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The Sources of Cost Difference in Health Insurance Plans
A Decomposition Analysis

Matthew Eichner, Mark McClellan, and David A. Wise

Almost two-thirds of Americans under age sixty-five are covered by employer insurance plans. Like Medicare costs, employer medical costs have also risen quickly in recent years, and in many respects, even more dramatic reforms in have occurred in firm health insurance plans than in the Medicare program. Yet research on the consequences of these reforms, including many types of managed care reforms, has been limited. Unlike with Medicare, the provisions of employer plans vary a great deal from firm to firm, and so do the costs of medical care, suggesting that differences in plan provisions may have a substantial effect on health care expenditures. Thus analysis of employer plans provides a unique opportunity to understand the relationship between plan provisions and expenditures for health care.

The mechanisms that might be effective in controlling cost, however, will depend importantly on the source of cost differences. For example, if cost differences are accounted for in large part by a small number of plan enrollees who are treated for specific high-cost illnesses, efforts to control cost must necessarily focus on the treatment of these illness. If cost differences are due to the use of different procedures for treating seriously ill

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patients, then it is important to know what the procedures are. In contrast, if cost differences result from more modest differences in the expenditures incurred by a large number of enrollees, then effective cost control mechanisms would have to be directed toward the medical utilization of more-typical enrollees, perhaps those who use only outpatient services.

In this paper we focus not on the incentive effects of plan provisions—whether demand-side price incentive or supply-side managed care limits on care—but on the sources of cost differences across plans. Our hope is that understanding the reasons for cost differences across plans will direct more focused attention to analysis of the ways that costs can be controlled. Indeed, this work is intended as an important first step in that direction.

We are engaged in a long-term project to analyze the determinants of cost differences across firms. In particular, we look forward to estimation that can be used to predict the effect on medical expenditures of specific changes in medical insurance plan provisions. The project is based on insurance claims records from a large number of employers. The vast amount of information in insurance claims records is both a blessing and a curse. A key advantage of claims data is the detail they provide. The detail also poses a challenge, however: how best to summarize and convey the information contained in the millions of claims filed each year under a typical employer-provided plan.

Our goal in this paper is to present a method that allows us conveniently to summarize information contained in the claims data. In particular, we want to describe the sources of cost differences across plans. We consider eight plans that vary in average expenditure for those filing claims, from a low expenditure of $1,645 to a high of $2,484. We then propose a method to decompose these differences into their component parts. The goal is to quantify the contribution of each of component to total cost variation across firms. We believe that this method allows us to point directly to the sources of cost difference and thus will help us to focus subsequent analysis where it is most likely to make a difference. Thus this general analysis of cost variation across plans will provide the basis for further studies of the incentive effects of plan provisions on costs.

Identifying the effect of plan provisions on health care costs is complicated for several reasons. Differences in plan costs may arise from many sources other than plan incentive effects, including geographic location and the demographic attributes of plan members. Much more difficult to account for are unobserved differences in the types of individuals selecting health plans: Individuals who expect to use more health care, who are more risk averse, or who have greater "taste" for health care are more likely to choose more generous coverage when an employer offers a menu of plans. This is the issue to which Eichner (1997) has devoted a great deal of attention, and it is the issue to which we will return once the sources of cost differences are better understood.

We believe that ours is the first effort at a detailed decomposition of the sources of cost differences across health plans. We consider both the rate of treatment and the treatment cost, given treatment, for thirty diagnostic groups. We first consider how much of the rate and the cost for each treatment can be attributed to the demographic mix of plan members. The total demographic effect is decomposed into the effect of demographic mix on the rate of diagnoses, and the effect on treatment cost given diagnosis. Then the cost differences that remain, after the demographic adjustment, are decomposed further into rate and treatment effects.

Previous descriptive studies have documented cost differences associated with firm location and employee demographic characteristics, based largely on aggregate cost differences. Yet it is unknown whether cost variation across plans is due to more intensive treatment of a few of high-cost enrollees or to marginally more intensive treatment for the majority of plan enrollees. We believe that understanding where the intensity, and hence cost, of treatment differs will be a basis for further analysis of the effects of plan provisions on costs.

Detailed descriptive analyses may also provide evidence on how cost differences due to selection effects arise within plans. Understanding both the incentives of plan provisions and the effects of self-selection into plans may be enhanced by detailed analyses of what kinds of patients and medical treatments contribute to cost differences. For example, a larger proportion of patients with heart disease or other chronic illness in one of two or more plans from which employees may choose may well reflect selection effects. On the other hand, higher costs due to more "elastic" conditions such as mental illness or back pain may well reflect plan provision (incentive) effects. Similarly, higher costs due to more intensive treatment given the occurrence of an illness may well represent plan incentive effects because these affect patients, providers, or both. Describing the sources of cost differences at this level of detail not only provides some evidence on whether cost differences are due to selection or incentives, but also provides a detailed foundation for more explicit causal studies of how plan provisions affect expenditures. For example, studies of changes in incidence or intensity of particular health problems resulting from reforms in health plan structure are likely to provide detailed insights into how particular plan provisions affect expenditures.

We address many, but not all, of these questions by analyzing cost differences in insurance plans offered by eight firms. We first describe the claims data that are used for the analysis and present summary information on medical expenditures in the selected firms. We then describe the decomposition method that is used to determine the sources of cost differences among these eight firms. Calculations based on this method are then presented, primarily using graphical representations. The last section is a summary and discussion.

8.1 The Data and Summary Description

8.1.1 The Data

The analysis is based on a unique data set obtained from MedStat. The data provide comprehensive information on medical utilization for enrollees in a variety of employer-provided health insurance regimes. The data include all inpatient and outpatient health insurance claims filed by employees and their dependents in forty-five firms that self-insure (i.e., these firms may pay an insurance carrier to process claims, but not to assume risk). All risk is borne by the employer, who essentially pays the annual medical bills of its employees and their dependents. The firms include a variety of industries, health care costs, plan provisions, and workforce characteristics.

The data content is standardized by MedStat, providing essentially identical data for each firm. Each claim includes a patient identifier, a provider identifier, the date of the medical service, the claim amount, the copayment and deductible amounts paid by the patient, the place of service—hospital, physician office, intermediate care facility, etc.—and International Classification of Disease, Ninth Revision (ICD-9) and Current Procedural Terminology (CPT) codes identifying the principal diagnoses and procedures performed. The patient's age, sex, and relationship to the employee, and employment status—hourly or salaried, active or retired—are also reported.

The primary goal of this paper is to illustrate the decomposition procedure. The analysis is based on expenditures in eight plans in seven large firms. These firms were selected for this initial study in part because they offer only one plan to each employee (one of the firms has two plans, but each plan serves a different employee group). To simplify interpretation of the results, we wish to confine the analysis here to differences across plans that can be attributed not to self-selection of plans by employees who are offered a menu of plans from which to choose, which is typical of most firm insurance regimes, but to the incentive effects of plan provisions. Selecting one-plan firms assures that (by and large) the cost differences observed are not confounded by the self-selection of employees into plans. The analysis is based on annual expenditure, where data for three years are used to calculate rates and treatment costs by plan.

8.1.2 Summary Description

Each person who reports medical spending in a year is assigned to a predominant diagnosis group. This is the group to which the largest share of an enrollee's expenditures can be allocated. There are thirty such groups listed in table 8.1. These include outpatient and residual (which includes

Table 8.1 Summary: Mean Cost by Diagnosis

Diagnosis	Mean Rate of Diagnosis	Mean Cost, Given Diagnosis ($)	Mean Expenditure per Enrollee	Percent of Total Expenditure
Lung cancer	0.00027	34,736	9.36	0.0044
Colorectal cancer	0.00031	27,819	8.71	0.0041
Acute myocardial infarction	0.00117	26,651	31.29	0.0147
Chronic obstructive pulmonary disease	0.00056	25,179	14.17	0.0067
Stroke (occlusive and hemorrhagic)	0.00077	24,901	19.19	0.0090
Congenital disease or disorder	0.00034	23,131	7.78	0.0037
Neonatal care	0.00091	22,917	20.83	0.0098
Heart failure	0.00072	22,826	16.40	0.0077
Arthritis	0.00087	22,788	19.82	0.0093
Prostate cancer	0.00029	20,000	5.87	0.0028
Ischemic heart disease, chest pain	0.00558	18,270	102.02	0.0480
Residual diagnoses	0.02225	17,656	392.93	0.1847
Breast cancer	0.00032	17,594	5.67	0.0027
Psychotic/major affective psychosis	0.00413	16,759	69.28	0.0326
Back/spine disorders	0.00257	15,509	39.92	0.0188
Neurotic disease or disorder	0.00144	15,050	21.73	0.0102
Injury/trauma	0.00401	13,964	55.94	0.0263
Diabetes	0.00081	13,228	10.70	0.0050
Gallbladder disease	0.00213	11,442	24.34	0.0114

(*continued*)

Table 8.1 (continued)

Diagnosis	Mean Rate of Diagnosis	Mean Cost, Given Diagnosis ($)	Mean Expenditure per Enrollee	Percent of Total Expenditure
Substance abuse	0.00262	10,944	28.70	0.0135
Respiratory infection	0.00299	9,872	29.48	0.0139
Benign female pelvic, etc.	0.00469	9,383	44.02	0.0207
Appendicitis	0.00104	8,123	8.49	0.0040
Benign prostate hypertrophy/urinary obstruction	0.00145	7,972	11.57	0.0054
Asthma	0.00126	7,792	9.84	0.0046
Abnormal pregnancy	0.00393	7,406	29.09	0.0137
Abnormal childbirth	0.00653	6,234	40.73	0.0191
Normal childbirth, mother	0.00279	5,350	14.94	0.0070
Normal childbirth, child	0.00475	3,152	14.97	0.0070
Outpatient	0.91847	1,110	1,019.55	0.4793
All	1.00000		2,127.33	1.0000

Source: Authors' tabulations based on MedStat data.

Note: Residual diagnoses are those not assigned to any of the other identified groups.

expenditures not assigned to any of the identified groups). Persons who are assigned to the lung cancer group, for example, having incurred substantial expenditure for the treatment of lung cancer, are likely to have incurred expenditures related to other diagnosis groups as well.

The diagnosis groups are listed in table 8.1 by the average cost of treatment—over all of the eight plans—given that diagnosis group. The average treatment cost ranges from $34,736 for lung cancer to $1,110 for the outpatient predominant diagnosis group. The average diagnosis rate is shown in the first column of the table. Almost 92 percent of enrollees are in the outpatient group. The diagnosis rate for the other groups is typically well under 1 in 100 and often as low as 1 in 1,000. Approximately 2 percent of enrollees are in the residual group. The diagnosis rate times the treatment cost given diagnosis give the average cost per enrollee, shown in the third column of the table. Finally, the proportion of total expenditures accounted for by each diagnosis group is shown in the last column. About 48 percent of cost is accounted for by the 92 percent of employees in the outpatient group and about 18 percent is accounted for by the approximately 2 percent who are in the residual category. The remaining 34 percent is accounted for by the 6 percent of persons in the other diagnostic groups. We will see that differences across firms in both diagnosis rates and treatment cost given diagnosis account for large differences in average expenditure. Indeed, both may contribute to higher or lower costs in the same firm, or one may increase and the other decrease cost in the same firm.

The key elements of cost difference are the diagnosis rate and treatment cost given diagnosis. The diagnosis rates in each plan are shown in table 8.2; the treatment costs are shown in table 8.3. Consider substance abuse, for example: The diagnosis rate varies from a low of 5 in 10,000 enrollees to a high of 6 in 1,000. The treatment cost varies from a high of $17,377 to a low of $7,117.

Beginning with the data in these two tables (including the raw data that underlie the means) we want to decompose the differences in average cost across plans that range from an overall low of $1,645 to a high of $2,484, a difference of more than 50 percent. There are three reasons for cost differences: (1) differences in the demographic attributes—age and gender—of enrollees, (2) differences in the illnesses that are treated—the diagnosis rate, and (3) differences in the cost of treating illnesses. Our goal is to attribute observed cost differences to these three sources. A particular complication is that treatment cost differences across plans may differ substantially by diagnosis, and we would like to know which diagnoses account for differences in treatment cost. A firm with low treatment cost for one diagnosis may have high treatment cost for another diagnosis; thus it is important to consider the interaction between diagnosis and treatment cost.

Table 8.2 **Rate by Diagnosis and Plan**

	Plan 15	Plan 26	Plan 12	Plan 25	Plan 18	Plan 2a	Plan 21	Plan 2b
Lung cancer	0.00037	0.00013	0.00009	0.00014	0.00016	0.00034	0.00016	0.00051
Colorectal cancer	0.00041	0.00010	0.00015	0.00019	0.00025	0.00041	0.00020	0.00050
Acute myocardial infarction	0.00103	0.00084	0.00049	0.00059	0.00087	0.00135	0.00080	0.00200
Chronic obstructive pulmonary disease	0.00022	0.00024	0.00017	0.00011	0.00039	0.00058	0.00035	0.00111
Stroke (occlusive and hemorrhagic)	0.00070	0.00033	0.00023	0.00030	0.00056	0.00080	0.00048	0.00147
Congenital disease or disorder	0.00022	0.00038	0.00047	0.00023	0.00031	0.00028	0.00028	0.00034
Neonatal care	0.00111	0.00072	0.00192	0.00065	0.00097	0.00057	0.00081	0.00054
Heart failure	0.00041	0.00025	0.00025	0.00024	0.00051	0.00054	0.00036	0.00150
Arthritis	0.00122	0.00083	0.00028	0.00060	0.00087	0.00123	0.00046	0.00126
Prostate cancer	0.00030	0.00020	0.00007	0.00034	0.00024	0.00054	0.00024	0.00039
Ischemic heart disease, chest pain	0.00465	0.00315	0.00252	0.00297	0.00398	0.00614	0.00295	0.01010
Residual diagnoses	0.01808	0.01639	0.02003	0.01451	0.01826	0.02017	0.01667	0.03169
Breast cancer	0.00055	0.00016	0.00017	0.00024	0.00022	0.00051	0.00020	0.00048
Psychotic/major affective psychosis	0.00240	0.00104	0.00302	0.00213	0.00327	0.00254	0.00338	0.00713

Back/spine disorders	0.00185	0.00208	0.00179	0.00231	0.00210	0.00240	0.00197	0.00382
Neurotic disease or disorder	0.00137	0.00117	0.00145	0.00087	0.00132	0.00083	0.00114	0.00202
Injury/trauma	0.00399	0.00441	0.00390	0.00332	0.00330	0.00323	0.00335	0.00519
Diabetes	0.00078	0.00045	0.00059	0.00027	0.00051	0.00048	0.00050	0.00154
Gallbladder disease	0.00325	0.00163	0.00166	0.00150	0.00234	0.00186	0.00160	0.00267
Substance abuse	0.00052	0.00082	0.00212	0.00113	0.00050	0.00099	0.00126	0.00621
Respiratory infection	0.00247	0.00232	0.00381	0.00150	0.00228	0.00175	0.00240	0.00411
Benign female pelvic, etc.	0.00461	0.00468	0.00448	0.00395	0.00472	0.00370	0.00489	0.00520
Appendicitis	0.00100	0.00124	0.00143	0.00111	0.00087	0.00072	0.00119	0.00099
Benign prostate hypertrophy/urinary obstruction	0.00159	0.00111	0.00113	0.00105	0.00097	0.00146	0.00100	0.00227
Asthma	0.00092	0.00103	0.00155	0.00053	0.00098	0.00060	0.00101	0.00183
Abnormal pregnancy	0.00432	0.00318	0.00853	0.00432	0.00294	0.00168	0.00538	0.00243
Abnormal childbirth	0.00941	0.00613	0.01408	0.00815	0.00524	0.00251	0.00806	0.00397
Normal childbirth, mother	0.00332	0.00164	0.00640	0.00297	0.00185	0.00238	0.00316	0.00164
Normal childbirth, child	0.00004	0.00923	0.01613	0.01064	0.00023	0.00045	0.00853	0.00054
Outpatient	0.92892	0.93412	0.90112	0.93317	0.93897	0.93896	0.92725	0.89655

Note: See table 8.1 for source and note.

Table 8.3 **Cost by Diagnosis and Plan**

	Plan 15	Plan 26	Plan 12	Plan 25	Plan 18	Plan 2a	Plan 21	Plan 2b
Lung cancer	22,811	51,401	36,164	35,193	38,320	31,841	34,712	34,209
Colorectal cancer	24,576	28,769	33,665	25,479	24,847	25,359	22,566	29,821
Acute myocardial infarction	26,572	30,417	30,825	31,205	24,331	27,610	31,244	25,388
Chronic obstructive pulmonary disease	11,355	43,222	18,236	33,461	29,452	21,320	44,338	22,318
Stroke (occlusive and hemorrhagic)	25,468	24,623	36,725	35,269	23,475	25,844	29,249	23,183
Congenital disease or disorder	18,123	17,152	25,688	22,122	20,862	25,945	26,587	21,877
Neonatal care	13,544	25,369	29,121	33,228	14,083	16,873	32,230	17,474
Heart failure	22,848	26,413	23,686	26,731	22,892	25,866	38,023	20,620
Arthritis	18,519	23,485	22,720	25,130	21,505	23,450	26,065	22,625
Prostate cancer	15,646	16,693	21,843	18,360	18,972	20,155	20,292	20,720
Ischemic heart disease, chest pain	15,981	17,984	16,908	25,762	17,707	21,073	26,401	16,699
Residual diagnoses	16,846	16,888	14,788	21,046	17,413	19,925	20,193	17,486
Breast cancer	17,875	19,052	27,399	14,944	13,997	15,489	32,427	15,288
Psychotic/major affective psychosis	16,513	17,825	17,559	26,429	17,627	19,508	24,956	13,837
Back/spine disorders	14,056	16,823	16,329	15,666	15,327	17,056	17,424	14,487

Neurotic disease or disorder	9,791	14,648	14,566	21,646	17,012	20,141	24,849	10,939
Injury/trauma	11,044	12,468	12,594	16,056	13,465	13,570	15,476	14,529
Diabetes	12,690	8,793	11,970	31,533	16,054	15,273	17,609	11,715
Gallbladder disease	9,353	10,884	12,167	12,194	9,843	12,333	13,282	11,606
Substance abuse	7,117	9,261	11,777	11,745	9,400	12,881	17,377	10,238
Respiratory infection	9,660	8,595	7,473	14,659	8,789	12,454	10,524	10,805
Benign female pelvic, etc.	8,031	8,729	10,218	10,446	8,822	9,904	9,799	9,073
Appendicitis	6,627	7,912	8,146	7,362	7,327	9,839	7,978	8,429
Benign prostate hypertrophy/urinary obstruction	6,310	7,138	6,939	8,312	8,335	10,066	6,868	7,911
Asthma	4,966	8,571	6,639	7,868	7,628	8,321	7,811	8,304
Abnormal pregnancy	6,475	7,679	7,575	8,767	7,120	7,749	7,406	6,907
Abnormal childbirth	5,421	6,275	6,388	6,708	5,887	6,557	6,345	6,020
Normal childbirth, mother	4,752	5,184	5,262	5,300	5,058	6,638	5,024	5,403
Normal childbirth, child	6,010	2,666	2,826	2,797	8,727	5,256	3,760	4,240
Outpatient	851	1,013	952	1,106	1,224	1,138	1,188	1,091
All	1,645	1,729	1,860	1,941	1,994	2,097	2,138	2,484

Note: See table 8.1 for source and note.

8.2 The Decomposition of Cost Differences

We begin with the eight plans described above. As explained, the members of each plan are divided into thirty predominant diagnosis categories, defined by the diagnosis group in which the largest share of a member's expenditure—in a given year—occurred. The data can be thought of as arranged in two 30 × 5 matrices, as shown in tables 8.2 and 8.3. The first matrix reports the proportion of enrollees in each plan who are in each of the diagnosis groups. The elements of this matrix are "rates" δ_{ki}, the proportion of enrollees in plan i who are in diagnosis group k. The second matrix reports the average cost of treating patients in each of the diagnosis groups. The elements of this matrix are costs d_{ki}, the cost of treating persons in plan i who are in diagnosis group k.

We want to know why the costs in one plan differ from the average cost. That is, we want to decompose the cost differences. Consider diagnosis k: What accounts for the difference in expenditure for treating patients in this diagnosis in Plan i, compared to the average expenditure for diagnosis k patients. The diagnosis could be pregnancy, cancer, or outpatient care, for example. The cost depends on two factors: (1) the proportion of enrollees treated for diagnosis k (the rate), and (2) the cost of their treatment given that diagnosis. Both the rate and the cost will depend on the demographic mix (age and gender) of persons in Plan i as compared to the average mix across all plans. Suppose that both the rate and the cost are adjusted for demographic mix, as explained below. Call the adjusted elements $\tilde{\delta}_{ki}$ and $\tilde{d}_{ki}$. Then the deviation from the average rate, and the deviation from the average cost, due to demographic mix, can be denoted by $\Delta\delta_{ki} = \tilde{\delta}_{ki} - \bar{\delta}$ and $\Delta d_{ki} = \tilde{d}_{ki} - \bar{d}_k$, respectively.

Table 8.4 illustrates the adjustment for substance abuse. The first row shows the unadjusted diagnosis rate by plan. The next row shows the rate adjusted for the demographic mix of each plan. While the unadjusted rates vary from 50 to 621 in 10,000, the rates adjusted for demographic mix range only from 250 to 278 per 10,000 enrollees. The rate deviations due to demographic mix are shown in the third row and are quite small compared to the unadjusted rate differences. Thus, for the group with substance abuse as a predominate diagnosis, not much of the rate difference can be attributed to differences in demographic mix across firms. Unadjusted treatment costs are shown in the fourth row and the costs adjusted for demographic mix in the fifth row. The deviation for average treatment cost that can be attributed to demographic mix ranges from −$71.33 to $574.51, which is very small compared to the unadjusted differences in treatment cost across plans.

We can write the total deviation of the rate and cost elements of Plan i from the average across plans as the sum of two parts, one due to demographic mix and the other due to other factors:

Table 8.4 **Unadjusted and Adjusted Rates and Costs for Substance Abuse**

	Plan 15	Plan 26	Plan 12	Plan 25	Plan 18	Plan 2a	Plan 21	Plan 2b	Average
Rate unadjusted for demographic mix	0.00052	0.00082	0.00212	0.00113	0.00050	0.00099	0.00126	0.00621	0.00262
Rate adjusted for demographic mix	0.00266	0.00274	0.00278	0.00259	0.00255	0.00250	0.00271	0.00258	
$\Delta\delta_{ki} = \tilde{\delta}_{ki} - \bar{\delta}_k$	0.00004	0.00012	0.00016	−0.00003	−0.00007	−0.00013	0.00009	−0.00004	
Cost unadjusted for demographic mix	7,117	9,261	11,777	11,745	9,400	12,881	17,377	10,238	10,944
Cost adjusted for demographic mix	11,519	11,169	10,994	11,057	11,091	11,153	11,337	10,873	
$\Delta d_{ki} = \tilde{d}_{ki} - \bar{d}_k$	574.51	224.65	50.36	113.35	146.69	209.16	392.61	−71.33	

Source: See table 8.1.

(1)
$$\begin{aligned}\delta_{ki} &= \left(\delta_{ki} - \tilde{\delta}_{ki}\right) + \left(\tilde{\delta}_{ki} - \bar{\delta}_{k}\right) + \bar{\delta}_{k} \\ &= \tilde{\Delta}\delta_{ki} + \Delta\delta_{ki} + \bar{\delta}_{k} \quad \text{and} \\ d_{ki} &= \left(d_{ki} - \tilde{d}_{ki}\right) + \left(\tilde{d}_{ki} - \bar{d}_{k}\right) + \bar{d}_{k} \\ &= \tilde{\Delta}d_{ki} + \Delta d_{ki} + \bar{d}_{k}\end{aligned}$$

Now we can decompose the expenditure on diagnosis k in firm i (that is, the proportion of enrollees in diagnosis group k times the treatment cost given that diagnosis) as

(2)
$$\begin{aligned}M_{ki} &= \delta_{ki} * d_{ki} \\ &= \left(\bar{\delta}_{k} * \bar{d}_{k} + \Delta\delta_{ki} * \bar{d}_{k} + \Delta d_{ki} * \bar{\delta}_{k} + \Delta\delta_{ki} * \Delta d_{ki}\right) \\ &\quad + \left(\bar{\delta}_{k} * \bar{d}_{k} + \tilde{\Delta}\delta_{ki} * \bar{d}_{k} + \tilde{\Delta}d_{ki} * \bar{\delta}_{k} + \tilde{\Delta}\delta_{ki} * \tilde{\Delta}d_{ki}\right) \\ &\quad + \left(\tilde{\Delta}\delta_{ki} * \Delta d_{ki} + \tilde{\Delta}d_{ki} * \Delta\delta_{ki}\right) - \bar{\delta}_{k} * \bar{d}_{k} .\end{aligned}$$

The first term in parentheses decomposes the cost difference—between firm i and the average cost—due to demographic mix. The second term in parentheses decomposes the difference due to other factors, after controlling for demographic differences. That is, this line indicates how the cost in firm i differs from the average assuming the demographic mix in firm i to be identical to the average demographic mix. The third term in parentheses recognizes the interaction between the deviation due to demographic mix and the deviation in adjusted costs. (The first term in the third line is the adjusted rate deviation times the cost deviation due to demographic mix. The second term is the adjusted cost deviation times the rate deviation due to demographic mix.) The components of the first two terms are easily interpreted. The third term, which in practice is very small, is less intuitive.

The decomposition in either of the first two brackets is illustrated graphically in figure 8.1. Consider the second term, which decomposes cost differences that remain after controlling for demographic mix. The square defined by heavy lines represents the average cost—across all firms—of treating persons in diagnosis group k. The deviation of the cost in Plan i from the average over all plans is represented by the three components of the outer box: (1) the ith plan deviation in the rate of diagnosis k holding the expenditure at the base level, which is represented by the top slice; (2) the ith plan deviation in treatment cost holding the rate at the base level, which is represented by the right slice; and (3) the product of the rate deviation times the expenditure deviation for Plan i, the interaction term, which is represented by the small square to the northeast. These terms

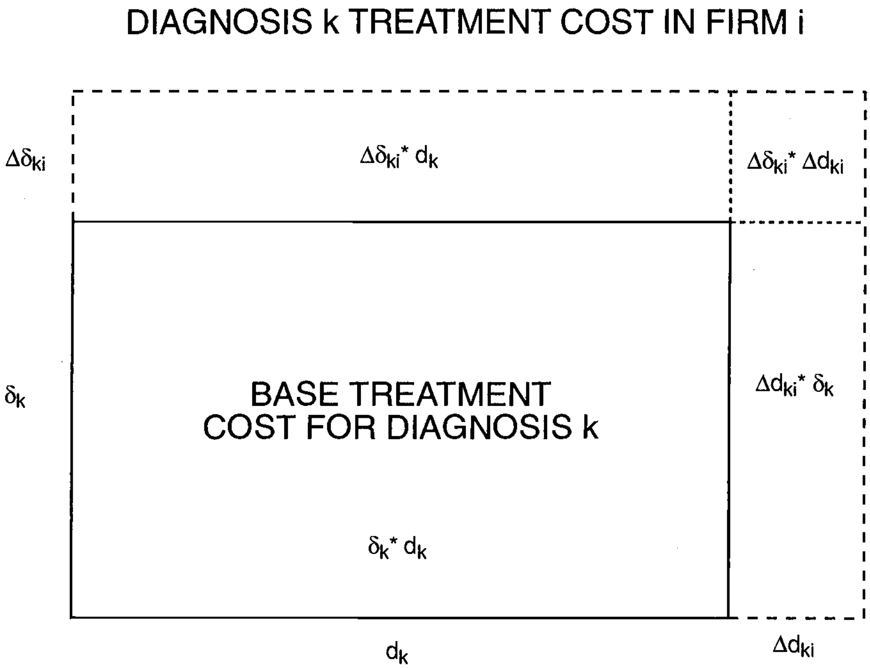

Fig. 8.1 Schematic decomposition of cost

essentially represent a total derivative describing how the cost in Plan *i* differs from the average cost. Both the effect of demographic mix and the effects of other factors can be decomposed in the same way.

The mean cost in firm *i* is obtained by summing over all diagnosis groups and is given by

$$
\begin{aligned}
(3)\quad \overline{M}_i &= \sum_{i=1}^{30} \delta_{ki} * d_{ki} \\
&= \left(\sum_{i=1}^{30} \bar{\delta}_k * \bar{d}_k + \sum_{i=1}^{30} \Delta\delta_{ki} * \bar{d}_k + \sum_{i=1}^{30} \Delta d_{ki} * \bar{\delta}_k + \sum_{i=1}^{30} \Delta\delta_{ki} * \Delta d_{ki} \right) \\
&\quad + \left(\sum_{i=1}^{30} \bar{\delta}_k * \bar{d}_k + \sum_{i=1}^{30} \tilde{\Delta}\delta_{ki} * \bar{d}_k + \sum_{i=1}^{30} \tilde{\Delta} d_{ki} * \bar{\delta}_k + \sum_{i=1}^{30} \tilde{\Delta}\delta_{ki} * \tilde{\Delta} d_{ki} \right) \\
&\quad + \left(\sum_{i=1}^{30} \tilde{\Delta}\delta_{ki} * \Delta d_{ki} + \sum_{i=1}^{30} \tilde{\Delta} d_{ki} * \Delta\delta_{ki} \right) - \sum_{i=1}^{30} \bar{\delta}_k * \bar{d}_k .
\end{aligned}
$$

These terms simply add up over all diagnoses the terms represented in the figure for one of the diagnoses. In addition to the BASE component, we refer to the terms in the three parts of this decomposition as mix effects with these names:

$$(4)\quad \overline{M}_i = \begin{bmatrix} \text{Demographic} \\ \text{Adjustment} = \\ \text{BASE + Rate Mix} \\ \text{+ Cost Mix} \\ \text{+ Rate * Cost Mix} \end{bmatrix} + \begin{bmatrix} \text{Demographic} \\ \text{Adjusted} \\ \text{Differences} = \\ \text{BASE + Rate Mix} \\ \text{+ Cost Mix} \\ \text{+ Rate * Cost Mix} \end{bmatrix} + \begin{bmatrix} \text{Interaction} = \\ \text{DemoRate *} \\ \text{OtherCost Mix} \\ \text{+ DemoCost *} \\ \text{OtherRate Mix} \\ \text{– BASE} \end{bmatrix}.$$

Consider the demographic adjustment. The BASE is just the average cost over all plans—in this case, \$2,127.33. The rate mix is the deviation from the average that can be attributed the effect of demographic mix on the rate at which diagnoses are treated. The cost mix is the deviation that can be attributed to the effect of demographic mix on treatment cost given diagnosis. Rate * cost mix is the interaction between the two. This term will be positive if the rate adjustment and the cost adjustment tend to be positively correlated. The terms in the second bracket have the same interpretation, but pertain to differences in rates and costs that remain after taking out the deviations from the average that can be attributed to demographic differences across firms.

The decomposition of the difference between medical expenditures in Plan *i* and the average over all plans we call $\Delta\overline{M}_i$ and is given by the equation above, less the BASE terms.

8.3 Results for the Eight Plans

8.3.1 Differences across Plans

The decomposition results for the eight plans are explained in some detail here. The presentation is primarily graphical, but we begin with table 8.5, which presents the complete decomposition succinctly. The eight plans are ordered from left to right by mean expenditure per enrollee, which is shown in the last row of the table. The average cost over all plans (\$2,127) is shown in the second to last row. The difference between the plan mean and the overall average is decomposed into the elements shown in the rows above. The difference is divided into three main components, which correspond to the sources identified in the equation for $\overline{M}_i$ above: demographic adjustment, demographic adjusted difference, and the interaction between the first two. Each of the first two main components is decomposed into three mix effects: rate, cost, and interaction. The third main component is composed of only two terms. The sum of the sources of cost

Table 8.5 **Summary of Decomposition Results**

Source		Plan 15	Plan 26	Plan 12	Plan 25	Plan 18	Plan 2a	Plan 21	Plan 2b
Demographic adjustment									
Rate	Term 1	65	−80	−168	−41	−24	130	−69	104
Cost	Term 2	86	−101	−208	−50	−21	151	−67	101 ln
Interaction	Term 3	1	3	16	1	0	7	1	2
Total		152	−179	−360	−90	−44	289	−135	207
Demographic adjusted									
Rate	Term 4	−197	−206	95	−285	−191	−281	−157	341
Cost	Term 5	−432	−1	10	296	119	−1	375	−160
Interaction	Term 6	7	−9	1	−102	−20	−29	−54	−31
Total		−622	−216	106	−91	−91	−311	163	150
Interaction									
First	Term 7	−1	4	−5	6	0	−11	2	6
Second	Term 8	−11	−7	−8	−12	1	3	−20	−6
Total		−12	−3	−13	−5	2	−8	−18	−1
Base		2,127	2,127	2,127	2,127	2,127	2,127	2,127	2,127
Mean		1,645	1,729	1,860	1,941	1,994	2,097	2,138	2,484

Source: Authors' tabulations based on MedStat data.

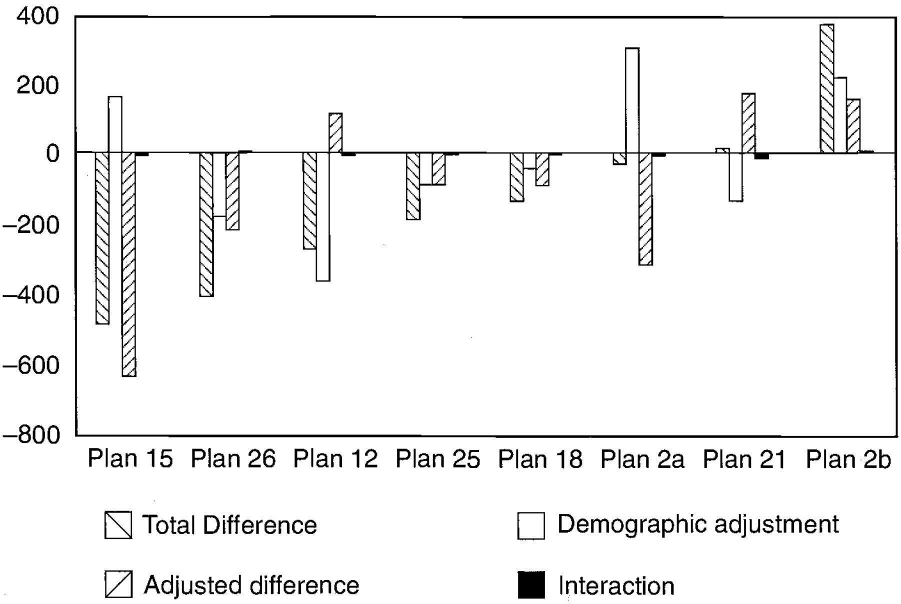

Fig. 8.2 Decomposition of total cost
Source: Authors' tabulations based on MedStat data

difference is equal to the difference between the plan cost and the overall average across all plans. Equivalently, the sum of the sources of cost difference plus the overall mean equals the plan mean.

The decomposition is more easily seen graphically and we explain the details of the decomposition with the aid of several figures. The first bar for each plan in figure 8.2 shows the difference between each of the plan costs and the overall average cost. The range is from −\$482 to \$356, a difference of \$838. This cost can be decomposed into the three main components. The first is the cost difference that is accounted for by differences in plan member demographic characteristics. The second component is the remaining cost difference after adjustment for demographic differences. The third is a very small interaction component. Plan 2a, for example, is disadvantaged, in the sense of having higher costs, by the demographic mix of its members. If for each demographic group expenditures in Plan 2a were equal to the average expenditure, expenditures in Plan 2a would be higher than the average by \$130 because Plan 2a members are more highly concentrated (than the average over all plans) in demographic groups that tend to use more medical care. On the other hand, adjusted for demographic mix, expenditures in Plan 2a are unusually low—\$151 below the average. Plan 2b is disadvantaged both by demographic mix and by higher costs adjusting for demographic mix. The third interaction term is very small and can essentially be ignored.

Both the demographic adjustment and the adjusted expenditure differences can be further decomposed into three components. The decomposition of the demographic adjustment is shown in figure 8.3. The first bar reproduces the total demographic adjustment from figure 8.2. The second bar shows the effect of demographic mix on the rate at which diagnoses are treated (holding the treatment cost constant). A bar extending upward indicates that the demographic mix increases the diagnosis rate in higher-cost diagnosis groups. (That is, the rate would be higher if the diagnosis rate for each demographic group in the plan were the same as the overall average.) The third bar shows the effect of demographic mix on treatment cost (holding the rate constant). Again, a bar extending upward indicates that the demographic mix increases the cost of treatment. (That is, the treatment cost would be higher if the cost of treating each diagnosis for a given demographic group in the plan were the same as the overall average treatment cost for that demographic group.) The fourth bar represents the very small interaction effect between these two components. As might be anticipated, the second and third bars move in parallel: Groups that are more likely to be in high-cost diagnosis groups are also more costly to treat

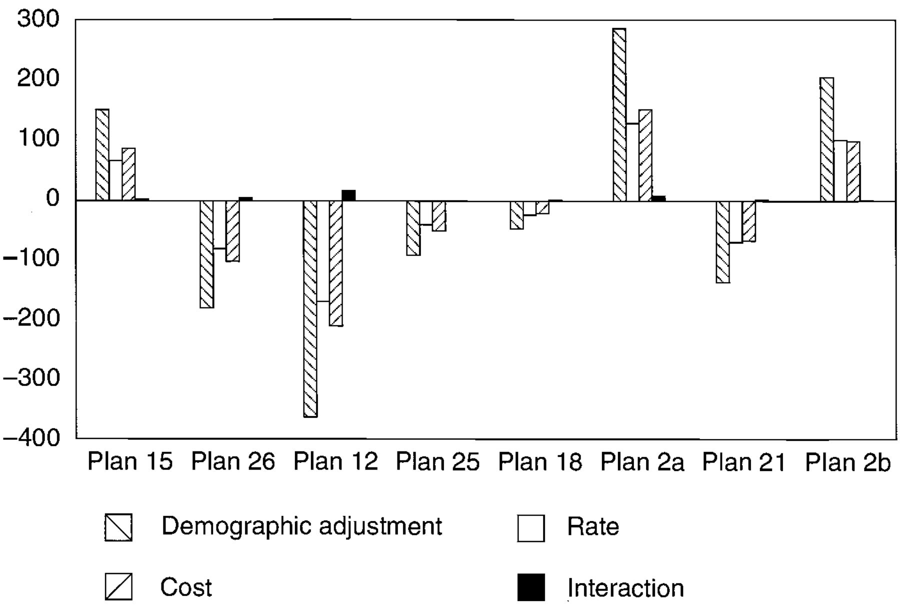

Fig. 8.3 Decomposition of demographic adjustment
Source: Authors' tabulations based on MedStat data

given that they are in the group. Thus the strong correlation between the two components.

Perhaps the most important differences are shown in figure 8.4, panel *A*, which describes the decomposition of the difference in cost that remains after the demographic adjustment. That is, suppose that all rates and treatment costs have been adjusted for demographic mix, and then ask what accounts for the remaining difference. With reference to the diagram again, there are three sources of difference between the expenditure in a plan and the average expenditure over all plans: (1) the difference in diagnosis rate, holding the treatment cost at the average, (2) the difference in treatment cost, holding the diagnosis rate at the average, and (3) the interaction of the first two. The first bar reproduces the difference in expenditure adjusted for demographic mix. Note that unadjusted average plan expenditures vary by \$838 (from −\$482 to \$356) as shown in figure 8.2. Even after adjusting for demographic mix differences among plans, however, the range is still very large, from −\$642 in Plan 15 to \$163 in Plan 21, a difference of \$805.

The next three bars show how the difference holding demographic mix constant is decomposed into the three sources. The second bar shows the difference that can be attributed to the diagnosis rate mix. A bar extending upward, as for plan 2b for example, indicates that the rate mix is concentrated in higher cost diagnoses. The difference attributable to rate mix ranges from a low of −\$285 in Plan 25 to a high of \$341 in Plan 2b, difference of \$626. The next bar indicates the difference that can be attributed to differences in treatment cost. Again, a bar extending upward indicates that treatment cost, given diagnosis, is higher than the average. After adjusting for demographic mix, the range in cost that can be attributed to treatment cost differences alone is still very large—from a low of −\$432 in Plan 15 to a high of \$375 in Plan 21, a difference of \$807.

The last bar shows the interaction between diagnosis rate deviations from the average rate and treatment cost deviations from the average. A bar extending downward indicates a negative correlation between the two. This component is typically negative, although there are two very small positive values (Plan 15 and Plan 12). Consider Plan 25, for example. The diagnosis rate mix favors diagnoses having low average treatment cost. However, in this firm treatment costs tend to be higher than the average. Looking across the plans, the negative interaction component indicates that lower diagnosis rates are associated with higher treatment costs. The firm, on average, treats fewer enrollees for high-cost diagnoses, but treatment cost for those who are treated are higher than the average treatment cost.

Unlike the demographic mix, which operates to change the rate mix and the cost mix in the same direction, the demographically adjusted rate and cost mix seem to follow no particular pattern across firms. (The

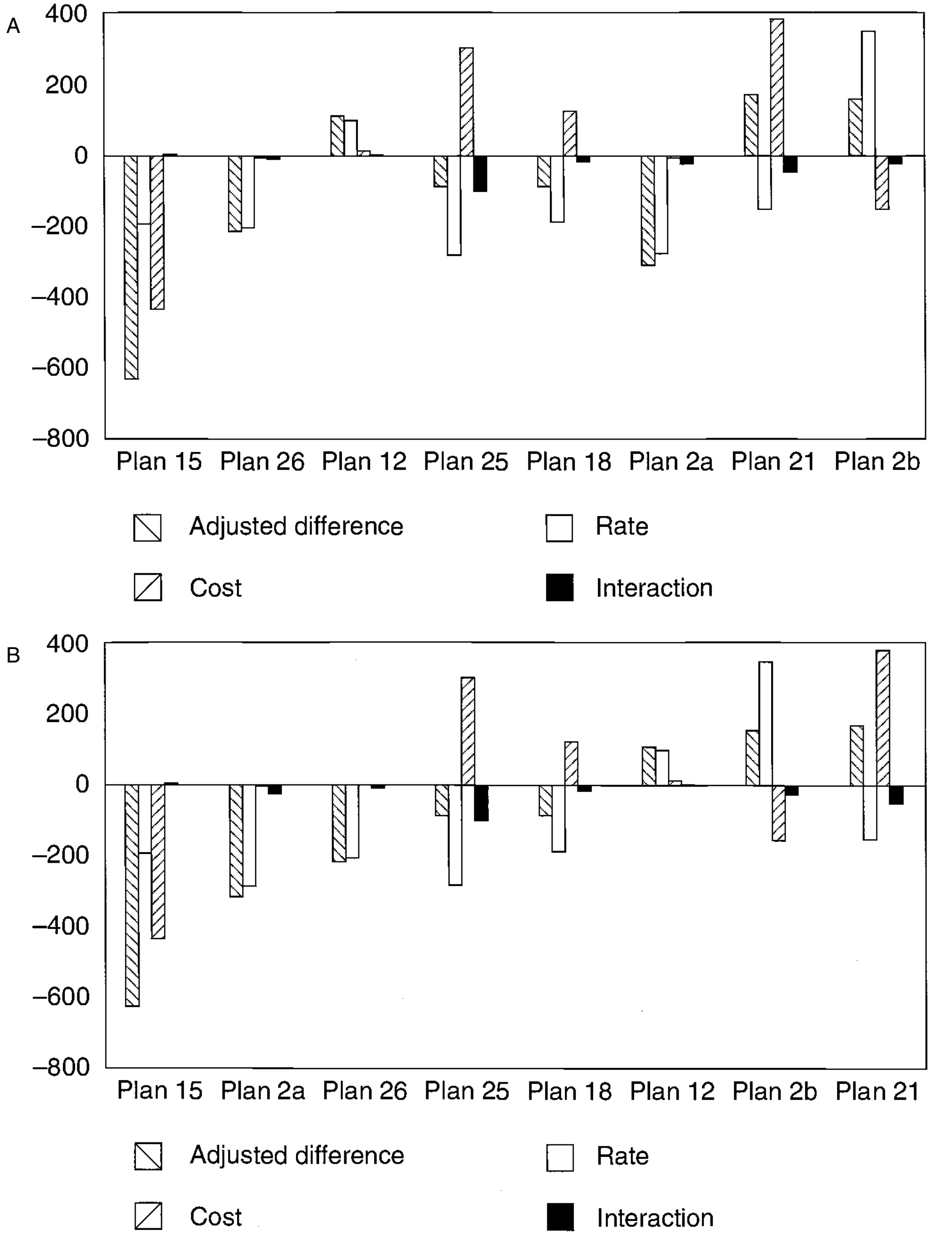

Fig. 8.4 Decomposition of adjusted cost difference (*A*) after demographic adjustment, and (*B*) after total adjusted cost difference
Source: Authors' tabulations based on MedStat data

within-firm interaction between rate and cost tends to be negative, as emphasized above.) Panel *B* of figure 8.4 presents the same data as panel *A,* but in this figure the plans are ordered by the total adjusted cost difference. It is easy to see in this figure that there seems to be no particular relationship between the component attributable to the rate mix and the portion attributable to the cost mix. While for the three plans with the lowest adjusted cost no component is positive (with the exception of the small interaction term for Plan 2a), for the other plans the rate and cost mix components seem to follow no particular pattern. Plans 2a and 2b are in the same firm and adjusted costs differ by $461. (The unadjusted cost difference is $387.) The difference is primarily accounted for the rate mix, which accounts for a difference of $622. The Plan 2a rate mix is concentrated in low-cost diagnoses and the Plan 2b rate mix is concentrated in high-cost diagnoses. This difference attributable to rate mix is partially offset by the cost difference: Costs are in fact $159 lower in Plan 2b than in Plan 2a.

For completeness, the very small differences that can be attributed to the interaction between the demographic adjustment and the adjusted cost differences is shown in figure 8.5. The last bar, for example, typically extends downward. This indicates that for most plans there is a small negative relationship between the demographic adjustment to treatment cost for a diagnosis and the adjusted rate deviation for that diagnosis.

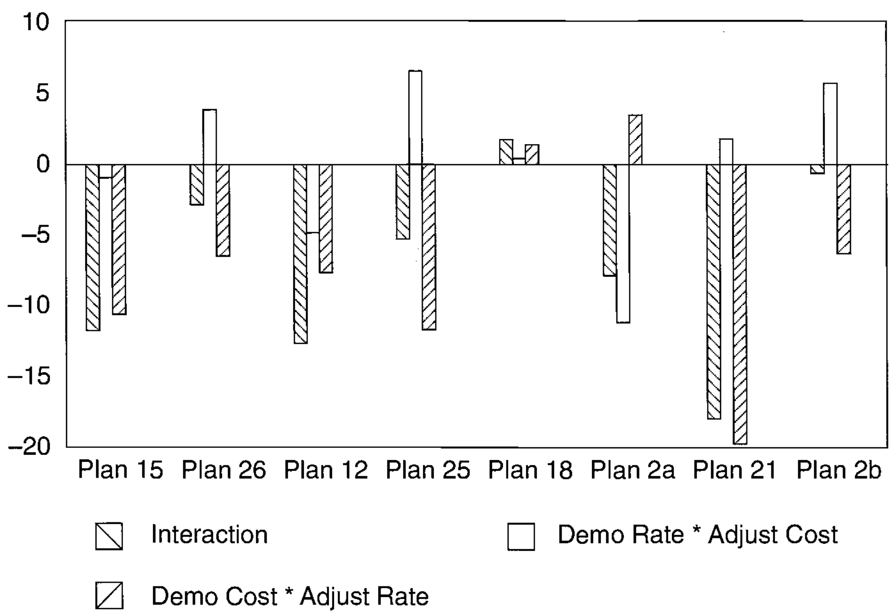

Fig. 8.5 Decomposition of interaction demo adjust and adjusted difference
Source: Authors' tabulations based on MedStat data

The tabulation below summarizes the results thus far. It shows first the range in unadjusted expenditures, then the range in demographic mix adjustments, the range in adjusted expenditures, and finally the range in adjusted treatment costs.

Range in differences by source

Source	Range ($)
Unadjusted expenditures	838
Demographic mix: Total	649
Demographic adjusted expenditures: Total	772
Rate mix	626
Treatment cost mix	807

Perhaps the most noticeable feature of these results is that the range in demographic adjusted expenditures accounted for by the treatment cost mix ($807) is almost as wide as the unadjusted range in expenditures ($838). That is, even though the effects of demographic mix are large, with the difference between the lowest and highest adjustments equal to $649, remaining differences in treatment cost are still very large. Differences in cost due to the different mixes of illness that are treated also accounts for large differences in cost ($626), once demographic mix is controlled for.

Once the decomposition has been set out in this way, more detailed comparisons can be made. For example, suppose we want to know for which diagnoses the treatment cost differences are the largest. Figure 8.6, panel *A*, compares the differences between treatment costs by diagnosis in the highest and lowest treatment cost plans (demographically adjusted). Plan 21 has the highest treatment cost and Plan 15 the lowest. The important feature of this figure is that in all but two diagnoses—which are ordered by average treatment cost—the cost is higher in the high-cost Plan 21 than in the low-cost Plan 2a. The differences are likely to be related to the mean cost of treatment. Thus panel *B* of figure 8.6 shows the cost difference normalized by the mean treatment cost (across all plans) for each diagnosis. Panel *C* of that figure shows the difference between the maximum and minimum treatment cost (over all eight plans), divided by the mean treatment cost. Is seems clear that the difference normalized in this way does not depend systematically on the average treatment cost. (This finding is closely related to evidence reported below on the proportion of variation in expenditures accounted for by each diagnosis.)

In contrast, figure 8.7 shows no evident pattern in the treatment rates in Plan 21 and Plan 15. Similar decomposition calculations based on plans from multiplan firms suggest that the rate as well as the treatment cost may vary systematically by plan, with the treatment cost negatively related

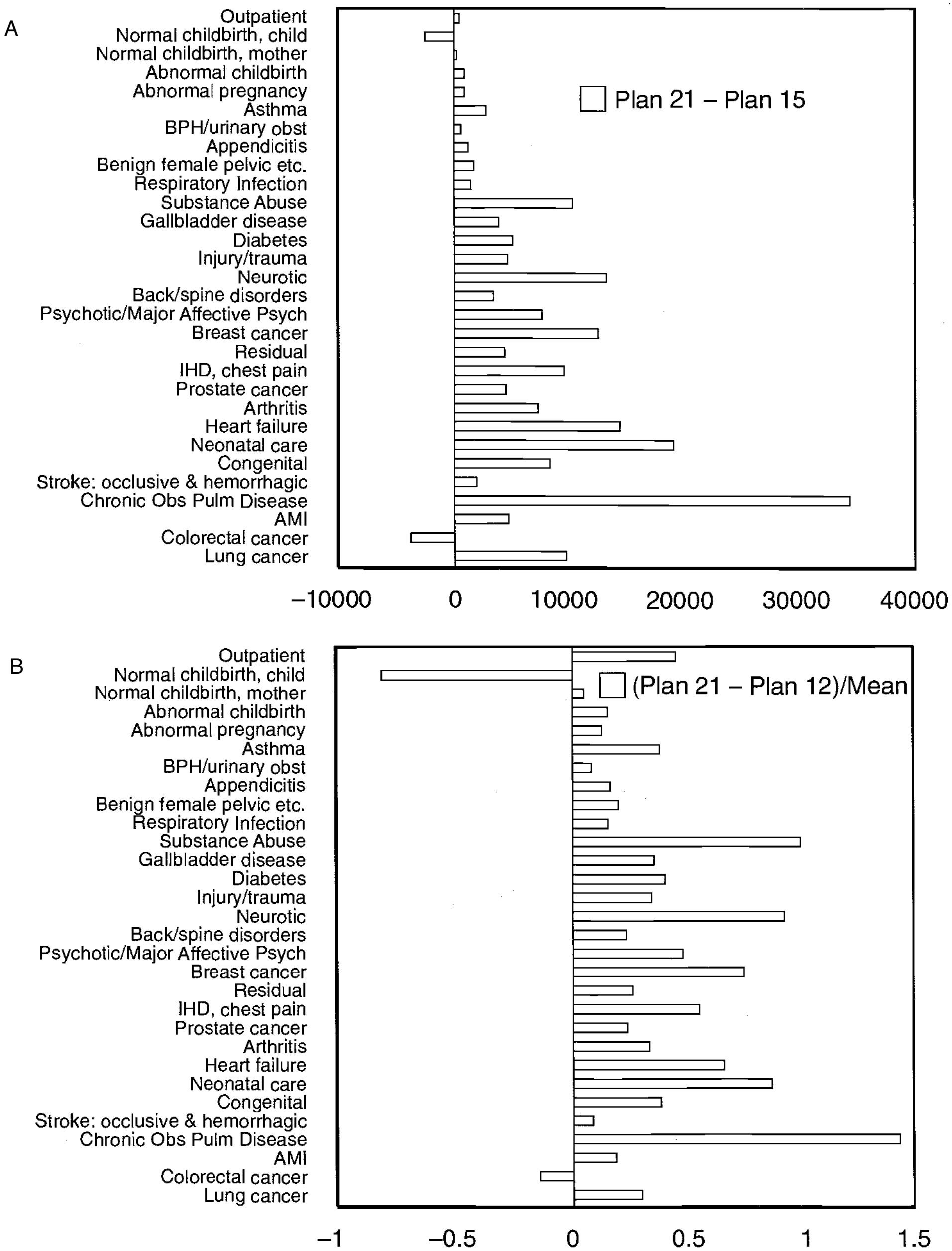

Fig. 8.6 (*A*) Adjusted cost difference, (*B*) adjusted cost difference versus mean, and (*C*) adjusted cost range versus mean

Source: Authors' tabulations based on MedStat data

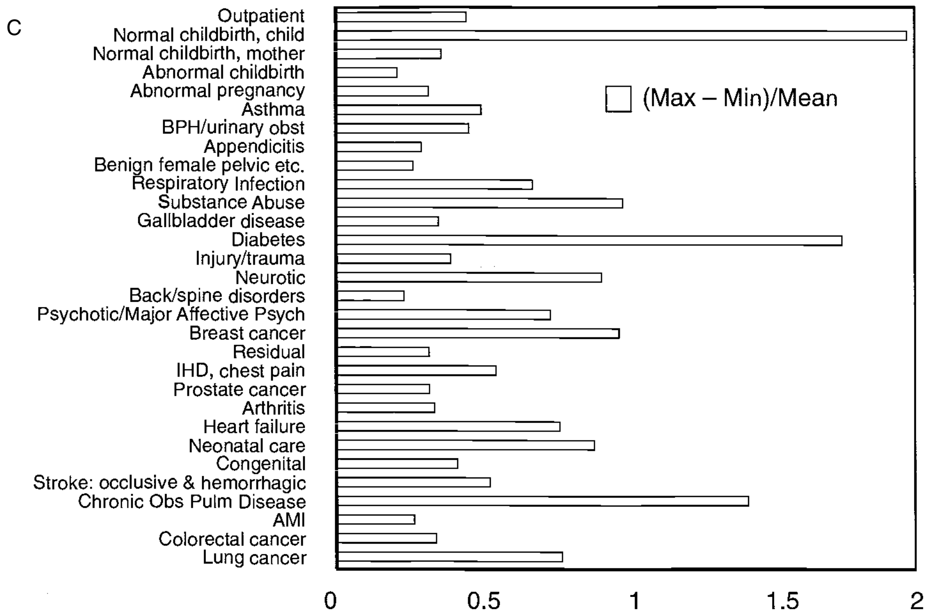

Fig. 8.6 (cont.)

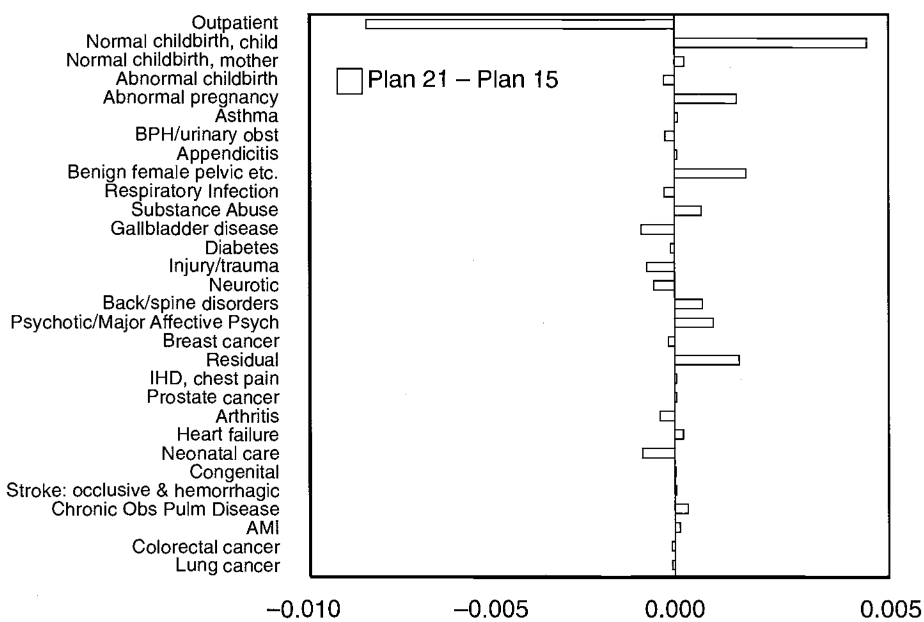

Fig. 8.7 Adjusted rate difference, two different firms' plans

Source: Authors' tabulations based on MedStat data

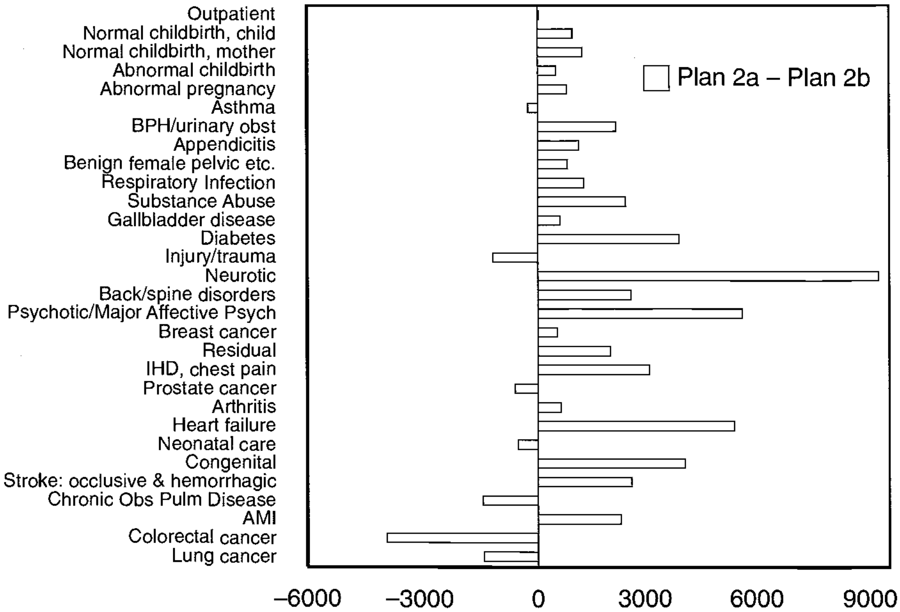

Fig. 8.8 Adjusted cost difference
Source: Authors' tabulations based on MedStat data

to the diagnosis rate. This negative correlation may well be due to plan self-selection effects, with persons more likely to incur high cost.

Figures 8.8 and 8.9 show the cost and rate differences, respectively, by diagnosis for the two plans—2a and 2b—that are in the same firm. Demographically adjusted costs are $159 higher in Plan 2a than in Plan 2b. It can be seen in figure 8.8 that the cost is greater in all but seven of the thirty diagnosis groups. On the other hand, the rate mix in Plan 2a is more concentrated in low-cost diagnoses than it is in Plan 2b. Indeed, the rate in the three lowest cost diagnoses is higher in Plan 2a, but lower in all but two of the remaining diagnoses. Thus these data suggest that the differences in plan provisions yield higher treatment costs in Plan 2a but fewer treatments for high-cost diagnoses. On balance, the lower treatment rate outweighs the higher costs.

8.3.2 Decomposing Total Variation

The description above, summarized in particular in the tabulation on page 257, decomposes into its component parts the difference between the expenditure in a given firm and the average expenditure across all the firms. It is clear, for example, that both the rate of treatment and the treatment cost given treatment, as well as demographic differences, contribute

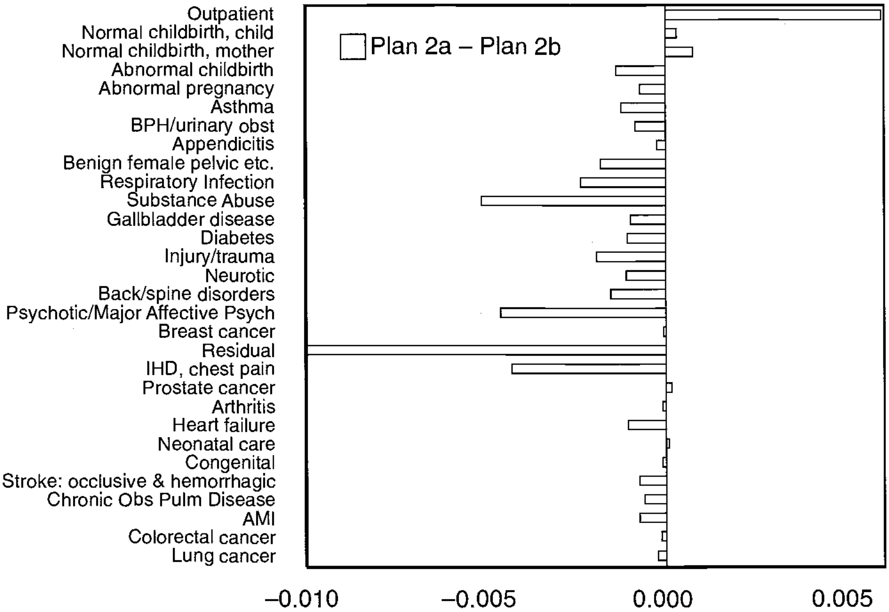

Fig. 8.9 Adjusted rate difference, two plans within one firm
Source: Authors' tabulations based on MedStat data

importantly to differences in expenditures. Another way to think about what accounts for the difference in expenditures across firms is to decompose the variance in expenditures. Unlike the decomposition described above, however, there is no mathematically exact way of doing this. However, we can provide an approximate decomposition of variation based on the extent to which each of these components differs from the overall average.

The procedure can be explained with reference to figure 8.1. For each diagnosis, the difference between the expenditure in a given firm and the average over all firms can be divided into the three components of the difference: rate, treatment cost, and interaction. With reference to the diagram, recall that d_k and δ_k are overall cost and rate averages, respectively, for disease k, and that Δd_{ki} and $\Delta\delta_{ki}$ are the firm-specific deviations from these averages. We use the absolute value of these deviations to describe potentially explainable variation across firms. First we calculate the sum of the absolute values of the three firm-specific rectangles for all diseases, which is given by

$$\sum_i \sum_k |\Delta d_{ki} * \delta_k| + |\Delta\delta_{ki} * d_k| + |\Delta d_{ki} * \Delta\delta_{ki}|.$$

The relative contribution of a particular disease to total variation is quantified by dividing the terms attributable to disease k by this measure of total variation, and is given by

$$\frac{\sum_i |\Delta d_{ki} * \delta_k| + |\Delta\delta_{ki} * d_k| + |\Delta d_{ki} * \Delta\delta_{ki}|}{\sum_i \sum_k |\Delta d_{ki} * \delta_k| + |\Delta\delta_{ki} * d_k| + |\Delta d_{ki} * \Delta\delta_{ki}|}.$$

Analogously, the contribution of cost variation (versus the contribution of variation in treatment rates, or the interaction terms) to this measure of total variation is given by

$$\frac{\sum_i \sum_k |\Delta d_{ki} * \delta_k|}{\sum_i \sum_k |\Delta d_{ki} * \delta_k| + |\Delta\delta_{ki} * d_k| + |\Delta d_{ki} * \Delta\delta_{ki}|},$$

and similarly for the contribution of variation in treatment rates and the contribution of the interaction terms.

Figure 8.10 shows the proportion of the variation accounted for by each of the diagnoses, after controlling for demographic differences across firms. Outpatient treatment and the residual treatments account for the largest proportions. These diagnosis groups also account for a large fraction of expenditures on average, as shown in figure 8.11, and it is not surprising that they should also account for a large fraction of the variation of cost across firms. Thus figure 8.12 shows the *ratio* of the proportion of

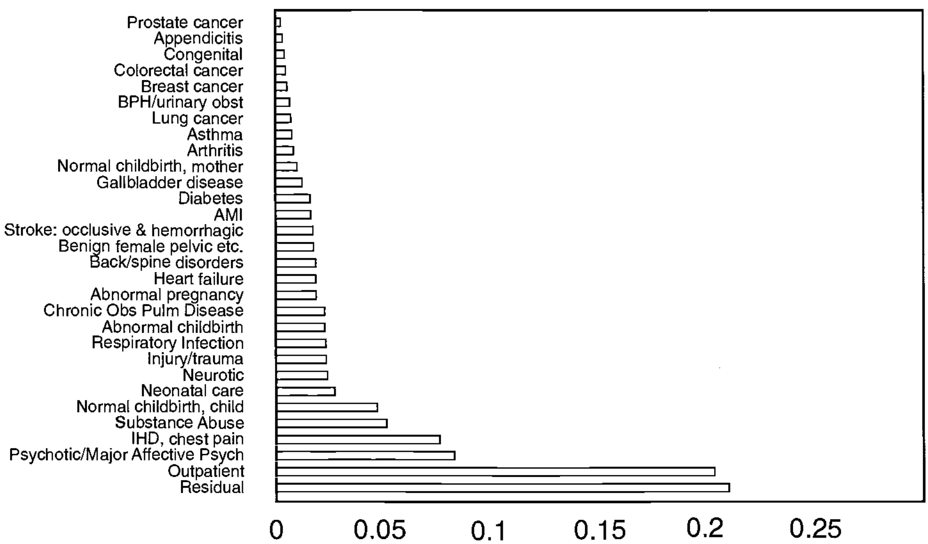

Fig. 8.10 Percentage of variation by diagnosis
Source: Authors' tabulations based on MedStat data

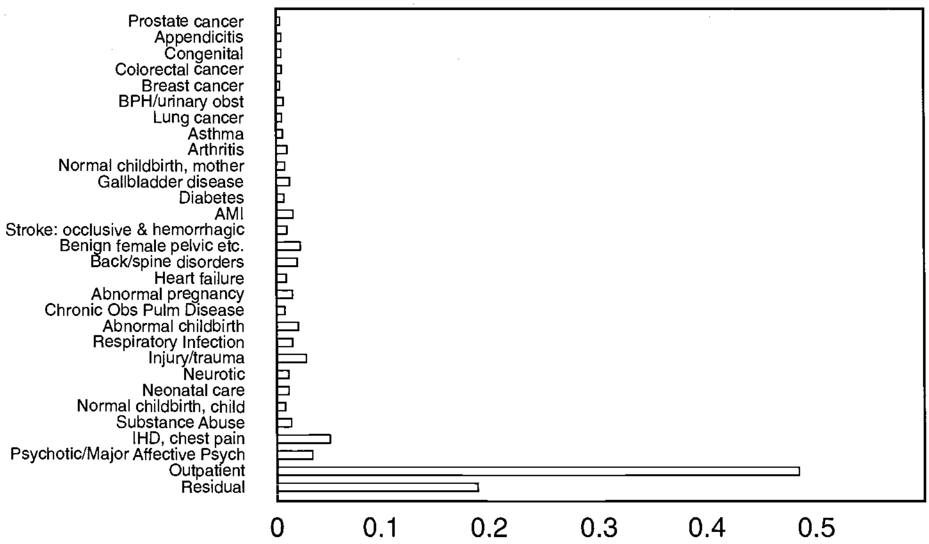

Fig. 8.11 Percentage of expenditure by diagnosis
Source: Authors' tabulations based on MedStat data

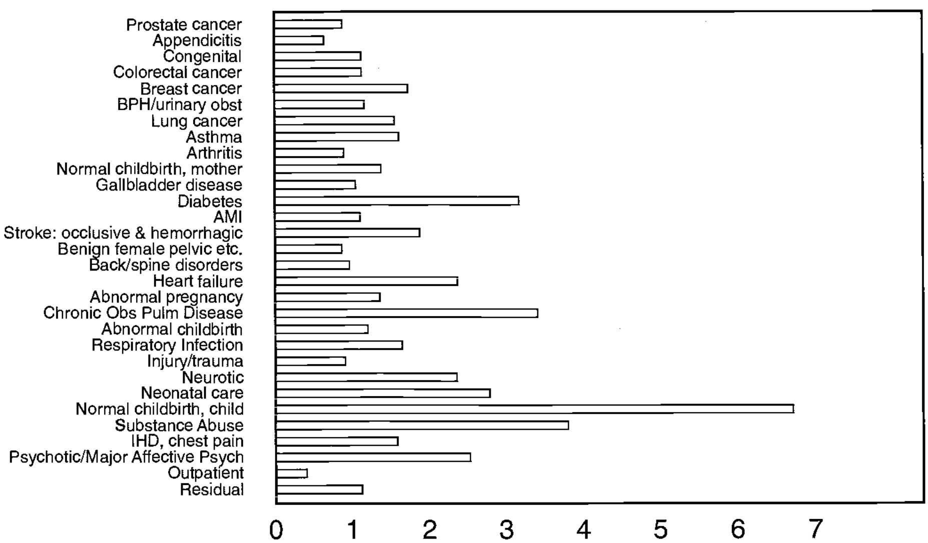

Fig. 8.12 Percentage variation/percentage expenditure
Source: Authors' tabulations based on MedStat data

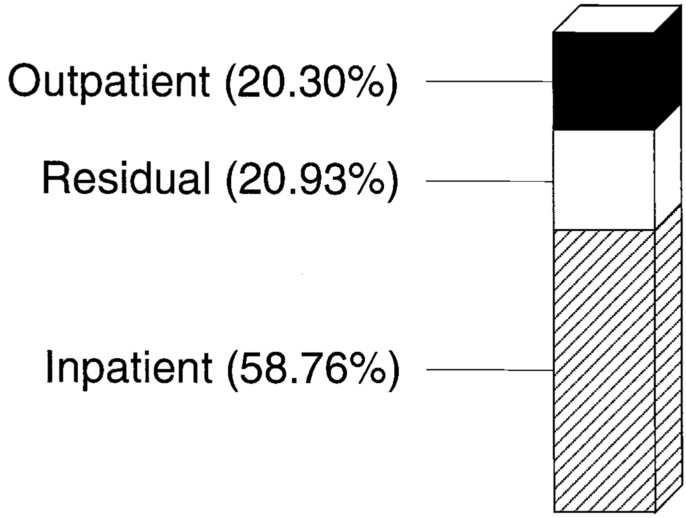

Fig. 8.13 Percentage of variation from outpatient, residual, and inpatient care
Source: Authors' tabulations based on MedStat data

variation explained to the proportion of expenditure, for each diagnosis. Relative to expenditure, outpatient care accounts for the smallest proportion of variation. Normal childbirth accounts for the highest proportion.

Perhaps more informative is the comparison between inpatient and all outpatient care, shown in figure 8.13. Although outpatient care accounts for almost 50 percent of expenditures on average, it accounts for only about 20 percent of the variation in cost across firms. Inpatient care accounts for about 34 percent of expenditures on average, but almost 59 percent of the variation in expenditures. Thus, one can conclude that inpatient care, which tends to include the most intensive medical treatments, varies substantially from firm to firm. (The residual group accounts for about 20 percent of expenditure and about 20 percent of variation in expenditure across firms.) With reference to figure 8.1, figure 8.14 shows that the most important component of variation is the diagnosis rate, which accounts for about 52 percent of variation across firms. Cost differences account for about 40 percent, and the interaction between the two for about 8 percent.

8.4 Summary and Discussion

To gain a better understanding of the sources of cost differences in health care expenditures across firms, we have developed a method to decompose expenditure differences across firms into their component parts.

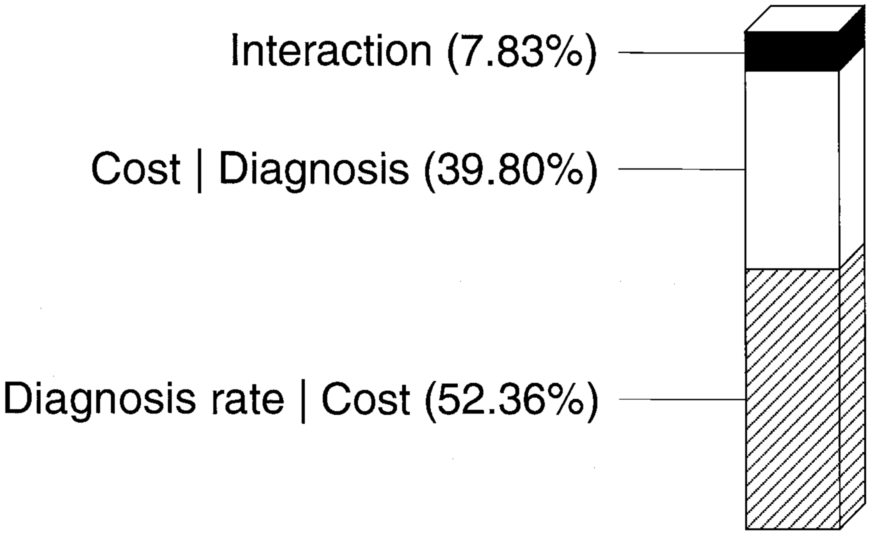

Fig. 8.14 Percentage of variation from diagnosis rate, cost differences, and the interaction of the two
Source: Authors' tabulations based on MedStat data

While an important goal is to illustrate the method, the substantive results also seem striking. We have documented large differences in health care spending across the eight firms included in our analysis. Our decomposition, of course, does not say why the differences exist, but it does indicate which differences must be explained, if differences in health care costs are to be understood. The results show large differences across plans in both treatment cost and in the rate of treatment for various diagnoses even after the demographic mix effects have been removed. Thus the findings suggest that differences in treatment intensity as well as diagnosis mix may be affected by differences in plan provisions. Both differences could be attributed to plan incentives. Recall that this analysis is based on one-plan firms, so that selection effects within firms are not confounded with incentive effects, as is typically the case when employees are offered a menu of plans from which to choose. Although these results do not adjust for regional differences in health care cost, they are consistent with cost differences attributed in part to regional differences in treatment practice and the price of health care. We know, however, that differences in treatment cost like those shown in figure 8.6 exist between firms in the same geographic locations. Indeed, there is a large difference between the costs in Plans 2a and 2b, which are in the same geographic locations. In this case the cost difference can be attributed primarily to difference in diagnosis rate mix.

We have also provided an approximate decomposition in the variation of expenditures across firms. Although outpatient care accounts for almost

50 percent of expenditures on average, it accounts for only about 20 percent of the variation in cost across firms. Inpatient care accounts for about 34 percent of expenditures on average, but almost 59 percent of the variation in expenditures. Thus one can conclude that high-cost inpatient treatments vary substantially from firm to firm. Understanding the exact sources of this variation may provide insights into reducing the cost of intensive treatments. (The residual group accounts for about 20 percent of expenditure and about 20 percent of variation in expenditure across firms.) The most important component of variation is the diagnosis rate, which accounts for about 52 percent of variation across firms. Cost differences account for about 40 percent, with the remainder accounted for by the interaction between the two.

Some of these descriptive findings on the relationship between demographic characteristics, disease treatment rates, and expenditures associated with particular diseases can be translated almost directly into implications for policy and further research. For example, we can quantify the average effects of each of these factors on private health care spending, and identify the high-variation groups that account for the bulk of differences in expenditures across employers. By using these methods with panel data, we can similarly quantify the main sources of changes in health care expenditures and the high-variation components of expenditure growth across firms. When combined with a breakdown of trends in the major components of health care cost, the decomposition will permit assessment of the determinants of future medical cost increases, under the current system. The findings can also be used to assess the effects of trends in the demographic composition of firm workforces. Finally, we can assess the effects of changes in insurance coverage, like opening Medicare to persons aged fifty-five to sixty-four. We believe that the method of decomposing cost differences among firms, as well as the method of apportioning variation, can now be fruitfully extended to analysis of the much larger number of plans in our file of firm claims data.

Reference

Eichner, Matthew J. 1997. Incentives, price expectations, and medical expenditures: An analysis of claims under employer-provided health insurance. Columbia University, Graduate School of Business. Mimeograph.

Comment Joseph P. Newhouse

This paper uses data from eight firms to decompose variation in medical spending across the firms. The firms' spending per person for medical care services varies from low to high by a factor of roughly 50 percent, and the main task of the paper is to understand what could account for such variation. In particular, the paper seeks to decompose spending differences among the firms into differences in the age-sex mix of persons enrolled (demographics), the incidence of diagnoses, and the cost of a given diagnosis. None of the firms permits choice of health insurance plan, which should minimize the role of selection in causing between-firm variation in spending.

The finding of variation in medical care spending, of course, is hardly unique to this study. Similar variation exists even at the state level. In 1991 the three lowest-spending states, Utah, Idaho, and Mississippi, spent \$1,904, \$2,037, and \$2,162 per resident respectively, whereas the three highest-spending states, Massachusetts, Connecticut, and New York spent \$3,333, \$3,298, and \$3,255 respectively (Basu 1996; the District of Columbia spent even more: \$4,693). As a percentage of the national average of \$2,648, Massachusetts spent 126 percent and Utah 72 percent.

Although no one has examined spending at the county level for the entire population, spending by Medicare enrollees varies substantially across counties. After adjusting for factor price and demographic variation across counties, variation in spending across counties is similar in magnitude to variation in spending across the eight firms (figure 8C.1).[1] However, because prices are set administratively in the Medicare system and because the values in figure 8C.1 approximately adjust for the geographic variation in price, almost all of the across-county variation comes from variation in the quantity of services delivered.

There is also substantial variation across areas in rates of diagnoses and procedures. For example, heart disease and cancer rates are known to vary geographically. Deaths from heart disease per 100,000 in 1995 were 216 in California and 350 in New York (U.S. Bureau of the Census 1998). The

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1. These data are actual payments made by Medicare for health maintenance organization enrollees, and are 95 percent of spending in traditional Medicare by county, adjusted for variation in age, sex, institutional status, welfare status, and employment status across counties, averaged over five years, and adjusted for inflation. Seventy percent of the amount is adjusted for variation in Medicare's hospital wage index to reflect factor price variation. The range of variation unadjusted for factor price variation but adjusted for the other factors listed above is from \$221 (Arthur County, Nebraska) to \$767 (Richmond County, New York).

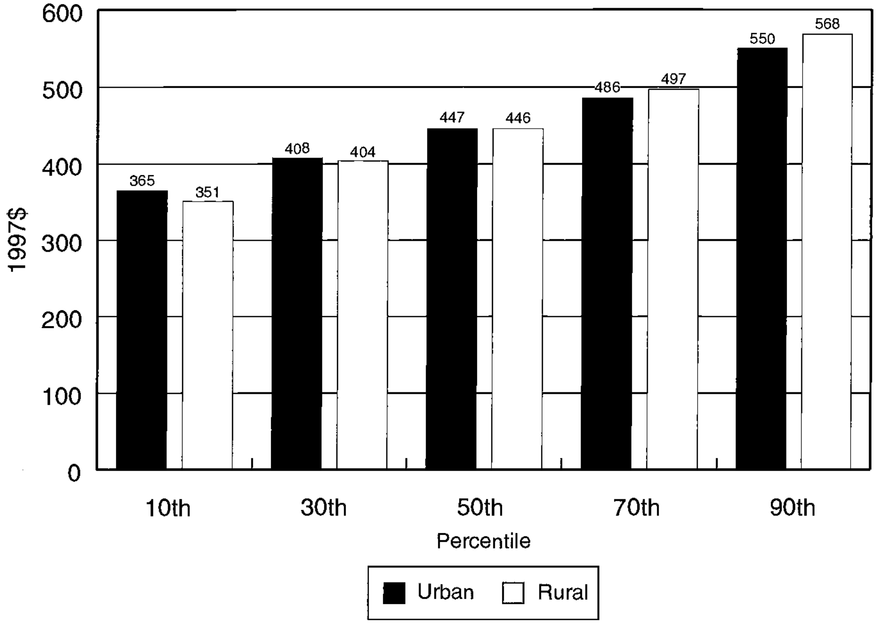

Fig. 8C.1 Standardized Medicare payments, by percentile, urban and rural counties, 1997
Source: Prospective Payment Assessment Commission (1997, 37)

cancer death rates in the two states were 162 and 213 respectively; it was 250 in Pennsylvania. Chassin et al. (1986) examined variation in the rates at which common procedures were performed in the Medicare population across ten states or large substate areas (e.g., coastal California, eastern Massachusetts). Typically the area with the highest rate carried out the procedure at about four times the rate of the lowest area, with the distribution of rates across the areas reasonably uniform. Furthermore, there was no strong correlation across procedures; areas that performed one procedure at high rates did not necessarily perform another procedure at high rates.

In short, there is enormous variation in both disease and spending geographically, and one would expect at least as much variation at the firm level. The data in Eichner, McClellan, and Wise, therefore, are consistent with what we know about variation in medical spending from other sources.

Typically, much of the variation in spending is attributed to differences in practice patterns among physicians, which in turn is related to medical uncertainty (Phelps 1992, 2000). Some variation is explained by plan provisions, but not a great deal. In the RAND Health Insurance Experiment, for example, which had substantial differences in mean spending across plans, the between-plan variation accounted for only 1 percent of the total variance in spending across individuals (Newhouse and the Insurance Experiment Group 1993). To the degree that there are coverage differences among the plans (e.g., one plan covering eyeglasses and another not), of course, there would be additional variation.

In decomposing the variation, the authors here show that the variation in spending across the eight firms is attributable partly to demographics, partly to variation in the incidence of diagnoses, and partly to variation in the costliness of diagnoses. Firms that have substantial positive deviations in one dimension may or may not have positive deviations in other dimensions, and vice versa. I now turn to some comments.

It is hard to know what to make of the size of the demographic deviations without knowing how well these eight firms represent the universe of all firms. It is not surprising, however, that demographics explain variation in spending. Firms differ in the age and sex mix of their workforces, and age and sex predict medical spending. Hence, some differences in spending across firms will inevitably be explained by age and sex. One might, therefore, attempt to focus on the variation in spending after adjustment for age and sex.

Here one runs into the problem that, although inpatient diagnoses tend to be coded reliably, outpatient diagnoses do not. Inpatient coding is thought to be reasonably complete and accurate because Medicare and some private-payer payment turn on the accuracy of inpatient diagnosis coding. (The diagnosis codes determine the Medicare diagnosis-related group and, in turn, payment.) In the case of outpatient diagnoses, however, payment does not turn on the coding for almost all payers. As a result, the coding of outpatient diagnoses can be seriously incomplete and/or inaccurate.

Table 8C.1 presents some data from Medicare on this point. These data

Table 8C.1 Consistency of Part B Diagnosis Coding

Diagnosis	Likelihood of a Part B Claim in 1995 Given a Claim in 1994 (%)
Hypertension	59
Coronary artery disease	53
Chronic obstructive pulmonary disease	62
Congestive heart failure	61
Stroke	51
Dementia	59
Rheumatoid arthritis	55
High-cost diabetes	58
Renal failure	56
Quadriplegia/paraplegia	52
Dialysis	59

Source: Medicare Payment Advisory Commission (1998, 17).

show the likelihood of a physician (Part B) claim in 1995 with the diagnosis conditional on there being a 1994 claim with the diagnosis; only those Medicare beneficiaries alive in 1994 and 1995 are included in the sample. For all eleven diagnoses examined, the likelihood of a claim is only moderately over 50 percent. Because one would have expected virtually all persons with these diagnoses to have made a physician visit in 1995, there would appear to be three possibilities: The 1994 diagnosis was in error; the 1995 diagnosis was in error; or the physician failed to write down a diagnosis in 1995. Because these problems occur upstream of MedStat, the firm Eichner, McClellan, and Wise use to collect and standardize the data, they suggest that some of the variation shown for outpatient diagnoses, which account for nearly half the spending, could be attributable to variation in coding practices. Moreover, if there is any non-randomness in coding errors, some of the variation in mean spending conditional on a diagnosis could also be noise.

Although employees at the firms had no choice of insurance plan, there could nonetheless be some selection effects in the data. The most worrisome diagnoses are perhaps mental health and substance abuse. Here the problem could occur if certain occupations or firms were more likely to attract individuals with such diagnoses, even independently of coverage provisions. Generous coverage provisions relative to other firms in the local labor market might motivate some job choice and add to the variation. Other diagnoses may also differ across firms for noneconomic reasons. Some occupations or industries may also be associated with certain cancers or with trauma, for example. In other words, some of the observed variation across the firms could well be epidemiologic as well as economic.

A possibly fruitful alternative decomposition would be into unit price and the real quantity of services. If this is done, it might prove interesting to compare the variation in the quantity of services with the variation in the quantity of Medicare services across the counties of residence of the workers in these firms. To the degree that employee use and Medicare use covary, one would emphasize physician practice patterns as an explanation of the variation.

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