THE RISE OF HMOs
Appendices

Ph.D. Thesis
March 2003
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APPENDIX A
DATA DEFINITION AND MEASUREMENT ISSUES

This appendix supplements Chapter 3, Research Methods and Data. That chapter features procedures for collecting and processing data on the outcome variable and on the 25 explanatory variables that were tested. This appendix goes into further detail on data definition and measurement for several variables. HMO Market Share, the outcome variable, is considered in section A1. Four inter-related hospital variables are addressed in section A2. Section A3 considers data definition and measurement for Average Years of Schooling. Section A4, the final section, addresses issues concerning estimates of Establishment Size.

In all cases, the unit of analysis is the Metropolitan Statistical Area (MSA), and the data set includes the best possible estimates for each variable for the 75 most populous MSAs in the U.S. as of 1990. As shown in Table 3-1, the Census Bureau classifies 18 large metropolitan areas, including the 12 most populous cities and Cleveland, Denver and Sacramento, as Consolidated Metropolitan Statistical Areas (CMSAs). Technically, each CMSA consists of 2 or more Primary Metropolitan Statistical Areas (PMSAs), and most Census Bureau statistics are provided for the PMSA level as well as the CMSA level. As a matter of convenience, the general policy in this report is to refer to all the included metropolitan areas as MSAs, or simply as cities, whether the Census Bureau officially classifies them as MSAs or CMSAs.

A1. Allocating Enrollment of HMOs That Served More Than 1 MSA

In order to estimate total HMO enrollment for each metropolitan area (MSA), the enrollments for all the HMOs operating in that MSA were added. Therefore, this project required the most accurate possible estimates of enrollment for each HMO for each MSA or CMSA. For many HMOs, constructing such estimates was straightforward. These HMOs operated entirely within 1 MSA during a particular year, and InterStudy’s estimate of enrollment is simply allocated to that MSA.

However, other HMOs operated in 2 or more MSAs during 1 or more of the analysis years, 1973, 1978, 1988 and 1993. A few HMOs operated in rural areas as well. InterStudy’s general procedure was to allocate these HMOs’ entire enrollment to the MSAs in which each HMO was headquartered. This was clearly unsatisfactory, and it was necessary to go through an enrollment allocation process.

Based on prior research (Baker 1994) the general algorithm was to allocate HMO enrollment proportional to the populations of the MSAs or other areas served by each HMO. However, in some cases, available information indicated that enrollment was not likely to be distributed proportional to MSA population. For example, some HMOs only operated in a sub-set of the counties of a particular MSA. In such cases, enrollment was allocated proportionally to the population of the counties in which the HMO operated rather than proportionally to the entire MSA population. In other cases, there is clear evidence that the HMO’s provider network and enrollment was concentrated in one MSA and that service in another MSA had only recently been added on a trial basis. In those cases, the estimated enrollment in the new MSA was downweighted relative to population, frequently by a factor of 50%. 

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The adjustments had the effect of increasing the HMO market share of some cities and decreasing it for others. Estimated HMO market share did not drastically change for most MSAs. Most of the adjustments involved less than 1% of an MSA’s population. Probably the most significant changes were made for the Sacramento area. About 170,000 Kaiser enrollees were “transferred” from San Francisco to Sacramento for 1973, and about 243,000 were similarly reallocated for 1978. Thus, Sacramento’s HMO market share went about by almost 20% for 1973 and by over 23% for 1978 as a result of these reallocations. In terms of rank, Sacramento moved from the middle of the pack for both years to having the greatest HMO market share for 1973 and the 2nd greatest for 1978.

The following paragraphs provide additional detail on the specific adjustment processes used for each of the 4 analysis years.

1973
Available evidence indicates that there were only 2 HMOs in 1973 that operated in more than 1 MSA. These were the 2 Kaiser plans in California, Kaiser Permanente Northern California and Kaiser Permanente Southern California. Historical county-level enrollment information was available directly from the staff of these 2 plans, and this data was used to generate the MSA-specific enrollment estimates for the 2 Kaiser plans for 1973.

1978
InterStudy’s 1978 enrollment report, which was officially released by the Federal government¹, lists HMOs by state of headquarters, and it does not indicate whether each HMO operated in more than 1 MSA at that time. However, in 1982, InterStudy released “Cities Served By HMOs”, which lists all the HMOs operating in each U.S. metropolitan area at that time. “Cities Served By HMOs” also shows the initial operating date of each HMO. If an HMO with enrollment in more than 1 MSA in 1982 was operational in 1978, it was usually assumed that the HMO operated in the same MSAs in 1978 as in 1982.

Using this approach, I found 17 HMOs that were likely to be operating in more than 1 MSA in 1978. These included the 2 California Kaiser plans, 4 other plans operating in California, 6 plans operating in the Northeast and 4 plans operating in the Midwest. For 1978, direct enrollment data was available for Kaiser Southern California, but not for Kaiser Northern California. Kaiser Northern California enrollment was allocated proportionally to the populations of the MSAs.

The enrollments of the other 15 HMOs were allocated according to an appropriate proportional weighting rule. In several cases, the HMO was headquartered in one of the 75 MSAs included in this study, but it also operated in an MSA or rural area not included in this study’s data set. Therefore, the net effect of the adjustments made for those cases was to slightly reduce estimated total HMO enrollment for the 75 MSAs.

1988
For 1988, it was found that 10 HMOs, including 3 Kaiser plans, needed enrollment allocation across MSAs or other areas. Because the HMO industry changed so much between 1978 and 1988, most of the plans whose enrollments were reallocated for 1978 did not need to have their enrollments

reallocated for 1988 and vice versa. Some of the HMOs that were reallocated for 1988 were HMO
Colorado, Ochsner of Louisiana and Health Maintenance Plan headquartered in Cincinnati, Ohio.

The 1988 enrollments for most of these plans were reallocated according to an appropriate
proportional weighting rule. The main exception was Health Options of Florida. Health Options
only reported total enrollment for the entire state. Health Options enrollment was allocated
proportionally to the square of the population of numerous Florida MSAs. Additional evidence
strongly suggested there was no HMO enrollment in the Sarasota-Bradenton MSA in 1988, so none
of the Health Options enrollment was allocated to Sarasota-Bradenton.

1993
For 1993, I was able to secure an internal InterStudy database, maintained in an Excel spreadsheet,
which included InterStudy’s estimates of MSA enrollments for individual HMOs.2 This internal
database, with data for over 500 plans, provided a great deal of valuable information, but it also
included several obvious errors (such as listed percentages adding to less than 50%) and numerous
apparent errors (such as inconsistencies with InterStudy Competitive Edge published for the same
date, July 1, 1993).

Whenever the internal database appeared to be accurate and consistent, it was used to adjust MSA
level enrollment estimates. In a number of cases, the internal database did not appear to be useful,
and enrollment for those HMOs was generally allocated according to the proportional weighting
rule. In several cases, the internal database appeared to have some good information, but it was
marred by an apparent typographical or arithmetic error. In those cases, common sense was used to
settle on the most reasonable set of estimates. The published report does list Counties served for
each HMO, and this information was useful in applying proportional weights.

A2 Definition and Measurement Issues for Hospital Variables

Because of the central role that hospitals play in our health care system, 4 variables describing the
supply, utilization and expense of hospital services at the MSA level are included in the statistical
analysis. The 4 hospital variables are: a) the number of hospital beds per capita, b) the utilization of
hospital bed-days per capita, c) charges per bed-day and d) hospital charges per capita. This section
describes these variables, and it addresses major measurement issues concerning them. It also
compares the definitions of these 4 variables for the 2 analysis periods, 1973-1978 and 1988-1993.

1973-1978 Period
The Area Resources File (ARF) offers measures of hospital beds and bed-day utilization for the year
1973. The ARF data for these 2 variables only includes general hospitals, which is appropriate. In
accord with the growth prediction method described in Chapter 3, hospital beds and bed-days are
tested as explanatory variables of HMO growth for the 1973-78 period. These 2 variables did show
a very high correlation (.95), and it would have been very difficult to distinguish their statistical
associations with HMO market share had the analysis revealed such associations.

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2 InterStudy planned on releasing estimates of total HMO enrollment by MSA. They started releasing those estimates
with their report for January 1, 1994, and they have been releasing them regularly since.

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The ARF was also used to generate data for 2 measures of hospital costs, charges per bed-day and hospital charges per capita. For the earlier period, the ARF only offers a single figure for combined general and special hospital costs for each county for 1975. This single figure also combines inpatient and outpatient costs. The county figures have been aggregated to the MSA level.

The estimate for charges per bed day was generated by dividing the ARF’s total hospital costs figure by total general hospital bed-days in 1973. 1973 was the only year for which any estimate of hospital bed-days was available, and the inconsistency in the years of the numerator and denominator is a minor problem. But the inconsistency of dividing combined general and special hospital charges by general hospital bed-days constitutes a more serious incompatibility of the numerator and denominator. A related flaw is that the inclusion of outpatient charges further reduces the accuracy of these estimates of charges per bed day. These problems mean that the dollar figure per bed-day is not meaningful per se, and analysis and interpretation based on results generated using this variable should be approached with caution. But this variable may still be a reasonable index for comparing hospital expenditures per hypothetical unit of service across MSAs.

Most of the problems of estimating costs per bed-day do not apply to estimates of hospital expenses per capita. In principal, including special hospital expenses and general hospital outpatient expenses is appropriate in measuring costs per capita. Additionally, the numerator and denominator are taken for the same year, 1975. Therefore, this variable is more reliable, and it is a legitimate measure of hospital expenses at the MSA level. However it is fairly highly correlated with the variable for beds per capita (.67) and hospital days per capita (.65).

1988-1993 Period
The same basic set of hospital variables have been generated for the 1988-1993 period. The measure for hospital beds per capita and hospital days per capita are based on 1989 data, and they are both fully comparable with the 1973 estimates.

For the hospital expenditure variables, the ARF offers total general hospital expenditures for each county for the year 1990. Thus, hospital charges per day for this period is estimated by consistently using general hospital data, making for a much more credible set of estimates. There is still a slight inconsistency in this data because the numerator (hospital charges) is for the year 1989, while the denominator (hospital bed-days) is for the year 1990. Additionally, it is believed that the numerator still includes outpatient as well as inpatient charges. However, the 1989/90 estimates for hospital costs per day are much more credible than those for 1975/73 since the later estimates are consistently based on data only for general hospitals.

Similarly, the 1990 estimates of hospital charges per capita are based only on general hospital charges, whereas the 1975 estimates used the sum of general and special hospital costs. The 1990 estimates are valid, just not completely consistent with the 1975 estimates. Additionally, the 1990 estimates for hospital charges per capita have very high correlations (.8) with the 1989 estimates for hospital beds per capita and hospital bed-days per capita.

A3 Average Years of Schooling
The ARF includes a measure of Median Years of Schooling for every county for the year 1980. ARF documentation indicated that this variable was measured to 1 decimal place (i.e. to tenths of a school year), and the intention was to use this variable to test for a relationship between median
schooling and HMO growth during the 1973 to 1978 period. However, the median years of schooling estimates for 36 of the 46 MSAs worked out to exactly 12.0. It is not clear if this is because high school graduation was the median level of schooling for all these MSAs or because the data for many of the observations was truncated. In any case, there wasn’t enough variability within this variable for it to be useful in the 1973 to 1978 multiple regression analysis.

For the 1988 to 1993 period, a different source and a different method were used to estimate average schooling at the MSA level. Average schooling in 1989 was estimated from census data showing the numbers of persons age 25 and above with various levels of educational attainment for each city. The 7 categories ranged from less than the completion of 9th grade to completion of a graduate or professional degree. An estimated average number of years of schooling was imputed for each of the categories, and these averages were used to construct a weighted average for each of the 75 MSAs. No special problems or issues arose with this method.

### A4 Establishment Size

Establishment size, i.e. the number of employees per private working establishment, was hypothesized to affect HMO growth at the MSA level. This variable is also referred to as firm size in the main text.

Data classifying private establishments by number of employees was available from the census publication *County Business Patterns*. For the 1973 to 1978 period, the best available data was for the census year 1980. The data listed the number of establishments in each county falling into each of 9 establishment size categories. The smallest category was 1 to 4 employees, and the largest was 1,000 or more employees. This data was aggregated to the MSA level, and an estimated average establishment size was imputed for each category. This permitted the construction of a weighted average establishment size for each MSA.

For the 1988 to 1993 period, the analogous census data for 1990 was used, and the method for constructing estimated average establishment size was mathematically identical. However, the collection and processing of the 1990 data was completed far more expeditiously because it was possible to download the necessary data from the Internet onto an Excel spreadsheet.

There are several limitations to the estimates for establishment size. The Census Bureau’s exclusion of government establishments and of self employed persons made the data less accurate and useful for the purposes of this study. For private companies, defining exactly what constitutes an establishment requires the application of specific rules, and the formulation and application of these rules by the Census Bureau may be subject to question. The years for which it would have been best to have data would have been 1978 and 1993, so the use of 1980 and 1990 census data further detracts from the data’s accuracy. The imputation of the same estimated average size for each of the 9 categories creates another possible source of error.

Overall, the weighted average estimates appear to give some useful information about establishment size. However, because of the several potential sources of error, it is possible that one or more estimates of MSA average establishment size include substantial measurement error.
This appendix consists primarily of plots of residuals and tables of diagnostic statistics for both the 1970s and 1990s. It supports the brief discussion of regression diagnostics at the end of Chapter 3 and the presentation of diagnostic results at the end of Chapter 4. Section C of Chapter 4 includes Table 4-11, which features the most influential cases revealed by the diagnostic analysis. Section B1 covers the final 1970s model and Section B2 covers the final 1990s model. Both of the sections begin with about a page and a half of text. Figures and tables follow the text.

**B1. Diagnostics for the 1970s**

This section exclusively refers to the final 1970s model, the results of which are presented in Chapter 4 (Table 4-6 and Subsection B3 of that chapter).

Figure B1 shows the studentized residuals for the 1970s analysis (F3rst) plotted against the predicted outcome values for the 1973-78 period (F3y). The units of the residuals are essentially the same as those for the outcome variable – percentage points of total MSA population. Each of the 46 MSAs included in this analysis have been numbered, and the MSA numbers, along with values for Cook’s Distances and dfbetas, are shown in Table B1.4

Figure B1 and the diagnostic statistics both show that the residuals are normally distributed, independent of predicted y values and independent of each other. There is little indication of heteroscedasticity here. The small degree of clustering apparent in Figure B1 is most likely a consequence of the small size of the data set, not of any non-linear relationships between the outcome and explanatory variables.

The standard deviation (SD) of the studentized residuals is 1.04 and none of the residuals have an absolute value greater than 3 SDs. Of the 46 observations, 3 cities have absolute residual values greater than 2 SDs. These are #15 Omaha, with a residual of –2.41 ($z=-2.32$), #41 Portland, with a residual of 2.34 ($z=2.26$) and #1 Las Vegas, with a residual of -2.13 ($z=-2.05$).5

Figure B2 shows the residuals (F3rst) plotted against the first of 4 explanatory variables, percent of physicians in group practice (StGr75p). This figure shows that the distribution of the group practice explanatory variable is somewhat skewed, but the residuals themselves are independent of this explanatory variable. Figure B3 shows the residuals plotted against the MDs per capita explanatory variable (MDPC). Figure B4 shows residuals plotted against RNs per capita (RNsPC). Figure B5 shows residuals plotted against Latitude (RelLat). Like Figure B2, Figures B3, B4 and B5 show that the residuals are independent of the respective explanatory variables.

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3 The full version of Appendix B runs 18 pages and includes 10 figures generated using Stata Release 4. Because of technical difficulties, the figures are not included in the electronic version of the complete set of Appendices formatted in Word 2000. Hard copies of the figures are available from the author.

4 For this period, the order in which the observations are numbered does not bear any significance.

5 These are also the 3 cities with the highest values for Cook’s distance. The reasons for, and implications of, their influential point status are discussed in Chapter 4, Table 4-11.
Table B1, besides providing the MSA numbers used in Figures B1 – B5, lists the Cook’s distances and the 4 dfbetas for all 46 observations. Cook’s distance provides a measure of the overall influence of each observation on the coefficient values of the final 1990s model. The 4 sets of dfbeta values, one each for Group Practice, MDs per capita, RNs per capita and Latitude, estimate the change in the t statistic for each coefficient if that particular observation were excluded.

There is no consensus concerning the critical value for a dfbeta statistic, but any critical value should be applied to the absolute value. The literature includes suggestions that $2/\sqrt{n}$ (which equates to .295 for this regression) or simply 1.0 be used. In this set of dfbeta values, there are none whose absolute value exceeds 1.0. There are 16 dfbetas in excess of .295, and 5 of these exceed .50. Three of the values in excess of .50 reflect the influence of Honolulu, Miami and Seattle on the Latitude coefficient, and these fairly high values are not surprising.

The dfbeta with the largest magnitude is -.785 for the influence of Omaha on the RNs per capita coefficient. As pointed out in Table 4-11, if Omaha is eliminated from the data set, the t statistic for RNs rises from 3.7 to almost 4.5. Therefore this diagnostic analysis tends to confirm the finding that concentration of nurses had a significant effect on HMO growth from 1973 to 1978. Lastly, a dfbeta of .570 shows the influence of Las Vegas on the coefficient of MDs per capita. This is also discussed in Table 4-11.

In conclusion, regression diagnostic analysis supports the validity of the final 1970s model. Where the analysis shows moderate outliers and influential points, their effects have been considered and appropriate caveats are included in the main text.

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Figure B1
1970s Plot of Residuals vs. Fitted Values
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Figure B2
1970s Plot of Residuals vs. Group Practice Variable
Figure B3
1970s Plot of Residuals vs. MDs per capita
Figure B4
1970s Plot of Residuals vs. RNs per capita
Figure B5
1970s Plot of Residuals vs. Latitude Variable
B2. Diagnostics for the 1990s

This section exclusively refers to the final 1990s model, the results of which are presented in Chapter 4 (Table 4-9 and Section B7 of that chapter).

Figure B6 shows the residuals for the 1990s analysis (Dmres) plotted against the predicted outcome values for the 1988-93 period (DMy). Again, the units of the residuals are percentage points of total MSA population. Each of the 75 MSAs included in this later analysis have been numbered, and the MSA numbers, along with values for Cook’s Distances and dfbetas, are shown in Table B2. For this period, the MSAs are numbered by the value of Cook’s Distance, with the MSAs with the lowest Cook’s Distances coming first.

Figure B6 and the diagnostic statistics both show that the residuals are normally distributed, independent of predicted y values and independent of each other. Specifically, there is little indication of heteroscedasticity in these residuals. The standard deviation (SD) of the residuals is 5.64, and none of the residuals have an absolute value greater than 3 SDs. Three cities have residuals with values greater than 2 SDs. These are #74 Indianapolis with a residual of –15.56 (z=-2.76), #73 Dayton with a residual of 13.36 (z=+2.37) and #72 Syracuse with a residual of –12.19 (z=-2.16).

Figure B7 shows the residuals (Dmres) plotted against the first of 4 explanatory variables, percent of physicians in group practice (StGr88p). This figure shows that the distribution of the group practice explanatory variable is somewhat skewed, but the residuals themselves are independent of this explanatory variable. Figure B8 shows the residuals plotted against the economic growth explanatory variable (EG7893). Figure B9 shows residuals plotted against MDs per capita (MDPC89).

Like Figure B7, Figures B8 and B9 show that the residuals are independent of the respective explanatory variables. The last of the figures, B10, shows the residuals plotted against the eastern Midwest dummy variable (Big10Dum). This figure highlights the presence of 2 outliers, Indianapolis and Dayton, among the eastern Midwest cities. Otherwise, Figure B10 indicates that residual values are independent of this dummy variable.

Table B2, besides providing the MSA numbers used in Figures B6 – B10, lists the Cook’s distances and the 4 dfbetas for all 75 observations. Cook’s distance provides a measure of the overall influence of each observation on the coefficient values of the final 1990s model. The 4 sets of dfbeta values, one each for Economic Growth, Group Practice, MDs per capita and the east Midwest dummy variable, estimate the change in the t statistic for each coefficient if that particular observation were excluded.

---

7 The figures for the 1990s show simple residuals, unlike the figures for the 1970s that show Studentized Residuals. However, for these datasets the difference is very small.

8 As discussed in Chapter 4, Indianapolis was the city with the greatest decline in HMO market share from 1988 to 1993, while Dayton was the eastern Midwest city with the greatest growth in market share. Syracuse was a Northeastern city that bucked the trend and saw a decrease in market share during this period. Market share in Syracuse went down by 4.10% while it grew robustly in Albany and Rochester, the 2 closest cities in this dataset.
There is no consensus concerning the critical value for a dfbeta statistic, but any critical value should be applied to the absolute value. The literature includes suggestions that $2/\sqrt{n}$ (which equates to .231 for this regression) or simply 1.0 be used. In this set of dfbeta values, there is only one whose absolute value exceeds 1.0. That is the dfbeta for the influence of Raleigh-Durham on the coefficient of MDs per capita. This influential observation is discussed in Chapter 4. There are 17 other dfbetas with absolute values in excess of .231, but only 2 with absolute values greater than .50. Those 2 reflect the influence of Indianapolis and Dayton on the coefficient for the east Midwest dummy, as discussed in Chapter 4.

In conclusion, examination of residuals and diagnostic statistics confirms that regression assumptions are correct for the final 1990s model. Where the diagnostic analysis shows outliers or influential points, their effects have been considered and appropriate caveats are included in the main text.

---

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1990s Plot of Residuals vs. Fitted Values
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<td>-.28939</td>
<td>.79022</td>
</tr>
<tr>
<td>74</td>
<td>Indianapolis</td>
<td>.209783</td>
<td>-.38161</td>
<td>.16409</td>
<td>-.23921</td>
<td>-.97113</td>
</tr>
<tr>
<td>75</td>
<td>Raleigh-Durham</td>
<td>.375422</td>
<td>-.38830</td>
<td>-.04690</td>
<td>-.12579</td>
<td>-.02750</td>
</tr>
</tbody>
</table>
Figure B7
1990s Plot of Residuals vs. Economic Growth Variable
Figure B8
1990s Plot of Residuals vs. Group Practice Variable
Figure B9
1990s Plot of Residuals vs. MDs per capita
Figure B10
1990s Plot of Residuals vs.
Eastern Midwest Dummy Variable
APPENDIX C
DESCRIPTIVE COMPARISON OF EXPLANATORY VARIABLE VALUES

This appendix relates to material in Chapter 4, primarily Tables 4-4 and 4-5. Those tables provide descriptive statistics for the study’s explanatory variables for the periods 1973-78 and 1988-93. This comparison of data for the 2 periods is offered for the purposes of providing information and possibly stimulating ideas concerning trends in a few of these variables. However, it should be noted that the 2 datasets are not completely comparable. As described in Chapter 3, the first dataset includes only 46 of the 75 MSAs that make up the 2nd dataset.

Table C-1 presents data from Tables 4-4 and 4-5 in a format that facilitates comparison across time. The mean values in all 3 of these tables are simple means of the values for the MSAs in each dataset. These means are not national means, nor are they population-weighted means for the included MSAs. Table C-1 only includes those 14 variables for which the mean values are substantively comparable.

Hospital statistics in Table C-1 are consistent with the national trend of declining hospital capacity and utilization during the 1970s and 1980s. Variable 1 shows that, by the measure used here, the number of hospital beds per 100 population went down from .472 in 1973 to .403 in 1989. Over the same period, the number of hospital days per 100 population (variable 6) declined from 1.32 to 1.02. Table C-1 reflects considerable inflation in hospital and other health care costs, with the estimated hospital expenditures per capita (variable 7) increasing from $213 in 1975 to $943 in 1990.

Table C-1 included 4 variables on the health care work force, namely variables 2-5 which respectively reflect concentrations of MDs, RNs, LPNs and Pharmacists. The table shows that the proportion of MDs increased by over 40% and the proportion of RNs more than doubled between the early 1970s and 1989 or 1990. For RNs, a more detailed examination of the data shows that the lowest value for 1990, .405, is higher than the mean value for 1972, .380. This suggests that the proportion of RNs went up in virtually every city included for both time periods. Interestingly, Table C-1 shows that the proportion of LPNs went down slightly, from .179 to .172 per 100 population, between 1974 and 1990. During that same period, the concentration of pharmacists increased by about 60%.

The table includes 2 variables that reflect characteristics of the physician population. The proportion of MDs aged 45-64, variable 10, went down moderately from .370 in 1975 to .343 in 1989. Since we have already seen that the MD population increased substantially during this period, it is understandable that the proportion of physicians under age 45 increased and the proportion ranging from ages 45 to 64 decreased. The table also shows a moderate increase in the percentage of physicians in group practice (variable 12); this is consistent with observed medical work force trends during this period. Variable 14, age of oldest HMO, is the final health care system variable in Table C-1. As would be expected, it shows that the age of the oldest HMO in the average MSA in these 2 datasets went up from 1978 to 1992.
Table C-1: Comparison of Explanatory Variable Values For the 2 Analysis Periods

All Information in this table is taken from either Table 4-4 or 4-5; Please see those tables and the accompanying text for additional detail and explanation.

<table>
<thead>
<tr>
<th>#</th>
<th>VARIABLE</th>
<th>1st Year Measured</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>2nd Year Measured</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hospital Beds per 100 population</td>
<td>1973</td>
<td>.472</td>
<td>.091</td>
<td>1989</td>
<td>.403</td>
<td>.108</td>
</tr>
<tr>
<td>2</td>
<td>MDs per 100 population</td>
<td>1973</td>
<td>.164</td>
<td>.036</td>
<td>1989</td>
<td>.235</td>
<td>.060</td>
</tr>
<tr>
<td>3</td>
<td>RNs per 100 population</td>
<td>1972</td>
<td>.380</td>
<td>.101</td>
<td>1990</td>
<td>.825</td>
<td>.158</td>
</tr>
<tr>
<td>4</td>
<td>LPNs per 100 population</td>
<td>1974</td>
<td>.179</td>
<td>.038</td>
<td>1990</td>
<td>.173</td>
<td>.057</td>
</tr>
<tr>
<td>5</td>
<td>Pharmacists per 100 population</td>
<td>1974</td>
<td>.051</td>
<td>.011</td>
<td>1990</td>
<td>.081</td>
<td>.018</td>
</tr>
<tr>
<td>6</td>
<td>Hospital Days per capita</td>
<td>1973</td>
<td>1.32</td>
<td>.268</td>
<td>1989</td>
<td>1.02</td>
<td>.293</td>
</tr>
<tr>
<td>7</td>
<td>Hospital Expenditures per capita</td>
<td>1975</td>
<td>213</td>
<td>43.1</td>
<td>1990</td>
<td>943</td>
<td>206</td>
</tr>
<tr>
<td>10</td>
<td>Proportion MDs Aged 45-64</td>
<td>1975</td>
<td>.370</td>
<td>.047</td>
<td>1989</td>
<td>.343</td>
<td>.040</td>
</tr>
<tr>
<td>12</td>
<td>% Physicians in Group Practice</td>
<td>1975</td>
<td>24.6</td>
<td>8.52</td>
<td>1988</td>
<td>28.7</td>
<td>8.9</td>
</tr>
<tr>
<td>14</td>
<td>Age of Oldest HMO</td>
<td>1978</td>
<td>10.9</td>
<td>13.2</td>
<td>1992</td>
<td>18.2</td>
<td>13.6</td>
</tr>
<tr>
<td>15</td>
<td>Per Capita Income</td>
<td>1978</td>
<td>7,700</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Employees per Establishment</td>
<td>1979</td>
<td>18.3</td>
<td>2.75</td>
<td>1993</td>
<td>16.0</td>
<td>2.04</td>
</tr>
<tr>
<td>18</td>
<td>% Workers Union Members</td>
<td>1976</td>
<td>25.2</td>
<td>9.04</td>
<td>1994</td>
<td>14.7</td>
<td>6.88</td>
</tr>
</tbody>
</table>
The table includes 3 economic variables. The increase in average per capita income (variable 15) from $7,700 to $20,255 reflects a combination of economic growth and general inflation during the 1978 to 1993 period. The number of estimated employees per private establishment (variable 17) shows a decrease from 18.3 to 16.0 between 1979 and 1993. As discussed in Appendix A, this variable may not be measured completely accurately. However, this tentative indication of a substantial decline in average establishment size is thought provoking. The percentage of the labor force who are union members (variable 18) shows a decline from 25.2% in 1976 to 14.7% in 1994. This is consistent with well known trends.

Population density (variable 19) is the only demographic variable included in Table C-1. It shows a slight increase from 523 to 527 persons per square mile between 1975 and 1993. This increase is probably artificially low. Nine out of the nation’s 10 largest cities already had operational HMOs in 1978, and they are included in the 1970s dataset. On the other hand, a large number of medium sized, relatively low-density cities, such as Memphis, Raleigh and Little Rock, were added to the 1990s dataset. It appears that the addition of these cities kept the average density of the 1990s dataset from surpassing that of the 1970s dataset by very much.
This appendix relates to material in Chapter 2, primarily Section A Nature of Cost Advantage. The conditions and methods that enabled HMOs to charge lower premiums were the subject of lively controversy in the 1980s and early 1990s. The following text was written to help clarify the nature of the controversy and the exact issues in dispute. However, recent empirical studies (Polsky and Nicholson 2001, Baker et al 2000 and Kemper et al 1999/2000) have provided new information and helped to resolve some of the questions. This algebraic analysis is made available for those who seek a more theoretical perspective from which to view the issues. Additionally, it is always possible that new data or analysis will revive controversy, and that such a theoretical approach will be needed.

In order to discuss research on premiums/costs, it will be helpful to refer to a few algebraic models. Relatively simple models can clarify the purpose of an otherwise confusing and disconnected series of studies. The basic finding of Luft’s (1978) suggests a very simple model of medical care costs, which might be referred to as Model I or as the naive model. This model refers to average costs for a specific population, and it is assumed that everybody in the population is enrolled in either an HMO or an FFS insurance plan.

**MODEL I**

\[ C = PH + (1-P)F \]

where

- \( H \) = Average Cost per capita for HMO enrollees
- \( F \) = Average Cost per capita for FFS enrollees
- \( P \) = Proportion of the Population enrolled in HMOs
- \( C \) = Overall Average Cost per capita for Medical Care

This model assumes that the average cost of enrollees in each system remains the same regardless of the level of \( P \) or any other factor. If this is true, and if \( H \) is lower than \( F \), \( C \) can be minimized\(^{10}\) by setting \( P=1 \), i.e. enrolling everybody in HMOs.

It is possible to construe favorable selection as a simple linear phenomenon affecting HMOs’ costs and consequently premiums. This is done in Model II (next page).

---

\(^{10}\) Within the feasible range
MODEL II

\[ H = a + bP \]
\[ F = c + dP \]
\[ C = P(a + bP) + (1 - P)(c + dP) \]
\[ C = c + (a + d - c)P + (b - d)P^2 \]

where

- \( C \) = Average Cost per capita for Medical Care
- \( P \) = Proportion of the Population enrolled in HMOs
- \( H \) = Average Cost per capita for HMO enrollees
- \( F \) = Average Cost per capita for FFS enrollees
- \( a \) = Intercept value for cost of HMO enrollees as enrollment approaches Zero. Is assumed to be positive.
- \( b \) = Rate of change in HMO costs as enrollment increases.
- \( c \) = Intercept value for cost of FFS enrollees when everybody is enrolled in an FFS plan.
- \( d \) = Rate of change in FFS costs as enrollment decreases. The favorable selection hypothesis would imply that \( d \) is positive.

In all models presented here, UPPER case letters symbolize directly measurable quantities, while lower case letters represent coefficients that can be quantitatively estimated.

This model, and similar but less general models, can be used to structure our understanding of how HMOs affect health insurance markets. If HMOs consistently enjoy favorable selection, their average costs will go up as they enroll greater fractions of the population; that is to say coefficient \( b \) will be positive. FFS costs will also increase as \( P \) increases in the presence of HMO favorable selection; coefficient \( d \) will also be positive. This is because FFS insurers are left with only the most expensive patients as HMOs enroll more of the population.

Under a very simple, but fairly reasonable set of assumptions, \( b \) and \( d \) are equal. If we then add a competition effect to the model, it would manifest as a reduction in the value of \( d \). With appropriate further assumptions, the competition effect is equal to the difference between average cost escalations for HMO and FFS, namely \( b \) minus \( d \). Even if HMOs are not any more cost efficient than FFS, they can still have a global cost reducing effect if they force FFS insurers to cut their costs.

Ideally, Model II will be fleshed out with empirically determined facts concerning medical costs under HMO and FFS insurance. Determining a specific individual’s costs at a specific time under two different insurance regimes necessarily requires a counter-factual scenario, and thus it is very problematic. But it is possible to use individual data to estimate FFS and HMO costs for very similar groups.

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11 Of course, the value of \( b \) need not be constant within the feasible range of \( P \). But considering the full range of possibilities considerably complicates the modeling process and makes testing far more difficult.

12 In this framework, HMOs are doing the “wrong” thing by favorably selecting enrollees, yet they get credited with a “good” result, namely cost containment. However, the less expensive or less risky enrollees also benefit from favorable selection, so the problem with selection is essentially one of income or utility distribution, not efficiency.
APPENDIX E
ILLUSTRATION OF POSSIBLE EFFECTS OF EXPLANATORY VARIABLES ON HMO ENROLLMENT

This appendix relates to material in Chapter 4, primarily the coefficients of the variables included in the final 1970s and the early 1990s models. Assuming that these associations reflect causal effects, these effects are illustrated for several hypothetical sets of circumstances here. This material is similar to the discussion in the first footnote to sub-section B5, Nurses In the Final 1970s Model, but it is more comprehensive.

For each of the 2 analyses, 1970s and early 1990s, 1 variable is excluded from this analysis and discussion. Latitude, which showed a statistically significant association for the 1973-78 period, is excluded. Logic argues against considering Latitude to be a causal variable when the units of analysis are cities. It is not possible to change a city’s latitude without changing its fundamental identity. Therefore, Latitude is a control variable in the final 1970s model. Similarly, East Midwestern Location, which showed a statistically significant association for the 1988-93 period, is excluded from this discussion. It is not possible to change a city’s east Midwestern location without changing the city’s identity, so this variable is also treated as a control variable.

For the remaining 6 variables (counting Group Practice and MDs per capita twice), Table E-1 illustrates the possible effects of changes in values on HMO enrollment, expressed both in terms of market share and of typical total enrollments. The 3 suitable variables from the final 1970s model are listed first, followed by the 3 suitable variables from the final 1990s model. After the name of each variable, its mean, standard deviation and coefficient from the regression analysis are listed. (Please see Table 3-3 for the year of measurement for each of these variables.)

The 5th column in Table E-1 shows hypothetical changes in the z-score of the variable value for any city. In this table increases 1.0 and 2.0 standard deviations are postulated for each variable. Multiplying the values in the last 3 columns by –1 easily derives the possible effects of decreases of 1.0 and 2.0 standard deviations. The 6th column shows the result of multiplying the standard deviation by the change in z-score. It shows the change in explanatory variable value that could produce the effects shown in columns 7 and 8.

Columns 7 and 8 show the “Bottom Line” for this table. Column 7 shows the possible effect in terms of HMO market share; most of these values run between 1% and 3% of MSA population. Column 8 adds another hypothetical but plausible element by translating the market share effects into actual HMO enrollees for a “typical” city. For the 1970s, the typical city in this data set is assumed to have a population of one million. For the early 1990s, the typical population is increased to one million, two hundred thousand. Both these numbers are close to the mean and median population values for their respective data sets. These hypothetical enrollment effects range from a low of 7,585 to a high of 53,453.

One purpose of Table E-1 is to facilitate comparing the possible effects of different variables for the same time period. For the 1970s, the table indicates that the group practice of medicine may have had a greater effect than either of the other 2 variables. However, those 2 variables, MDs per capita and RNs per capita, appear to have had effects of similar magnitude. For the 1990s, this analysis indicates that economic growth may have had the greatest effect on HMO growth, a negative effect.
Also for the later period, the table can be interpreted as indicating that the 2 MD variables had negative effects of about the same magnitude.

In terms of both market share percentages and enrollees, the hypothetical effects for the early 1990s are somewhat greater than those for the 1970s. However, both the mean and the standard deviation for the outcome variable are considerably higher for the later period. Therefore, the higher numbers shown for the 1990s are misleading. Consistent with both the t and R² statistics shown in Tables 4-6 and 4-9, the 1970s model does better at explaining HMO growth of its period than does the 1990s model.

### Table E-1

**Illustration of Possible Effects of Explanatory Variables on HMO Enrollment**

Illustrative Changes and Effects Are Purely Hypothetical

<table>
<thead>
<tr>
<th>Explanatory Variable</th>
<th>Mean Value</th>
<th>Stndrd Dev.</th>
<th>Coeff.</th>
<th>Hypothetical Change of Value</th>
<th>Possible Effect %</th>
<th>Hypothetical Enrollment Effect on &quot;Typical&quot; City (see note)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1970s ANALYSIS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% MDs Gp Pract</td>
<td>24.6%</td>
<td>8.52%</td>
<td>0.172</td>
<td>plus 1.0</td>
<td>8.52%</td>
<td>1.47</td>
</tr>
<tr>
<td>% MDs Gp Pract</td>
<td>24.6%</td>
<td>8.52%</td>
<td>0.172</td>
<td>plus 2.0</td>
<td>17.04%</td>
<td>2.93</td>
</tr>
<tr>
<td>MDs/100</td>
<td>0.164</td>
<td>0.036</td>
<td>21.07</td>
<td>plus 1.0</td>
<td>0.036</td>
<td>0.76</td>
</tr>
<tr>
<td>MDs/100</td>
<td>0.164</td>
<td>0.036</td>
<td>21.07</td>
<td>plus 2.0</td>
<td>0.072</td>
<td>1.52</td>
</tr>
<tr>
<td>RNs/100</td>
<td>0.380</td>
<td>0.101</td>
<td>9.25</td>
<td>plus 1.0</td>
<td>0.101</td>
<td>0.93</td>
</tr>
<tr>
<td>RNs/100</td>
<td>0.380</td>
<td>0.101</td>
<td>9.25</td>
<td>plus 2.0</td>
<td>0.202</td>
<td>1.87</td>
</tr>
<tr>
<td><strong>1990s ANALYSIS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Econ Growth</td>
<td>164%</td>
<td>29%</td>
<td>-7.68</td>
<td>plus 1.0</td>
<td>29%</td>
<td>-2.23</td>
</tr>
<tr>
<td>% MDs Gp Pract</td>
<td>28.7%</td>
<td>8.9%</td>
<td>-0.153</td>
<td>plus 2.0</td>
<td>8.9%</td>
<td>-1.36</td>
</tr>
<tr>
<td>% MDs Gp Pract</td>
<td>28.7%</td>
<td>8.9%</td>
<td>-0.153</td>
<td>plus 2.0</td>
<td>17.8%</td>
<td>-2.72</td>
</tr>
<tr>
<td>MDs/100</td>
<td>0.235</td>
<td>0.060</td>
<td>-22.05</td>
<td>plus 1.0</td>
<td>0.060</td>
<td>-1.32</td>
</tr>
<tr>
<td>MDs/100</td>
<td>0.235</td>
<td>0.060</td>
<td>-22.05</td>
<td>plus 2.0</td>
<td>0.120</td>
<td>-2.65</td>
</tr>
</tbody>
</table>

**Note:** Reflecting population trends, the typical city of the 1970s is assumed to have 1,000,000 population, but the typical city of the early 1990s is assumed to have 1,200,000 population.
APPENDIX F
PRIOR EXPECTATIONS FOR
STATISTICAL RESULTS

This appendix relates to material in Chapter 3. Sub-section B3 of this chapter summarizes how the initial hypotheses for the results of this study's statistical analysis were developed. The bulk of this appendix consists of the 2 memos, one dated 1996 and the other dated 1999, which stated and explained the initial hypotheses. Those interested in how the regression results compare with these 2 sets of expectations are referred to Chapter 5, sub-section B1, Comparison With Expectations.

F1 – Memo Submitted Before Performance Of 1970s Regression Runs

Martin Markovich                   April 4, 1996
RAND Graduate School               Ph.D. Thesis

FINAL MEMO TO COMMITTEE
BEFORE 1970s REGRESSION RUNS

Preparatory to running the 1st set of analyses for the Thesis, The Rise of HMOs, this memo will serve 2 purposes. Firstly, it will address some issues which were raised by Glenn concerning the factors that led to the successful establishment and robust growth of HMOs during the 1970s. In this connection, I will briefly address the impact of the Federal HMO Act, which was passed in 1973 and amended in 1976.

Secondly, this memo will discuss the specifications and my expectations for the analysis of HMO Market Share growth from 1973 to 1978. After briefly describing the data set I have compiled, it will detail the form of the dependent variable, the explanatory variables that will be used to estimate it and the specific units on which the analysis will be performed. There will also be discussion of subsequent supplementary analyses. Along with the specifications, I will list my expected results for these regressions. Naturally, unusually strong or surprising results may indicate modifications in the regression program and in the final form of the analysis.

A) Descriptive Analysis of HMO Growth in the 1970s

When Glenn Melnick and I met on March 1, we discussed the factors that led to HMO creation and growth, particularly how new HMOs marketed themselves to become viable. The period under analysis in this part of the thesis is 1973 to 1978, so I investigated the literature on HMO growth during this period. My primary source is the Brookings Publication, Politics and Health Care Organization: HMOs as Federal Policy, by Lawrence D. Brown; although this work is primarily intended to evaluate the effects of the Federal HMO Act of 1973, it also provides considerable background on the formation, management and success or failure of HMOs during the period. Page references in this section refer to Brown's work.

In Chapters 2 and 3, Brown points out HMOs needed to create and maintain a delicate balance between several stakeholders. The management of each individual HMO had the critical task of keeping all these stakeholders committed to the organization. In the 1970s, each HMO, whether established or aborning, was unique in substance and background and there was no formula available for forming an HMO and making it thrive. There was still active resistance to the concept;
rapid growth was possible, but explosive growth was very unlikely because most providers were still suspicious of HMOs.

As described by Brown, 5 categories of stakeholders were essential to each HMO's success: a sponsor, subscribers, physicians, one or more hospitals and financial institutions. In some cases, the initial sponsor could also provide financial support, but most initial sponsors either didn't have sufficient financial resources or didn't see the HMO as essential to their operations. Some of the early sponsors included labor unions, both Blue and commercial insurance plans, foundations, industry, medical schools, groups of physicians and various levels of government. In many cases financial support had to be cobbled together from a combination of these and other sources, including bank loans.

Serious marketing to employers and their employees could only begin once the organization had a core staff of physicians (usually at least 6). In some cases the physicians brought their patients with them. However, most HMOs relied on marketing staffs to secure or increase their enrollment. Because HMOs really were new and different, enthusiastic marketing was necessary to overcome ignorance and risk aversion (Brown, pp. 84-85). HMOs that relied on Blue marketing staffs almost always were dissatisfied with the results because the needed sales approach was very different from that which worked for Blue plans (p.94).

Once the HMO began operation, word of mouth from satisfied customers became critical to expansion (p.95). However, satisfying customers required another delicate balance - between restriction of services and overutilization. The 2 primary forms of overutilization were unnecessary hospitalizations and referrals to fee-for-service specialists (p.87). The HMO's Medical Director played a critical role in establishing standards that would strike the balance while keeping their medical staff happy (p. 100). Given the difficulties involved, its not surprising that most young HMOs were in a "struggle for life itself." (p. 90)

Brown refers to the "fragility" of HMOs several times (pp.78, 127). This was in context of his perception of the disappointing growth of HMOs in the 1970s in response to the Federal HMO act. From the perspective of 1996, when HMOs enroll 56 million persons, collect over $75 billion in premiums annually and continue to grow at double digit percentage rates, the term "instability", conveying high potential for growth, decline or mutation, seems more correct. We see frequent formations, dissolutions, sales, mergers, divisions and profound changes in goals, affiliations and operating methods up to the present. For example, in the last 6 months of 1994, a relatively stable and prosperous period for HMOs, 85 out of 520 listings in the bi-annual InterStudy report changed, with half the changes stemming from the creation of new plans. The HMO story of the past 30 years is one of continued growth even as individual HMOs faced highly uncertain futures.

In summary, HMOs in the 1970s did not form or grow by using standard procedures or tactics. They had to strike and maintain a delicate balance between their stakeholders, and their policies and patterns of behavior were very varied, complex, difficult to measure and unpredictable. Quantification and statistical analysis of internal HMO operations during this period is nearly impossible.

Instead I am quantifying and analyzing the environments (MSAs) in which each HMO operated. Because of the instability and sensitivity of HMOs to positive and negative factors affecting their well being, I expect to find certain environmental characteristics were more favorable

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13 For HMOs that didn't target the general private insurance market, non-geographic environmental factors were also important. Other target populations were primarily either Medicaid beneficiaries or members of specific unions. Medicaid HMOs continue to be a separate category to this day (some HMOs serve both the general and Medicaid populations). Although Medicaid HMOs are probably influenced by MSA specific environmental factors, their existence poses problems for this analysis. However, HMOs that only served the membership of specific unions tended to expand into the general market or merge with HMOs that did.
than others; specifics are discussed later in this memo. In principle environmental conditions should have influenced a) the ability of HMOs to form and achieve viability, b) the willingness of stakeholders, many of whom reevaluated their affiliation continuously, to maintain participation, and c) the rate of hospital admissions and specialist referrals by HMO medical staff. My first goal is to determine which environmental factors had the greatest impact. But a more advanced goal is to assess whether each influential factor operated primarily through formation, continued affiliation or control of utilization.

Brown's book largely reflects disappointment with HMO growth in the 1970s because it had been believed that the Federal HMO Act would stimulate explosive growth in the number and enrollment of HMOs. Writing in 1982, Brown found that these expectations were unrealistic because of the difficulty of creating successful HMOs and opposition to HMO provision of health care. Brown's basic contention was that it would take time for HMOs to assume pre-eminence in the health finance system under any Federal policy short of mandating universal membership, and his position has been validated.

However, based on Brown's account, the subsequent evolution of the industry and the preliminary results of my analysis of HMO enrollment in 1973 and 1978, it seems clear that the act facilitated HMO growth in some ways, but impeded it in others. The Act publicized and legitimized the concept, which may have been its greatest contribution. The act sought to mandate that employers offer federally qualified HMO coverage to all employees (dual choice), but that provision was apparently never formally invoked. The act also offered a program of grants and loans for HMO establishment and expansion, Brown cites the Rhode Island Group Health Association (RIGHA) as an early recipient of a federal loan.

On the other hand, the act created confusion and even discouragement within many HMOs. The standards for federal qualification, including comprehensive coverage on a scale rarely seen even in Blue plans, community rating, open enrollment and others were completely out of touch with insurance industry practices then or now (some of these requirements were eliminated in the 1976 amendments). Paradoxically, these stringent requirements may have been more daunting to large well established HMOs than to newcomers who had little to lose. Specifically, Kaiser, on whose model the act was partly based, responded by reducing their expansion program in the face of continued uncertainty over federal policy. Brown cites a Kaiser spokesman who said "Kaiser didn't need federal money, and we really didn't need dual choice. ... So we decided to delay as long as possible our qualification and in the meantime work for amendments to the law." (p. 330)

On balance, the act didn't make much difference to overall HMO enrollment during its years of attempted implementation. In 1981, President Reagan discontinued the program for subsidizing individual HMOs and reduced the scope of federal activities to support HMOs in general. During the same period, Federal policy was changed to facilitate enrollment of Medicare and Medicaid beneficiaries by HMOs. HMO enrollment continued to grow, with almost all of the growth coming through the enrollment of private insurance policyholders. National enrollment grew from 10.2 million in 1981 to 33.6 million in 1990. Thus the HMO Act of 1973, as amended, stands as an interesting, but ultimately secondary factor in the colorful history of HMOs. The real action, as Brown discussed, lay elsewhere.

B) Specifications and Expectations
  1) Data

The data set I have compiled has been discussed in the Draft Prospectus and other memos and presentations to the Committee. As you know, this study is looking at the 75 largest MSAs in the U.S. as of 1990. However, only those MSAs which had positive HMO enrollment in 1978 or
1973 are subject to the main analysis. This comes to 47 MSAs, sufficient to run and analyze regressions with several explanatory variables. Because of the relatively small number of observations, some results may have material substance but not pass the standard test of statistical significance.

The chief Outcome V will be the change in the percentage of the population enrolled in HMOs from 1973 to 1978 for each MSA. For example, if 2% of New Moscow's population were enrolled in HMOs in 1973, and 6% of its population were enrolled in 1978, than the outcome value for New Moscow would be +4%, regardless of any changes in the MSA's population over that interval. This V is referred to as StrDif.

Using log transformations of the market share variable was initially appealing because differences in logs should better measure compound growth. However, as Bob Bell pointed out, the log transformation presented 2 problems; it made it difficult to handle cases where HMO enrollment increased from 0%, and it assumed that MSAs with high HMS in 1973 would experience greater variance in growth in straight percentage terms. Inspection and analysis of the data did not bear out this assumption, and we concluded that the StrDif variable was more useful in measuring changes in HMO enrollment during this period.

A histogram showing the frequency distribution of the StrDif variable is attached. All but 2 of the MSAs show increases in HMO Market Share (HMS), and these fall into a fairly standard pattern. 25 MSAs experienced a small degree of growth, between 0.0 and 1.4% of their population. The density of the histogram basically decreases as it measures greater degrees of growth, and the 3 MSAs that display growth between 6.0 and 7.3% are the leaders.

These relatively low levels of growth reflect 2 central features of the HMO movement at this time: 1) the movement had enrolled small percentages of most urban populations up to that time, and, for reasons discussed in Section A, usually grew at only modest rates, and 2) the Kaiser system, which accounted for almost 60% of HMO enrollment in 1973 (Brown p. 401), was relatively stagnant during this period, partly because of uncertainty over the HMO Act.

More strikingly, the histogram also shows that 2 MSAs saw decline in HMS during this period; in one of these, market share went down by 14.8%, while the other registered a 2.6% decline. These 2 outliers reflect the instability of HMOs. In the MSA with the 2.6% decline a relatively small HMO went out of business between 1973 and 1978, leaving no HMO enrollment. In the MSA with the very large loss of market share, a large (for the time) HMO shrunk drastically, reorganized and changed its name; Glenn suggested eliminating this conspicuous outlier from the analysis.

I expect to use the following explanatory variables, listed in 4 categories, in the analysis. All these Vs are for the period 1973-1975 unless indicated otherwise. Those Vs marked with an asterisk * are the focus of this analysis' primary hypotheses:

**Medical Supply**
- BedsPC* - Hospital Beds per capita
- MDPC* - Active Non-Federal MDs per capita
- RNsPC - Registered Nurses per capita
- LPNsPC - Licensed Professional Nurses per capita
- PharmPC - Pharmacists per capita

**Other Medical System Measures**
- HDPC - Hospital Days per capita (see below)
- HXPC - Hospital Expenditures per capita (see below)
- BMktSh73* - Percentage of population enrolled in Blue Cross or Blue Shield Health Insurance Plans
- ErsCPD - Crude Measure of Hospital Costs per Day
- StGr75p - Statewide Percentage of MDs who practiced in groups in 1975
Issues have come up about a few of these variables. MSchYr80 is almost worthless because a value of "12" is recorded for almost every urban county in the U.S. (the documentation says that this variable is measured to tenths of years, but that's not the way the data is formatted). EmptoE79 is a very crude measure of employment concentration, calculated from some questionable assumptions, but I think its worth giving it a shot.

Several people have suggested using dummy variables for United States Region instead of Longitude and Latitude. I personally prefer the Longs and Lats because they reflect geographic reality more accurately, and, in the framework of regression assumptions, it is preferable to use continuous Vs instead of dummies whenever possible. I have "moved" Honolulu closer to the West Coast along the Longitude V so that it is less of an outlier. However, it is simple to use region dummies and see how their effect contrasts with that of the Longs and Lats.

The most critical issues concern the measurement of the related concepts of Supply, Utilization, and Expense. Four of the Vs measure these concepts: a) the number of hospital beds (BedsPC), b) the utilization of hospital bed-days (HDPC), c) expenses (and charges) per bed-day (ErsCPD) and d) hospital expenses per capita (HXPC). These variables are organically related, and will normally show a pattern of correlations.

In fact, the only case where 2 explanatory Vs show a correlation in excess of .9 is BedsPC and HDPC (r=.95). There was almost a perfect correspondence between the number of hospital beds in an MSA and the number of days these beds were occupied. This reflects very high hospital occupancy rates during this period. This result is a little disappointing because Hospital Beds and Bed-Days are distinct attributes and they could have different effects on HMO Market Share. The reality of that time does not permit analysis of this distinction, but the strong equivalence between Supply and Utilization simplifies the rest of the analysis.

Measuring costs is more problematic. The Area Resource File (ARF) offers a single figure for combined general and special hospital costs for each county for 1975; these have been aggregated to the MSA level. There are 2 principal ways of transforming this V so as to make it useful for cross-metropolitan comparisons. The 1st method is to compute costs per hospital bed-day, and the 2nd is to compute hospital costs per capita. Unfortunately, there are distinct problems with both derivative Vs.

The cost per hospital day V (ErsCPD) is theoretically preferable because it offers a measure of price. If accurately measured, this is an excellent index of overall health care costs. However, this V suffers from 2 technical problems. First, only expenditures for General and Special hospitals combined are available, but bed-days are only available for General hospitals. I attempted to remedy
this problem by using 1981 data, which distinguishes between general and other bed-days and likewise with expenses. But the 1981 data was of poor quality, so this remedy was not possible.\textsuperscript{14}

Secondly, the hospital expenditure figure includes outpatient as well as inpatient services. These problems mean that the dollar figure per bed-day is not meaningful, although the V could still be a reasonable index for comparing hospital expenditures per hypothetical unit of service across MSAs. Nonetheless, confidence that this variable reflects the desired facts must be lower than it is with most of the other V$s.

Interestingly ErsCPD showed a correlation of -.46 with HDPC (and a correlation of -.38 with BedsPC). Straightforward economic analysis would interpret this correlation as a reflection of movement along a demand curve, with areas with greater concentration of hospital beds forced to reduce charges in order to maintain high utilization rates. However, this result may be inconsistent with other studies that have found high utilization tends to coexist with high costs and charges.\textsuperscript{15}

Because the ErsCPD V is flawed to begin with, and because resolving these fundamental but poorly understood relationships is beyond the scope of this study, this controversial result makes ErsCPD less likely to be valuable in the analysis and interpretation of HMO Market Share.

The problems of ErsCPD do not apply to HXPC, hospital expenses per capita. In principal, including special hospital expenses and general hospital outpatient expenses is appropriate in measuring costs per capita. The problem with HXPC is a correlation of .67 with BedsPC (and a correlation of .65 with HDPC). This high correlation and the small size of the data set make it unlikely that the analysis will find distinct effects between the Supply and Expense measures.

My solution to these problems is pragmatic. The analysis will begin with the intention to test the hypothesis that supply of hospital beds (BedsPC) positively influenced the growth of HMOs in the mid 70s. However, I will also run regressions with the HXPC and ErsCPD variables. If particularly strong results appear, this will be suggestive for interpretation, evaluation and possibly subsequent research.

With the exception of the problems discussed above, the explanatory V$s are promising for regression analysis. Somewhat surprisingly, they all show considerable ranges and variances. For example, StU76 varied (in percents) from 6.6 to 37.1 with a mean of 25.3 and a standard deviation of 8.9. Histograms of these V$s show reasonable approximations of a normal distribution and few outrageous or inexplicable outliers. In general, these V$s show relatively low correlations with each other, reducing concern that the analysis will be marred by multi-collinearity. Out of 210 possible correlations between these 21 V$s, only 17 show absolute values in excess of .5.

2) Method

The explanatory V$s will be used to estimate the outcome (MSA change in HMO Market Share from 1973 to 1978) using Ordinary Least Squares linear regression. Because of the precautions I have taken, it is very unlikely that the change in HMO Market Share would have caused the observed values of any of the explanatory V$s, thus eliminating the problem of endogeneity. Of course, this does not necessarily mean that the causal relationship runs directly

\textsuperscript{14} Conceptually, IF special hospital beds and bed-days were very highly correlated in 1981 and IF special hospital expenses were a fixed function of their days in 1981 and IF these relationships could be assumed to apply to 1975, THEN I could estimate the general hospital expense component for 1975 by subtracting imputed special hospital expense values from the total expenditures. In fact, general hospital expenditures were missing from about half of the needed counties, making it impossible to compare general hospital expenditures for 1985 with those imputed for 1975. There were other inconsistencies in the 1981 data.

Although it would be possible to attempt further patches using data from still other years. I concluded that there would be inconsistencies and weaknesses in any estimate of cost per bed-day I could use.

\textsuperscript{15} Try to find ref.
from the measured explanatory V to the outcome, even if the results are statistically significant. As discussed elsewhere,\textsuperscript{16} 2 correlated variables could both be caused by an underlying phenomenon, or the explanatory variable may indeed have a causal effect on the outcome, but only through a chain of causal effects which make the relationship harder to understand and less likely to apply to other situations.

Taking an approach which is more associated with statisticians than with econometricians, I will be open minded in ascertaining the statistical relationships between the outcome and the explanatory Vs. While results of prior studies indicate that certain relationships are likely, much of this analysis unprecedented in the published literature. Furthermore, most of the explanatory variables are distinct from each other, both conceptually and statistically. Therefore a major goal is to establish the strongest patterns within the data and to build upon the strong findings in making further inferences.

Modern software such as Stata offers the opportunity to run many regressions and at least make a quick assessment of the results of each one. Not only does this enable the analyst to try many specifications in search of the most meaningful results, but it is a substantial aid to understanding as well. My strategy in running these regressions will be to regress the outcome on each of the explanatory Vs individually in order to survey the statistical relationships. Simply examining the correlation table serves a similar function, but running regressions offers additional useful information from the coefficients.

Following the simple regressions, I plan to run a large number of regressions using 2 of the explanatory Vs in order to see how the explanatory power adds or overlaps. Regressions with more explanatory Vs will follow. Unless preliminary results show a major surprise, the main focus will be on testing the primary hypotheses, which concern the BedsPC, HXPC, MDPC, BMktSh73 and Incom78i variables. Where indicated, I will estimate non-linear or cross-product explanatory Vs, but the limited number of observations restricts the scope for analysis of more complex relationships.

Although I will be looking for strong patterns in the data, it is not wise to construct final results simply on the basis of those equations that yield the highest r-squared values. The final goal is to construct one or more equations that offer a coherent and useful account of the causes of variance in the outcome.

Regression diagnostics, including the examination of residuals, the identification of influential points and the graphical display of data, constitute a critical follow-up to the regressions. Besides confirming or challenging the assumptions of randomness, normality and independence, regression diagnostics can provide insights as to the essence of the results, suggestions for alternate functional forms and reliable interpretations.

3) Expectations

Expectations and hypotheses were discussed in detail in the Draft Prospectus of March 1995; the BMktSh73 variable was addressed in the Memo to Committee of February 1, 1996. Most of what follows repeats material from those 2 memos. Several of the variables listed on page 5 have never been utilized in statistical analysis of HMO enrollment. These include EmptoE79, RNsPC, LPNsPC and PharmPC. Strangely, geographic position, whether expressed in Longs and Lats or in Region dichotomous Vs, was not previously used.

\textsuperscript{16} Markovich, M, Assignment 1, Tutorial on Causality, June 1995, unpublished, pp.3-4.
The regression analysis will test the effects of the following variables (in 3 categories) on HMO Market Share. The expected results are indicated:

### Primary Hypotheses

<table>
<thead>
<tr>
<th>Variable</th>
<th>Expected Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>BedsPC</td>
<td>Positive</td>
</tr>
<tr>
<td>MDPC</td>
<td>Positive</td>
</tr>
<tr>
<td>BMktSh73</td>
<td>Positive</td>
</tr>
<tr>
<td>Incom78i</td>
<td>Negative</td>
</tr>
</tbody>
</table>

### New Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Expected Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>HXPC</td>
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</tr>
<tr>
<td>EmptoE79</td>
<td>Positive</td>
</tr>
<tr>
<td>RNsPC</td>
<td>Positive</td>
</tr>
<tr>
<td>LPNsPC</td>
<td>No Effect</td>
</tr>
<tr>
<td>PharmPC</td>
<td>Positive</td>
</tr>
<tr>
<td>RelLong</td>
<td>Negative</td>
</tr>
<tr>
<td>RelLat</td>
<td>Positive</td>
</tr>
</tbody>
</table>

### Old Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Expected Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>AOldest (Control Variable)</td>
<td>Positive</td>
</tr>
<tr>
<td>ErSCP</td>
<td>Positive</td>
</tr>
<tr>
<td>StU76</td>
<td>No Effect</td>
</tr>
<tr>
<td>Mig7077p</td>
<td>Positive</td>
</tr>
<tr>
<td>StAMA71</td>
<td>No Effect</td>
</tr>
<tr>
<td>StGr75p</td>
<td>Positive</td>
</tr>
<tr>
<td>MDMAProp</td>
<td>No Effect</td>
</tr>
<tr>
<td>PopDens</td>
<td>Positive</td>
</tr>
<tr>
<td>MSchYr80</td>
<td>No Effect</td>
</tr>
</tbody>
</table>

Naturally, it is unlikely that all the hypotheses listed above will be affirmed. Chances are most of the explanatory Vs will not show statistically significant or materially important effects. The Vs which I think are most likely to show significant effects are BedsPC, MDPC, Incom78i, AOldest, RelLong and Mig7077p.

The Draft Prospectus also discussed 2 other classes of hypotheses. The 1st of these concerned the use of prior period Vs to estimate HMO Market Share (HMS); the concept was that the prior values would have predictive power, but not as much as the current period Vs would. Because of the problem of causality, superior predictive power of current values may be moot; if the higher t-statistics are due to the endogeneity of the later values, then such results would say nothing about the causes of HMS (although they would say something about the causes of the values of the explanatory variables).

However, if other evidence or reasoning indicated that the explanatory Vs were not endogenous, then greater predictive power of current values would have 2 important implications. First, the contrast would show that the causal effect manifested itself in a shorter time than the period of the lag (which is generally about 4 years), and, second, it would show that these Vs are useful for generating short term (less than 2 year) forecasts.

The 2nd class of hypotheses concerned the comparison of results for the 2 periods, the mid-1970s and the early 1990s. While HMO enrollment nationwide grew at similar rates during these 2 periods, it is unclear whether similar forces were responsible at both times. If the 2 sets of regressions showed similar results, then this would be powerful evidence that causes of HMO growth remained strong over several decades. There are some technical problems with comparing
these 2 sets of regression results; the principle problems concern comparable construction of the dependent $V_i$, inclusion of the same explanatory $V$s and measurement of the similarity/difference of the 2 sets of results. But these technical problems are surmountable if the data sets are sufficiently similar and if some additional analysis is performed.

However, this program has not been formally approved by the Committee. With my imminent move to Florida and changes in my working environment, I need direction as to priorities in completing this Project. I am still ready to complete the parallel analyses if the Committee approves this plan. But, naturally, the analysis so far has suggested other directions which could produce insights and other paths to completion and approval of the Thesis. I would like to discuss this at the April Committee meeting, and I will present the options in a fuller and more structured way at that time.

4) Supplementary Analyses

Of the nation's 75 largest MSAs, 29 had HMOs with enrollment in 1973. From 1973 to 1978, HMOs were formed in 19 additional MSAs, while 1 MSA saw its only HMO go out of business. Ignoring the MSA which lost its only HMO, the MSAs can be logically divided into 3 classes: a) those that had HMOs in 1973 and kept at least some HMO enrollment, b) those that saw their 1st HMO formed between 1973 and 1978, and c) those that didn't have any functioning HMOs in 1973 or 1978.

Logically, any of 3 logit analyses can be conducted to distinguish the 3 groups of MSAs: a vs b&c, b vs c and c vs a&b. If MSAs qualified for the categories by a known deterministic process, than any 2 of these analyses would logically imply the results of the 3rd (i.e. if we know what caused MSAs to have HMOs by 1973 and what caused HMOs to form between 1973 and 1978 in those MSAs that didn't have them, then we should be able to imply what distinguished MSAs with no HMOs in 1978 from those that had HMOs). However, since all 3 analyses are subject to stochastic uncertainty, then it is possible they would produce results that are inconsistent or even conflicting.

But the regression analysis of HMO Market Share and the logit analysis of HMO existence may show very different results for substantive reasons. The factors that lead to the establishment of a first HMO with a small number of enrollees may be quite different than the factors that promote rapid growth by 1 or more HMOs in an MSA. For example, a prior study has found that per capita Income is positively associated with HMO presence, but negatively associated with HMO Market Share conditional on presence.17

However, should the logit analysis show results similar to that of the multiple regression analysis, then tobit analysis becomes an option. Tobit analysis would permit combination of data for MSAs with and without HMOs in 1978 and would offer greater statistical power.

17 "An Empirical Analysis of HMO Market Share" by Morrisey and Ashby, Inquiry, Summer 1982, Table 2, p.143.
This memo is comparable with the “Final Memo to Committee Before 1970s Regression Runs” of April 4, 1996. The 1st purpose is to provide some description of HMO growth during the 2nd analysis period, 1988-1993. This description will be helpful in explaining differential HMO growth across MSAs during this period and in forming hypotheses for the multiple regression analysis.

Secondly, this memo will delineate the specifications and hypotheses for the analysis. Data and specifications are very similar to those of the analysis of the 1st period, 1973-1978. Thus, only the distinctions and differences from the prior analysis will be emphasized. However, expectations, or hypotheses, are different from both the prior set of hypotheses and the prior set of results. Hence, expected regression results will be explained in detail.

A) Descriptive Analysis of HMO Growth From 1988-1993

Probably the most important factor influencing patterns of HMO growth during this period was the industry shakeout of the late 1980s. The explosive growth of the mid 1980s\textsuperscript{18} was succeeded by an industry crisis from 1987-90. Many individual plans and a few national HMOs started losing money in the late 1980s. The most spectacular failure was Maxicare, which dropped from 2.2 million enrollees in 1986 to less than 300,000 in 1993.

During the shakeout period, some HMOs continued to prosper and keep growing. Overall national HMO enrollment continued to grow, but at a rate of less than 4% in both 1989 and 1990. The number of HMO plans declined, dropping from 662 in 1987 to 556 in 1990.

The main cause of the shakeout was that HMOs had proliferated and grew too quickly in the 1980s. As both enrollment and premiums rapidly increased, many HMOs became large corporations with tens or even hundreds of millions of dollars in annual revenues. But many of these organizations didn’t have the structure, procedures or management skills to handle these responsibilities.

Lack of proper management made it difficult for some HMOs to control costs, which were rising rapidly during this period. Inept marketing may have caused some to suffer from adverse selection, which made other cost control mechanisms futile.

76 HMOs went out of operation completely from 1988 to the middle of 1990. Of these, 55, or 72%, were located in the South and Midwest. On the other hand, only 6 of the bankrupt plans were

\textsuperscript{18} National HMO enrollment increased by over 20% during all 4 of the years from 1984 to 1987, and the increase in the number of plans was even faster.
located in the Northeast. The trends in shutdowns and enrollment suggest the Northeast was ready to adopt the evolving HMO concept which had originated in the West.

It is not entirely clear what attributes made the Northeast receptive to HMO growth during this period while the South and Midwest were less so. Possible explanations include the higher population densities in the Northeast, higher levels of medical costs there and the long-standing presence of a few HMOs in that region.

The worst effects of the HMO shakeout were felt by 1990. But most HMOs did not attempt to repeat the heady growth of the mid 1980s. By one measure, national annual enrollment growth remained under 7% through 1993. The total number of plans in the US did not start growing again until 1995.

The compound growth in enrollment of all HMOs combined with the reduced number of plans meant that by 1995 the average HMO had more than twice the enrollment of the average plan in 1987. Possible reasons include economies of scale, enhanced market power and greater financial stability of larger plans.

B. Specifications and Expectations

i. Outcome Variable
The Outcome variable (V) will be the change in the percentage of the population enrolled in HMOs from 1988 to 1993 for each MSA. This can also be referred to as the change in Market Share. For the 1973-1978 period, this V was non-zero for only 47 of the country’s 75 largest MSAs. By 1993, HMOs had at least some enrollment in each of these MSAs, enabling me to conduct the analysis with more degrees of freedom (DoF).

There was considerable difficulty estimating HMO market share by MSA for 1993. This was primarily because many HMOs had significant enrollment in more than 1 MSA. Some Interstudy data assigning enrollment between MSAs (and in some cases to rural areas) was available, but it was fragmentary and inconsistent.

The estimates included in this data set were generated after careful scrutiny of available InterStudy data. In other cases, interpolating assumptions and specific knowledge of HMOs and MSAs was used to generate enrollment values, as had sometimes been necessary for the years 1973, 1978 and 1988.

Between the 2 periods, the substance of the outcome V changed in 3 notable ways. First, staff and group HMOs suffered a large decline in relative importance, as virtually all HMO growth occurred within IPA plans.19 Most HMOs strove to give their subscribers an ever greater choice of physicians. Correspondingly, a decreasing percentage of HMO physicians took all their patients from 1 HMO.

19 InterStudy placed HMOs within 5 classifications, Staff, IPA, Group, Network and Mixed. HMOs classified as “Mixed” were essentially IPA HMOs which contracted with, but did not rely exclusively upon, large groups. By 1993, over 60% of HMO enrollment was in IPA or Mixed HMOs.
The 2nd change was the growth of Medicare and Medicaid HMOs. By 1993 Medicare HMOs enrolled 2.18 million people, and Medicaid HMOs had 1.92 million subscribers. These 2 purchasers were responsible for almost 10% of HMO enrollees.

The 3rd change was the emergence of point of service plans (POS) as a major type of HMO. POS enrollment accelerated from 1991 to 1993, and by July 1993, 2.3 million persons were enrolled in POS. Enrollment would climb to almost 6.3 million in 1996.

This entire analysis rests on the assumption that the HMO concept provides the crucial connecting thread between a wide diversity of HMOs across 2 decades. If one does not accept that assumption, then the results lose much of their meaning.

A histogram showing the frequency distribution of the Outcome V is attached as Figure 1. As shown, there are 2 mild outliers where HMO market share declined by over 15% of total population, and another 15 MSAs that saw smaller declines. 44 of the 75 cities saw growth of between 0% and 9%, and 12 MSAs saw growth of between 9% and 15%. In 2 cities, market share increased by more than 15% of total population.

For the 1970s analysis, one conspicuous outlier which saw a dramatic decline in HMO Market Share was eliminated from the analysis. This was justified on 2 grounds. 1st, this outlier would have had a dominant effect on all regression results under the specification chosen. But more importantly, there was reason to suspect that the high level of HMO enrollment reported for 1973 was spurious. If anything, the subsequent decline in “HMO” enrollment showed that resistance to the HMO concept was weakening in that MSA.20

I undertook a preliminary examination of the numbers and conditions of the 2 MSAs reporting the greatest decline during the 1988-93 period. Difficulties in accurately estimating enrollments make the extent of the declines somewhat uncertain. However, it is clear that both MSAs saw substantial declines in enrollment and that these declines were caused by the nationwide HMO shakeout.21 Therefore, unless my current information on either of these 2 MSAs is substantially inaccurate, it is unlikely that dropping one or both from the analysis would be justified.22

The change in HMO growth at the MSA level between the 1973-1978 period and the 1988-1993 period is shown analytically in Table 1 below. Mean HMO growth in the 2nd period is almost double that of the 1st period. But both the standard deviation (S.D.) and the range (Max-Min) more than tripled between the 2 periods. This shows that, even when the higher overall level is accounted for, variability of HMO growth is greater in the 2nd data set.23

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20 According to most observers, the large HMO operating in Stockton in 1973 was not really an HMO but a physician sponsored front intended to pre-empt the entrance of Kaiser into that insular but rapidly growing community.
21 The 2 MSAs are Indianapolis and Raleigh-Durham. In both cities, the Maxicare plan and 1 other large HMO lost most of their enrollment.
22 However, it would be instructive to run the analysis without these 2 MSAs and conduct diagnostic analysis of influential points on the regression results with them included.
23 If the outlier with large HMO Market Share loss were included, the relative variability for the 1st period would be comparable to that of the 2nd period.
TABLE 1
DESCRIPTIVE STATISTICS
FOR HMO MARKET SHARE
FOR THE 2 TIME PERIODS

<table>
<thead>
<tr>
<th>Period</th>
<th>Obs</th>
<th>Mean</th>
<th>S.D.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>1973-78</td>
<td>46</td>
<td>1.99</td>
<td>2.12</td>
<td>-2.60</td>
<td>7.26</td>
</tr>
<tr>
<td>1988-93</td>
<td>75</td>
<td>3.78</td>
<td>6.59</td>
<td>-17.94</td>
<td>18.40</td>
</tr>
</tbody>
</table>

ii. Explanatory Variables
The explanatory Vs used in the 1990s analysis are very similar to those used for the 1970s. It was not always possible to replicate the exact same variable, but most of the 1970s Vs have a very close analog in this data set. Table 2 lists 25 potential explanatory Vs. Of these, 22 were tested in the 1970s analysis, and 23 will be tested in the 1990s analysis. MSA values for 2 of the 1970s Vs, Blue Cross/Blue Shield Market Share and A.M.A. Membership, were not available for the later period.

3 Vs that were not used in the 1970s analysis are being added to the roster of possible explanatory Vs for 1988-93. These are Population Growth from 1970 to 1993, Economic Growth from 1978 to 1993 and the proportion of MDs who were family practitioners (FPs) or general practitioners (GPs) during the 1989/90 period. These will be discussed in the expectations sub-section.

Table 2 shows that many of the explanatory Vs were measured in a straightforward and accurate manner for both of these periods. For a number of other Vs, minor technical problems arose, but the variable is still usable. For example, the 1st analysis used net migration from 1970 to 1977 as an explanatory variable, but the corresponding variable for the 2nd period is net migration for only 1 year, 1991. 2 Vs, hospital costs per day and average schooling are more accurate than they were for the earlier period.

One major difference between the 1st and 2nd datasets lies in the degree of correlation among supply related variables such as Hospital Beds per capita and LPNs per capita. Among 21 explanatory variables for the 1970s, only 17 out of 210 possible correlations showed absolute values in excess of .5. Among the 22 explanatory variables for the late 80s/early 90s, 29 out of 231 possible correlations show absolute values in excess of .5.

Most of the high (|r| >.5) correlations for the later period are between supply related Vs such as Hospital Beds per capita and Licensed Practical Nurses per capita. The greater degree of correlation among these variables in the later period may be due to the imposition of increased market rationalization and discipline in the supply of health care resources.

24 Actually, the 20th variable listed in the table, Regional Dummies, is a set of 8 closely related geographic Dummy variables.
25 For the 1970s Hospital Costs per day V, only combined General and Special Hospital Costs were available for the numerator, while only General Hospital Days were available for the Denominator, producing a serious inconsistency. For the early 1990s, both costs and days are only for general hospitals.
Some of the other high correlations found within the 1990s data set are to be expected, such as the correlation of .75 between Population Mobility and Population Growth or the correlation of -.59 between MDs per capita and the proportion of Middle Aged (i.e. from 45 to 64) Mds. The other high correlations include a value of -.60 between the proportion of RNs and Population Growth.

The increased number of high correlations within this data set means that there is a greater danger of multi-collinearity influencing regression results. When collinearity or multi-collinearity is present among explanatory variables in a regression equation, estimated coefficients will tend to have large variances and small t statistics.

The simplest solution to multi-collinearity is to avoid having highly correlated explanatory Vs in a regression. Since most of my explanatory Vs are not highly correlated, and since I am trying to construct a relatively modest regression model with only 3 or 4 explanatory Vs, this problem is avoidable.

iii. Method

The method will be identical with that used for the 1973-78 period. The primary tool will be ordinary least squares multiple regression. It will be used to develop the statistical model which is most consistent with the data and contributes most to our understanding of the causes of HMO enrollment growth.

Numerous regression specifications using different combinations of Vs will be tested in search of the most structural model. For the 1 or 2 statistical models which show the most promising results, regression diagnostics will be applied to test the validity of statistical assumptions and to ascertain if any individual observations have a disproportionate influence on the model results.

One small addition to this regression program will be the inclusion of the model that was chosen from the analysis of the prior period. I found that HMO Market Share Growth was a function of 4 Vs, % of MDs in Group Practice, MDs per capita, RNs per capita and Employees per Establishment. Comparing the results of identical models for different periods will provide a crude index of the extent of change between the 2 periods.26

iv. Expectations

For the 70s analysis I developed 4 primary hypotheses, each referring to a specific explanatory variable. As it turned out, none of the 4 primary hypotheses were supported by the regression analysis. However, the development and statement of primary hypotheses helped to sharpen the analysis and improve understanding of the analytic results. This time the primary hypotheses all reflect my core belief that general economic and demographic Vs were more influential in the 1988-93 period than they were in the 1973-78 period.

Table 3 shows the same 25 explanatory Vs included in Table 2. For each V, the table shows the 1970s hypothesis, the 1970s result, and my hypothesis for the early 1990s analysis. Expectations are listed for 21 of these Vs, 9 of which are expected to show statistically significant effects. These 9 are discussed in this sub-section.

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26 I plan to calculate several statistical measures to estimate the extent of change in structural relationships and to test its statistical significance.
Hospital Costs per day, Age of Oldest HMO, Employees per Establishment, Population Density, Average Schooling and Proportion of Family Practitioners are expected to have a positive causal relationship with HMO enrollment growth. Net Migration, Population Growth and Economic Growth are expected to have a negative effect. However, Net Migration and Population Growth have a correlation of .75, making it unlikely that both Vs will show effects independent of each other.

I consider the expectations concerning, Economic Growth, Net Migration/Population Growth, Employees per Establishment and Population Density to be the most important hypotheses for the 1988-1993 period.

My expectation of negative effects from economic and demographic growth may be surprising at first, but these expectations are rooted in the descriptive analysis of HMO growth and dispersion during this period. The hypothesis is that the HMO boom of the mid 1980s saw aggressive growth in the most rapidly growing and changing metropolitan areas of that period and some of this growth was wiped out by the subsequent industry shakeout.27

The expectation of a positive effect of establishment size is based on similar reasoning. I believe that HMOs had aggressively marketed to smaller firms during the mid 1980s and that enrollment of small firm employees accounted for much of the growth of that period. However, marketing to small firms generates high administrative costs and considerable risk of adverse selection.28

Under this hypothesis, HMOs with contracts with large numbers of small firms went out of business or at least had to drop many of their small employer contracts. If this trend was pervasive enough, MSAs with smaller firms and establishments would have been less likely to see substantial enrollment growth during the 1988-93 period.

For the mid 1970s period, I had also hypothesized a positive causal effect of establishment size, but regression results consistently showed a small negative effect which didn’t quite attain statistical significance.29 Despite this, I’m hypothesizing a negative effect for the 2nd period, albeit for somewhat different reasons.

The expectation of a positive effect from Population Density reflects other changes in the nature of HMOs between 1978 and 1988. As they shifted from closed panels to more IPA type arrangements, HMOs were confronted with market pressures to provide consumers with the greatest possible choice of physicians and other providers. Assembling and supervising large provider networks was one of the critical challenges they faced during the 1980s and early 1990s, and the geographical dispersion of most American cities made the job harder.

27 A contrasting hypothesis would be that, in the mid 1980s, HMOs grew most rapidly in the MSAs where they had previously had little or no presence. The bust tended to revert relative levels of HMO enrollment to those of the early 1980s. This hypothesis could be operationalized by making, say, 1983 market share an explanatory V for 1988-93 growth with an expected positive relationship (i.e. those MSAs with low HMO market share in 1983 would be expected to have less market share growth for the 1988-93 period).
28 See Health Economics by Phelps, pp. 296-298.
29 A positive effect was hypothesized in the belief that large paternalistic employers played a leading role in the growth of HMOs. However, the negative effect that was found suggests that, during the mid 70s, HMOs were more successful at marketing to the large diverse body of small employers than at securing contracts with large employers.
My hypothesis is that it was easier to develop and maintain large provider networks in denser MSAs. The reduced geographic dispersion in these cities may have facilitated meetings and other contacts between HMOs and providers. This hypothesis was suggested by the accelerated growth of HMOs in the Northeast while growth was slowing in the Midwest and South.

Complementary to the shift to larger networks was the increased use of primary care providers (PCPs). In some cases, HMOs encouraged their enrollees to designate a PCP on the grounds that the PCP could provide more continuous and coordinated care than a loosely connected set of specialized physicians. However, HMOs also required enrollees to have a referral from their PCP in order to see any other provider - i.e. the PCP was a gatekeeper.

Some HMOs liked to recruit Family Practitioners (FPs) or General Practitioners (GPs) to serve as PCPs. FP/GPs were oriented toward handling a wide variety of medical problems. Additionally, utilization and reimbursement of FP/GPs relative to specialists went down in the 1970s and 1980s, so they were available to contract with HMOs and provide care to large numbers of patients for economical rates. Therefore, the hypothesis is that those MSAs with higher concentrations of FPs and GPs were more likely to increase their HMO market share.30

Hospital Costs per day and Age of Oldest HMO were hypothesized to have a positive effect in the 1970s, but they didn’t show any effect. For hospital costs however, there are 2 reasons to believe we will see an effect in the later period. First, both the overall cost level, adjusted for inflation, and the rate of price increase were higher in 1988-93 than they were in 1973-78. The cost driven component of HMO enrollment growth may be stronger for the later period.

Secondly, hospitalizations were a more significant cost factor for the Medicare population than for the commercially insured population. Since Medicare HMOs were paid 95% of the average fee for service Medicare expenses in their geographic sub-region, it is likely that blossoming Medicare HMOs in high hospital cost areas had additional resources with which to attract patients in these areas.

Likewise, Age of Oldest HMO did not show any effect in the mid 1970s. But state Medicaid administrators may have been influenced by knowledge of and familiarity with the HMO concept. Therefore, the Age of Oldest HMO in an MSA, or in a state, may have had a positive effect on Medicaid HMO enrollment, and, through that, on overall HMO market share in that MSA.

Finally, I hypothesize that Average Schooling had a positive effect on HMO enrollment during this period. This is because more educated consumers were likely to be attracted to Point of Service (POS) plans, which gave patients the option of going to out of network providers in return for a higher co-payment.31

30 Subsequently, FPs did not dominate the gatekeeper role. Children generally were referred to Pediatricians for primary care, many women preferred to use their Ob/Gyns in this role, and Internists signed up to be gatekeepers for many people with chronic medical problems. Some HMOs allowed patients to list any network physician who was willing to play that role as their PCP.

31 Admittedly, if a particular explanatory variable only influenced one particular type of HMO, than that hypothesized effect would be better tested using enrollments in only that type of HMO. But its still worthwhile to test these hypotheses using overall HMO enrollments.
In sum, there are 9 hypothesized relationships that I expect to show causal effects in this analysis. However, the limitation imposed by only 75 observations makes it unlikely that all 9 variables will show a substantial effect in one regression equation.

5 of the hypotheses are intimately related to my belief that growth within MSAs during this period was more influenced by general demographic and economic conditions than by the characteristics of the health care industry. The other 4 hypotheses relate more specifically to certain aspects of HMO growth during 1988-93.

Conclusions

This project was initially motivated by a simple observation. The large differences in the growth and levels of HMO enrollment in different cities provide a remarkable opportunity to understand the HMO industry and to consider alternative public policies toward HMOs.

The analysis of the 1973-78 period confirmed the judgement of many experienced health care managers and analysts, namely that the availability of providers and the receptivity of physicians specifically were critical elements in HMO growth during this early period. The forthcoming analysis of the 1988-93 period will show whether these elements continued to be important, or if broader demographic and economic factors played a stronger role as the HMO phenomenon continued to evolve.

HMOs were considered a very desirable form of health insurance across the policy analysis community when this project began. Ironically, they are now considered to be inimical to quality health care by many elected officials, and great pressure is being brought to render HMOs liable in Civil Court for real and alleged misdeeds.

The forthcoming analysis will test the 9 hypotheses described above and test for causal effects of the other Vs. Because of the strong results for the 1973-78 period, the results of the 1988-93 analysis are sure to be interesting and meaningful. The policy implications of both sets of results will be examined in the final report.

Selected References
InterStudy Competitive Edge Vol. 3, #2, 1994.
APPENDIX G
SUMMARY TABLE OF 3 PREDECESSOR ARTICLES

This appendix relates to material in Chapters 2 and 5. It presents a table summarizing 3 of the published articles on the growth of HMOs (Goldberg and Greenberg 1981, Morrissey and Ashby 1982 and Welch 1984). All 3 of these articles used data from the 1970s, making their results roughly comparable with the results of the first set of analyses performed for this study. Their results are summarized and discussed in Chapter 2, Section E, Causes of Enrollment Growth. This table provides additional detail. The results of this study are compared with the results of these previous studies in Chapter 5, sub-section B2, Comparison With Prior Studies.

Table G-1
Summary and Comparison of 3 Prior Studies
On HMO Enrollment Growth
All Numerical Values are t-Statistics
Please See Bibliography for Full References

<table>
<thead>
<tr>
<th>Source of Statistics</th>
<th>Goldberg and Greenberg</th>
<th>Morrissey and Ashby</th>
<th>Welch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable Name</td>
<td>Equation 6</td>
<td>Equation V</td>
<td>OLS Eqn 2</td>
</tr>
<tr>
<td>Per Capita Income</td>
<td>None</td>
<td>-1.65</td>
<td>-1.65</td>
</tr>
<tr>
<td>Extent of Unionization</td>
<td>1.83</td>
<td>1.06</td>
<td>None</td>
</tr>
<tr>
<td>Hospital Costs</td>
<td>1.98</td>
<td>None</td>
<td>3.05</td>
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<tr>
<td>Extent of Physician Group Practice</td>
<td>1.8</td>
<td>0.72</td>
<td>None</td>
</tr>
<tr>
<td>Population Mobility</td>
<td>1.94</td>
<td>1.88</td>
<td>-0.91</td>
</tr>
<tr>
<td>State Regulation: Reserves Requirements</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>State Regulation: MD Employment</td>
<td>0.46</td>
<td>None</td>
<td>-2.55</td>
</tr>
<tr>
<td>State Regulation: Certificate of Need (CON)</td>
<td>0.16</td>
<td>None</td>
<td>2.25</td>
</tr>
<tr>
<td>Lagged Values of HMO Enrollment</td>
<td>None</td>
<td>6.36</td>
<td>23.7</td>
</tr>
</tbody>
</table>

Note: Sign for Goldberg and Greenberg’s t-stat for Population Mobility is reversed from the published statistic because the article uses a measure of Population Immobility.
Supplemental analyses were conducted to assess the effects of certain decisions concerning the composition of the 1970s data set. The rationale for these analyses is presented in Chapter 3, sub-section B3 and the results are discussed in Chapter 4, sub-section B3. This appendix presents the numerical results of these 3 supplemental analyses.

Supplemental Analysis 1
Rerun 1970s Final Model on Data Set with 27 Cities (all of which had positive HMO enrollment in 1973)

```
. reg StrDif StGr75p MDPC RNsPC RelLat
```

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>115.909316</td>
<td>4</td>
<td>28.977329</td>
</tr>
<tr>
<td>Residual</td>
<td>42.6413422</td>
<td>22</td>
<td>1.93824283</td>
</tr>
<tr>
<td>Total</td>
<td>158.550658</td>
<td>26</td>
<td>6.09810224</td>
</tr>
</tbody>
</table>

Number of obs = 27
F( 4, 22) = 14.95
Prob > F = 0.0000
R-squared = 0.7311
Adj R-squared = 0.6822
Root MSE = 1.3922

| StrDif | Coef.       | Std. Err. | t      | P>|t| |
|--------|-------------|-----------|--------|-----|
| StGr75p | .1585988     | .0320431   | 4.950  | 0.000 |
| MDPC    | 15.4673      | 11.34786   | 1.363  | 0.187 |
| RNsPC   | 15.60708     | 4.770113   | 3.272  | 0.003 |
| RelLat  | -.0000164    | 5.89e-06   | -2.790 | 0.011 |
| _cons   | -9.985598    | 1.923712   | -5.191 | 0.000 |

[95% Conf. Interval]
| StGr75p | .0921455    | .2250522 |
| MDPC    | -8.066719   | 39.00132 |
| RNsPC   | 5.714467    | 25.49968 |
| RelLat  | -.0000286   | 4.22e-06  |
| _cons   | -13.97513   | -5.996064 |
Supplemental Analysis 2
Rerun 1970s Final Model on Data Set with 74 Cities (the entire frame except for Stockton)

```
.reg StrDif StGr75p MDPC RNsPC RelLat

Source       | SS            | df            | MS            | Number of obs = 74
-------------+----------------+---------------+---------------+------------------
Model        | 102.586661     | 4             | 25.6466653    | F( 4, 22) = 10.52
Residual     | 168.23103      | 69            | 2.43813087    | Prob > F = 0.0000
-------------+----------------+---------------+---------------+------------------
Total        | 270.817691     | 73            | 3.70983138    | R-squared = 0.3788

| Coef.  | Std. Err. | t     | P>|t| | [95% Conf. Interval] |
|--------|-----------|-------|------|-----------------------|
| StrDif | .1399291  | .0252945 | 5.532 | 0.000 | .089468 - .1903902 |
| StGr75p| 7.495598  | 4.429943  | 1.692 | 0.095 | -1.341896 - 16.33309 |
| MDPC   | 6.504662  | 2.365279  | 2.750 | 0.008 | 1.78606 - 11.22326  |
| RNsPC  | -3.76e-06 | 4.22e-06  | -0.891 | 0.376 | -0.000122 - 4.65e-06 |
| RelLat | -5.772938 | 1.191559  | -4.845 | 0.000 | -8.150032 - 3.395844 |

Supplemental Analysis 3
Logistic Regression Analysis of Operational HMO Establishment from 1973 to 1978

```
.logistic Exist78 StGr75p MDPC RNsPC RelLat

Logit Estimates

```

Number of obs = 47
chi2(4) = 5.38
Prob > chi2 = 0.2505
Log Likelihood = -29.020726
Pseudo R2 = 0.0848

| Coef.  | Std. Err. | z    | P>|z| | [95% Conf. Interval] |
|--------|-----------|------|------|-----------------------|
| Exist78| .8623092  | .0753807 | -1.695 | 0.090 | .7265295 - 1.023464 |
| StGr75p| 62.01632  | 486.5531 | 0.526 | 0.599 | .000013 - 2.96e+08  |
| MDPC   | .0672013  | .3143981 | -0.577 | 0.564 | 7.00e-06 - 645.1861 |
| RNsPC  | 1.000007  | 7.99e-06 | 0.901 | 0.367 | .9999915 - 1.000023 |

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ABBREVIATIONS

Journals and Other Frequently Cited Sources
AER - American Economic Review
AHL – American Health Line
AJPH – American Journal of Public Health
HA - Health Affairs
HCFR - Health Care Financing Review
HSR - Health Services Research
JAMA – Journal of the American Medical Association
JEL - Journal of Economic Literature
JEP - Journal of Economic Perspectives
JHE - Journal of Health Economics
JPE - Journal of Political Economy
MCRR - Medical Care Research and Review
MMFQ - Milbank Memorial Fund Quarterly
NEJM - New England Journal of Medicine
NYT - New York Times
QJE - Quarterly Journal of Economics
RWJ – Robert Wood Johnson Foundation
WSJ - Wall Street Journal

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