myocardial infarction. Components may be negative if adjusting for the given variable widens the gap in costs between the health plans. "Per capita" refers only to the universe of enrollees in which the condition is examined; see Table 2 for details. Costs are totals for FY94 and FY95.

Interaction Terms

The final part of our appendix shows the full set of interaction terms for the decomposition of cost differences for AMI. We do not present results for other conditions, although they are generally similar.

APPENDIX TABLE I — COMPLETE LIST OF TERMS FROM DECOMPOSITION OF COST DIFFERENCES, ACUTE MYOCARDIAL INFARCTION, FY94-95

Decomposed Term	Percentage of Cost Difference Explained
Incidence	77.0
within-condition mix	6.0
Treatments	1.3
Price	49.4
(incidence)*(within-condition mix)	-3.3
(incidence)*(treatments)	-0.7
(incidence)*(price)	-27.3
(within-condition mix)*(treatments)	5.8
(within-condition mix)*(price)	-1.5
(treatments)*(price)	-2.8
(incidence)*(within-condition mix)*(treatments)	-3.2
(incidence)*(within-condition mix)*(price)	0.8
(incidence)*(treatments)*(price)	1.6
(within-condition mix)*(treatments)*(price)	-6.8
(incidence)* (within-condition mix)*(treatments)*(price)	3.7
total (without rounding)	100.0

Note: This analysis includes only individuals between the ages of 30 and 64. Costs refer to payments for all services and prescription drugs within 90 days from the date of diagnosis of the AMI. Components may be negative if adjusting for the given variables widens the gap in costs between the health plans.