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ABSTRACT

In Miami, average inpatient Medicare spending on people in their last six months of life was about double Medicare spending in Minneapolis; average ICU days were nearly *four* times higher. What are the implications of such differences for the efficiency of health care? In this paper, we used Medicare claims data to document the extent of these variations across 306 hospital referral regions in the U.S. We did not find strong evidence that the spending differences were due to underlying variation in health levels across regions. Nor did we find evidence of any benefits from higher spending levels; regional survival rates following acute conditions like AMI (heart attacks), stroke, and gastrointestinal bleeding were not correlated with more intensive health care spending. Finally, a number of recent studies suggest that people prefer less, rather than more intensive treatment. In sum, our results suggest that (i) regions providing more intensive care are not gaining net health benefits over regions providing less care, and (ii) allocative inefficiency may be present, in that patients are not necessarily matched with the treatment they prefer.

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I. Introduction

Thinking about efficiency in health care is straightforward in theory, but quite difficult in practice. Health economists have struggled for years to measure efficiency in hospital and health care more generally. One branch of the literature has concentrated on an objective measure of cost, typically the cost of a hospital bed or a hospital bed-day. Thus the question is, to what extent is a hospital bed-day produced at minimum cost?[1] A large branch of the literature has addressed a more general question; what is the least-cost method of improving some dimension of health by a given amount?[2] For patients who are serious ill with (say) congestive heart failure, there exists an optimum intensity of care, a "best practice" or productively efficient combination of testing, pharmacological treatment, nurse staffing rates, hospital days, and follow-up care that can best restore a given level of cardiac functioning at lowest cost. We follow McEachern (1994) in defining this measure of cost-minimization to be *productive efficiency.*

In practice, we observe widely divergent patterns of care for patients and for populations. For example, the underlying rate of surgery for men with enlarged prostates, a benign (non-cancerous) condition that interferes with urination, varies more than four-fold among geographic regions in the United States. Revasucularization procedures (bypass surgery and angioplasty) vary more than three-fold (Wennberg and Cooper, 1997). The intensity of care delivered to the seriously ill, measured as the amount of care delivered during the last six months of life, varies five-fold. For example, in some regions about 48% of such patients are admitted to an ICU while in others, fewer than 9% are

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[1] See Gaynor and Anderson (1994), Friedman and Pauly (1981), Breyer (1987); also see Chapter 7 in Rosko and Broyles (1988); the more recent literature on hospital costs is concerned with stochastic demand for hospital beds.

[2] For an excellent introduction to the enormous literature on cost effectiveness analysis, see Gold, Russel, Siegel, and Weinstein (1996).

admitted (Wennberg and Cooper, 1997). These patterns raise a question about allocative efficiency -- even if surgical procedures for enlarged prostates or heart disease are productively efficient, in the sense of minimizing average costs, perhaps these procedures are being allocated across regions -- and people -- in a decidedly inefficient way.[3]

In this paper, we consider these issues of productive and allocative efficiency in health care. It is important to note, however, that the mere existence of geographical variations does not imply the existence of either productive or allocative inefficiency. One interpretation of variations across areas (Theory 1) is they are simply the consequences of underlying differences in illness rates or in patient preferences for treatment. In this view, variations in surgical treatment for enlarged prostates are the consequence in part of mismeasurement; health care researchers are simply misled by geographic variations because they are unable to control for confounding factors. And what variation remains reflects geographical differences in preferences.

The second interpretation (Theory 2) is that different hospitals and health care systems have very different protocols and standards for conducting surgery and treating illness. In some regions, many more men with enlarged prostates will end up having surgery or many more serious ill patients will be treated in the ICU than their counterparts -- with equivalent preferences and health status -- living elsewhere. In this view, "location is destiny" or in the language of econometrics, location is an instrument.

Theory 1 and 2 have very different implications. In Theory 1, the health care system is productively and allocatively efficient, at least in the sense that all American citizens are receiving treatment consistent with their preferences, and

[3] Again, we follow the McEachern (1994) terminology; allocative efficiency is "The condition that exists when firms produce the output that is most preferred by consumers..." (page 550).

according to a well-established body of scientific evidence and knowledge. Not every hospital will be hugging the productively efficient production "envelope," of course, because of economies of scale and volume in the treatment of common diseases (e.g., McClellan and Staiger, 1997). But the important policy issues are not whether the intensity of services in a community such as Miami is much different from those in Minneapolis, but instead whether these regions (together with other regions in the US) lead to marginal benefits which exceed marginal costs at the national level. Not surprisingly, then, an important policy debate under Theory 1 is whether rationing health care on a national level is the appropriate policy to contain potential overproduction in medical technology and services.[4]

According to Theory 2, it is difficult to address national priorities in health care spending if in fact different communities are following such widely different treatment patterns. Instead, the immediate question is, which community's rate is right? Theory 2 thus points to exploiting empirically the natural experiments afforded by the geographic variation phenomenon by measuring the correlation between inputs of resources and outputs of health. As we discuss below, the implications of Theory 2 are not simply about allocative efficiency (which rate is right?) but productive efficiency broadly defined (are some rates always wrong?)

In this paper, we begin by considering Medicare expenditures and physician visits in the last six months of life for two communities, Miami and Minneapolis. People who are in their last six months of life are generally quite sick (particularly toward the end of this period), regardless of where they live. Thus we believe that how such patients are treated provides a good indicator of the local pattern of practice with respect to the chronically ill. And we find substantial differences in how people in their last six months of life are treated in the two cities. In

[4] For a discussion of global budget caps, see Aaron (1992). A uniform percentage decrease in health care costs will have a much different impact than setting a fixed per capita level of spending across regions.

Minneapolis, the average number of days spent during the last six months of life in an intensive care unit (ICU) is 1.3, in Miami 4.8 days. On average, Medicare patients in their final 6 months in Miami can expect 76% more primary care physician visits, and *440%* more specialist visits, than Medicare patients in Minneapolis.

How to interpret such differences? It may be the case that in Miami, the higher levels of spending in the last six months of life yields improvements in life expectancy. We address this question by using a prospective sample for the entire U.S., either for the elderly Medicare population, or a more select group of people admitted to the hospital with diseases which result in a near certain chance of hospitalization: heart attacks, strokes, GI bleeding, hip fractures, and lung and colon cancer. Thus the question we address is, do regions in the U.S. exhibiting more aggressive treatment patterns in the last six months of life (what we argue is a "marker" for treatment intensity for chronic illness) also experience more favorable survival outcomes? Briefly, we find no evidence of any improved outcome (as measured by survival) associated with increased levels of spending. These results suggest that the increased spending in Miami does not translate to improved life expectancy. In other words, hospitals may be at the minimum point of their long-run average total cost curve in producing hospital beds-days, but stray far from the productively and allocatively efficient level in producing health.

While mortality may be the appropriate outcome variable to assess (say) the effectiveness of intensive care units, there is usually more to efficiency than simply life expectancy. Individuals seek to maximize utility, and there are some costly procedures offering improved health functioning at the cost of increased mortality risk. Other costly procedures may have no impact on survival rates, but do affect different aspects of health status. For example, surgical treatment of enlarged prostates improve urinary flow, but can affect adversely sexual functioning. Thus it *could* be the case that people in Miami prefer the more intensive health care services because of a possible payoff in improved health status. We examine the importance of heterogeneity in preferences in light of the results from recent experiments in informed patient decisionmaking for patients with enlarged prostates (BPH) and angina due to coronary artery disease. And while these studies are not specific to Miami, they do suggest that while some preferred the more intensive treatment options, on average patients preferred rates of surgery lower than the level prescribed by most physicians. Thus the allocative costs of increased levels of surgical intervention could be even larger than those considered in standard cost-benefit tradeoff comparisons.

II. A Look at Miami and Minneapolis

The hospital referral regions for Miami and Minneapolis include a larger area than just the cities themselves. They were determined as part of an effort by the *Dartmouth Atlas of Health Care* (Wennberg and Cooper, 1997) to map the entire U.S. into 306 regions, each of which has one or more hospitals offering cardiovascular or neurosurgical services. Thus the Minneapolis hospital referral region (HRR) is comprised of zip codes whose residents tend to be admitted, or referred to, the major hospitals in Minneapolis, even though the actual region extends well beyond the city limits (see Figure 1).[5] Individuals (and their utilization records) are allocated to Miami or Minneapolis not because they go to those hospitals, but because they live in zip codes where (typically) the majority of patients do go to such hospitals.

[5] The geographical boundaries of the Miami and Minneapolis areas are defined using methods in the Dartmouth Atlas of Health Care (Wennberg and Cooper, 1997). In the Atlas, every zip code in the U.S. was allocated to a Hospital Service Area (HSA); a local hospital (or more than one hospital in the same city or town) which served as a primary source of hospital care. The allocation of zip codes was done on the basis of a 100 percent sample of Medicare hospital discharges. In total there were 3,436 HSAs in the U.S. However, many of these HSAs were small in size, with low volume local hospitals sending their patients to larger hospitals for complicated procedures. The Atlas therefore allocated each of these HSAs to a Hospital Referral Region (HRR); each HRR has at least one hospital which provides major cardiovascular and neurosurgical procedures.

These two regions have been shown in prior research to have vastly different patterns of health care spending on a per capita basis. One problem inherent in comparing different regions is that they do in fact differ with regard to community-level disease patterns such as AMI and stroke rates. However, even after correcting for such differences, there are still substantial differences in *per enrollee* rates of utilization (Wennberg and Cooper, 1997; Skinner and Fisher, 1997). For example, Figure 2 summarizes data on differences in all per capita Medicare reimbursements, inpatient services professional and laboratory services, and home health care (Wennberg and Cooper, 1997). As the left-hand panel shows, the two cities are clearly at the opposite ends of the spectrum in terms of overall Medicare spending. (Each of the fainter dots in the diagram represents one of the other 306 hospital referral regions in the U.S.)

On the right-hand-side panel, the height of the bars shows the ratio of price-illness-age-sex-race adjusted levels of services to the U.S. In Minneapolis, home health services are 39% of the national average, while in Miami they are 60% above average, meaning their ratio is roughly 4 to 1. By contrast, the ratio between Miami and Minneapolis for inpatient services is just 1.5 to 1, suggesting that services with the greatest discretionary (and profitability) component -- home health and laboratory services -- are the ones most sensitive to geographic location.

A different way of comparing spending is to look at expenditures and utilization during the last six months of life, a period of time when many Medicare enrollees are quite ill. Comparing spending in the last six months of life is useful for three reasons. First, it is more difficult to invoke plausible clinical scenarios that would explain the observed differences on the basis of difference in level of illness. Second, this spending has been shown elsewhere to account for a large fraction of total Medicare spending; thus how people are treated near death has an important impact on the overall Medicare budget (Lubitz and Prihoda, 1984). And third, spending levels among this group are probably particularly good markers of how intensely a region's medical system treats the very sickest, reflecting a sometimes unstated concern that too much is done for people who are going to die anyway.

Figure 3 shows that the Miami and Minneapolis regions are again at the opposite ends of the national distribution in the intensity of care during the last six months of life. Inpatient Medicare expenditures differ by about 2-to-1 ($14,212 in Miami versus $7,246 in Minneapolis), with an even greater divergence in the average number of ICU days per person in their last six months of life (the right-hand side panel).

These are indicators of inpatient hospital use. A more telling comparison is the average number of physician visits billed to Medicare for those in their last 6 months of life. In Miami, the number of primary physician visits is certainly higher, 12.5 visits versus 7.1 visits, or a difference of 76% (Figure 4). The differences between the two regions, however, are most apparent in the average number of specialists' visits during the last six months of life; 25.4 in Miami versus 4.7 in Minneapolis, a nearly 5-fold difference. Some of this difference could be explained by the greater HMO penetration in Miami, meaning those people who remain in our Medicare claims data (the fee-for-service patients) are sicker. But even if we include the HMO patients in the denominator, thereby assuming they experience *no* visits to the doctor, the ratio of specialists visits in the region is still about three-to-one. Thus we believe that the proliferation of specialist visits in Miami is central to the story of why these communities differ so much.

It is important to emphasize that the differences in indicators shown above largely reflect a different approach to the treatment of the chronically ill. For some surgical procedures, such as knee replacements and back surgery, rates of surgery are actually *lower* in Miami.

III. How to Interpret Population-Based Differences in Utilization

As we noted above, there are basically two ways to interpret the differences in treatment patterns for those in the last six months of life. In Figure 5 (Panel A), we consider one way to characterize these differences, where we summarize the intensity of care on the horizontal axis Z (measured in dollars) and life-year extension on the vertical axis. According to Theory 1, most hospitals experience similar intensities of service. Not all health care systems are at the production possibility frontier, but they do not vary significantly in terms of their intensity of care, and any variation that does occur is primarily because of differences in patient health or patient preferences. For example, more people may die in hospital in Miami, but it is because of a lack of family support (or even available nursing home beds) rather than differences in the underlying approach to treating sick patients.[6] According to this theory, we would describe hospitals as clustering around one of the points (perhaps Point A), or if differences in preferences lead to differences in intensity of care, along a continuum between Points A and B. Thus it makes sense to talk about national standards of care, because most hospitals are delivering about the same level of intensity.

According to Theory 2, however, there exists wide variations in how a given disease is treated, leading to much more variable levels of intensity, perhaps ranging from A to E or beyond, with additional dispersion below the production frontier, as represented perhaps by point C. These exogenous variations, however, can be used to gain information about the nature and shape of the production function. By comparing outcomes between high-intensity and low-

[6] Although Miami does not lack for home health care services on a per capita basis.

intensity areas, one can begin to answer the question of whether the health care system is described best by clusters around Point A or at the flat of the curve (D) where more health spending yields nothing in expected lifespan? Or are some regions on the wrong side of the curve, Point E, where the iatrogenic costs of health interventions actually lead to worse outcomes? (Fisher, et al, 1997). For hospital procedures devoted simply to helping people to survive, such as ICU facilities, risk-adjusted survival rates are a good measure of outcomes.

The analysis becomes more complex once one recognizes the essential multidimensionality of outcomes. For many procedures, the objective is not to maximize lifespan, but to improve the overall quality of life. Chemotherapy may have proven benefits in extending survival rates for breast cancer but it can come at a large cost to the patient. Furthermore, there is tremendous heterogeneity across patients in the tradeoff; in one recent study, 12 percent of the sample would undergo standard chemotherapy for metastatic breast cancer in return for an expected additional lifespan of just one week. By contrast, 28 percent of the sample would not undergo standard chemotherapy in return for increased longevity of 18 months (McQuellon et al, 1995). Similarly, there is wide variation in preferences for chemotherapy to treat advanced-stage non-small cell lung cancer (Brundage, Davidson, and Mackillop, 1997; Silverstri, Pritchard, and Welch, 1998; McNeil, et. al., 1982). For example, in the Silverstri, Pritchard, and Welch study, all respondents had been treated with chemotherapy previously for advanced non-small cell lung cancer. The authors write about the patients' response to a hypothetical case involving the decision of whether to elect chemotherapy:

> In the setting of severe toxicity, for example, 5 (6%) patients would choose chemotherapy for only 1 week of additional survival while 9 (11%) others would not choose the therapy even when offered 24 months of additional survival. In both scenarios, however, less than

half the patients would choose chemotherapy given the "best guess" of the actual average benefit - a 3 month difference in median survival.

This heterogeneity in preferences makes it very hard to calculate a single "quality-adjusted life year" (or QALY). For the average person, the loss in functioning and pain is not worth the extra life years, thus, the QALY associated with chemotherapy would probably be negative. But clearly, the average QALY is relevant only for the average person. For some people, the QALY associated with chemotherapy is positive, for others clearly negative. Thus Panel A of Figure 5 is not an adequate representation of the types of tradeoffs facing individual patients.

Panel B in Figure 5 demonstrates the problem of treatment choice when preferences are heterogeneous. For simplicity, we consider just the tradeoff between lifespan and a generic quality of life measure X, shown on the horizontal axis. Thus we are implicitly considering a three-good model; utility depends on three goods: non-medical consumption Y - Z, where Y is income and Z (as before) health care resources, lifespan L, and quality of life X. Medical technology provides a tradeoff between X and L; the opportunity set MM' is shown for a given level of Z equal to Z_1. This represents the possible tradeoffs between lifespan and quality of life given the current state of medical technology. (A similar tradeoff curve exists for lower or higher levels of Z; one hopes that more Z yields a tradeoff curve to the northeast of MM'.) In this case, the point C, which appears to be productively inefficient in Panel 1 above, is actually preferred by some patients, shown by the α preference ordering, while point B is preferred by a different group of patients with preference orderings β. This is why we cannot simply "quality-adjust" those life years; the different groups α and β disagree over the relative weights placed on lifespan extension versus quality of life.

The problem becomes more complicated once one accounts for a third class of medical procedures which are unlikely to have much impact on life expectancy, but which will have a larger effect on different aspects of the quality of life. For example, it is unlikely that surgical treatment for benign prostatic hyperplasia (BPH) will have a large impact on expected lifespan, but it might be expected to affect symptoms (positively) and sexual functioning or incontinence (adversely). Thus the decision to choose surgical treatment of BPH is taken along the flat of the survival curve (point D), where increased spending will yield no benefit in terms of lifespan, but will affect different dimensions of one's quality of life X.

There are two points here. The first is that "best practice" medical care does not guarantee allocative efficiency. There is often a wide range of treatments available for a given problem, and which treatment is chosen should depend on the preferences of the individual patient (i.e., whether they are α or β types). If an α type receives treatment option B (perhaps because the alternative, C, was not offered or downplayed by the physician), then allocative inefficiency would result. And second, it seems unlikely that preferences among the various choices could vary systematically across regions in a way to generate such large differences in treatment patterns, particularly if the regions are (on average) in the vicinity of points D. Of course, without further research on actual preferences in the two regions, we cannot *prove* that preferences do not differ to the degree suggested by treatment variation, but the evidence (discussed below) suggests that, if anything, individuals prefer the less intensive options when given the choice.[7]

IV. Do Health Differences Explain Variation in End-of-Life Expenditures?

We return to asking whether Theory 1 might explain the dramatic differences in health care spending in the last six months of life. This question is best seen as part of the very large and sometimes contentious debate over "small area variations." It is well-established that differences in per capita medical utilization across the U.S. and other countries exists. Typically, researchers include as many "supply" and "demand" related measures as can be mustered, but there is still a large residual that remains. The battle is over the residual: does it represent exogenous differences in practice patterns (Theory 2) or does it represent preference or health-related factors that are simply not measured by the researcher (Theory 1). Without delving into details, we simply note that most research is unable to explain the variations using conventional measures of health needs (e.g., Wennberg and Fowler, 1977; Henke and Wallace 1991; Wennberg and Cooper, 1997; Fisher et al, 1994; Wennberg, et al, 1989; Gruber and Owings, 1996; Skinner and Fisher, 1997; although see Green and Becker, 1994).[8] Thus

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[7] A final issue is whether people choosing between more.and less intensive treatment on the basis of quality of life, as in the BPH example above, should face copayments for the more intensive treatment. If in fact survival rates are not affected by the decision to treat surgically BPH, then might not patients be required to face some fraction of the extra resource cost?

[8] There is also a literature suggesting that small area variations can be explained simply by random variation in averages of regions with small sample sizes (Diehr, et al, 1990). However, the research using often 100 percent samples of Medicare data (e.g., Wennberg and Cooper, 1997) shows that the regional variation is not due to small sample problems.

under theory 1, regional variation is explained more by tastes (or unmeasured health needs), perhaps reflected in the decision of individuals to initiate contact with physicians (e.g., Escarce, 1993; Folland and Stano, 1989). The issue of whether to initiate contact with physicians, however, is not likely to be as important among this sample of Medicare enrollees in the last 6 months of life. Instead, the observed differences most likely reflect the *intensity* of care.

Still, it may be the case that the intensity of medical spending in the last six months of life is the consequence of patients in some regions dying of diseases requiring more costly palliative care. Thus we would like to test the hypothesis of whether end-of-life expenditures are related to the mix of diseases in the hospital referral region (HRR). To do this, we regress the HRR-level measures of average inpatient spending in the last 6 months of life as a function of Medicare hospital admissions for a set of common diseases that are reasonable measures of underlying community health levels: AMI, stroke, GI bleeding, hip fractures, and lung and colon cancer in 1994-95 (see Wennberg and Cooper, 1997 for details). All regressions were weighted by the Medicare population in each of the 306 HRRs.

Table 1 displays coefficients from this first regression correlating just health indicators with spending near the end of life. There are generally significant effects, and the adjusted R^2 is 0.18. The coefficient on AMI, for example, is negative; this suggests that people with AMI are more likely to die quicker, and at lower cost, than other diseases such as lung or colon cancer[9] While these diseases account for a large fraction of overall mortality, they explain only a small fraction of the variance in spending near the end of life.

[9] We have included both types of cancer in one category because of relatively small sample sizes, particularly in later regressions.

A more general regression model is also presented in Table 1 that includes resource levels (hospital beds per thousand, specialist MDs per 100,000, and primary care MDs per 100,000) and the ratio of for-profit hospital beds (the denominator is the sum of for profit plus not-for-profit beds). The adjusted R^2 rises to 0.54, and the age-sex-race adjusted bed capacity is highly significant. A rise of one standard deviation in bed capacity is predicted to increase spending near the end of life by $741. And while the impact of primary care physicians on Medicare end-of-life spending is not significant (and in fact negative), the impact of specialists is strong and very significant. Finally, the ratio of for-profit hospitals is also large and significant. The coefficient implies that an increase in the percentage of for-profit hospitals from 0 percent to 50 percent is associated with an increase in end-of-life spending of $713. (The national average is $9420.) One could argue, of course, that in the long term the supply of physicians in Miami and Minneapolis is not random; perhaps physicians are attracted to Miami because of the heavy volume of practice. The point remains that the characteristics of the regions that should matter most under Theory 1 for end-of-life spending -- disease burdens -- explain less than 7 percent of the overall difference between Miami ($14,212) and Minneapolis ($7,246). In sum, we find it plausible to adopt, as a working hypothesis, that Medicare spending in the last six months of life contains a strong degree of exogeneity across regions.[10]

V. Does the Higher Spending Lead to Better Outcomes?

Even if there are real differences in how people get treated among areas, it still may be the case that people in regions with high levels of health care do

[10] Given that these two cities were chosen on the basis of their extreme differences in treatment patterns, it might be expected that they would exhibit the greatest deviation from the norm. The point holds, however, for other regions also. Note also that our claim to exogeneity with respect to spending patterns on patients near death does not require that one accepts a "supplier-induced demand" view of the health care system, only that variations in medical spending on patients near death is not simply the consequence of health differences.

better; thus the extra expenditures in Miami could be justified by the improved health status of their population.[11]

We address this question in two ways, both using data from the entire U.S. First, we consider whether differences in end-of-life spending have an impact on the overall age-sex-race-adjusted mortality rates in the United States. Using the statistical methods developed in Fisher et. al. (1997), we perform a logistic regression on life expectancy for a 20 percent sample of the Medicare population (more than 5 million individuals) controlling for a wide battery of possible confounding factors such as levels of disability, poverty rates, and underlying levels of the five types of diseases noted above. Table 2 provides estimates of the coefficient of interest -- the partial impact of spending in the last six months of life on mortality -- along with a description of the additional variables; also see the Appendix for a full set of regression results.

Briefly, there appears to be little correlation between the intensity of care near the end of life and mortality rates, whether intensity is measured by spending, days in the hospital, or ICU days near the end of life. If anything, there is a slight positive (and highly significant) correlation between ICU days mortality rates; an increase of 1.0 in the average number of ICU days in the last 6 months of life is predicted to increase mortality rates by 0.8 percent.

One objection to this analysis is that there may be reverse causation; sicker regions would tend to have higher spending near the end of life, and hence generate a spurious correlation between the two variables (possibly masking the true negative correlation). This objection, however, carries less weight given that we are restricting our measure of spending to the universe of people near death. Sicker communities might well spend more per Medicare enrollee and experience a

[11] Thus our approach is similar to those comparing intensity of care and outcomes in New Haven and Boston; see Fisher et. al. (1994) and Wennberg et. al. (1989).

higher mortality rate, but it is not clear that sicker communities would spend more *per person* for the set of people who die. Still, it is useful to consider this question using a different approach that focuses on disease-specific mortality rates.

We selected a 5% sample of Medicare enrollees who were diagnosed with diseases that almost surely caused admission to the hospital; AMI, stroke, GI Bleeding, Hip Fractures, and Lung/Colon Cancer), for a two-year period 1992-93. Conditional on having an AMI or stroke, one might expect that the underlying health status, and survival probabilities should be similar across areas, thus potentially correcting for the reverse causality problem. As our marker for the intensity of health care in the region (or HRR), we also include the average Medicare spending, and average number of ICU days, for each HRR during the last six months of life (for all residents in 1994-95). [12]

We also include as independent variables controls for age, sex, and race; details of the logistic analysis are reported in Table 3, with the full results from one regression shown in the Appendix. Once again, there does not appear to be any positive impact on mortality of the region-level intensity of care for enrollees in the last six months of life (either measured in dollar terms or in ICU days)

One might object to this analysis because end-of-life spending is probably accounted for largely by treatment for chronic diseases, not for sudden medical emergencies such as AMI and stroke; thus our indicator may not summarize well how a given AMI or stroke would be treated. Another way to approach this problem is to calculate the *disease-specific* levels of health care spending by HRR. We do this by first regressing Medicare reimbursements, at the individual level, on age, sex, race, and illness dummy variables. This regression reflects possible

[12] While these data are from 1992-93 and the end of life data from 1994-95, the temporal mismatch is not likely to bias our results substantially, given the secular stability in spending patterns of HRRs.

differences in Medicare spending as the consequence of demographic or illness variation across regions. We then average the residuals in each region (after controlling for these demographic and illness factors); these HRR-level constructed residuals were highly correlated with HRR-level spending in the last 6 months of life.[13] We then used the HRR-level residuals in a second-stage regression seeking to explain mortality rates, with insignificant results (regressions not reported). We regard these results as preliminary, however, given the larger sample sizes necessary for statistical power.

Of course, it could be that our measure of outcome, survival, does not adequately reflect the true underlying quality of life enjoyed by patients in Miami over those in Minneapolis. While we have no direct evidence on quality of life outcomes in the two regions, we can turn to more general evidence from research on whether patients in fact prefer these more intensive forms of treatment.

VI. Do Patients Prefer More Intensive Levels of Health Care? The Case of Surgery

In this section, we return to the issue of preferences in health care, and to the notion that specific surgical procedures could improve the quality of life even if survival rates are not improved (or worsened). Thus we seek to address whether in fact patients *prefer* the more intensive patterns of health care. In contrast to treatment intensity during the last six months of life, the goal of surgery is often to increase the quality of life, not the length of life. In fact, the risks inherent in surgery often mean that improvements in the quality of life come at the cost of a small increase in the chance of early death. But length-of-life versus quality-of-life are not the only tradeoffs. For example, most patients who undergo prostate surgery for Benign Prostatic Hyperplasia (BPH) experience a

[13] In other words, there is a strong HRR-level correlation between the intensity of spending in the last six months of life, and the intensity of spending more generally for these common acute conditions.

change in sexual function (retrograde ejaculation) and there is a risk of incontinence and impotence. Men with BPH thus face a dilemma; although surgery provides the best option for reducing symptoms, it involves tradeoffs that involve tangible risks. Men and women with stable angina benefit more in terms of immediate reduction in symptoms by undergoing coronary artery revascularization. But again there are tradeoffs. For example, among the Medicare population, mortality from bypass surgery is about 2%; a substantial number of those who undergo this operation experience a loss in short term memory and other impairments of cognition.

Research shows that men, when fully informed about the options and their possible consequences, differ substantially in their preferences for surgery. For the case of BPH, the objective of the surgery is to improve the *symptoms* of enlarged prostates, these include difficulty or strain in urination. In one study, a sample of men with prostate symptoms was presented with information about the risks and benefits of surgery, and then asked about their own preferences (Barry et al, 1995); a summary table of results from a logistic regression is shown in Table 4. The partial effect of severe (rather than moderate) symptoms is to raise the chance of choosing surgery (odds ratio of 1.48, or an increase of 48 percent) but the results are not significant.[14] By contrast, two much better (and significant) predictors of whether the patient chooses surgery were (i) if the given symptoms bothered the patient (odds ratio of 7.0) and (ii) the degree of concern about the chance of impotence (odds ratio of 0.2). In other words, the most important predictors of whether the men chose surgery was less the severity of the symptoms, and more the degree to which the symptoms bothered the patient, and their concerns about the possibility of impotence. Thus geographical regions

[14] A mild symptom score reduced (significantly) the odds of having surgery. However, mildly symptomatic men generally do worse after surgery, and probably should not be offered the option.

have the potential for significant allocative inefficiency, even if their average rates are "right." The necessary condition for efficiency is that the patients desiring surgery are the ones that get it and the patients who *don't* want surgery don't get it.

Two experiments designed to study the effects of shared decision making on the rates of surgery provide an insight into the extent that surgery may be misallocated in the United States. The first, conducted in two staff model HMOs, implemented a change in the way clinical decisions were made for prostate surgery. After viewing an interactive video that informed patients about the risks and benefits of alternative treatment, patients were encouraged to choose the treatment they would prefer. Surgery rates were measured before and after the video was introduced, and also with reference to a control population. In each HMO, rates dropped about 40%, suggesting that the amount of surgery formally "prescribed" by the HMO exceeded the amount that informed patients wanted (Wagner, et. al., 1995). The resulting demand for prostate surgery is shown in Figure 6; interestingly, this benchmark was less than virtually every region in the United States. Similarly, a randomized trial of a shared decision making program for treatment of coronary artery disease suggests that patient demand for revascularization (at least in Canada) may be lower than the rate of revascularization in nearly every HRR in the United States; see Figure 6 (Morgan et. al., 1997).

These findings suggest a point that should be easily absorbed by economists. If patients are both less enthusiastic about surgery than the national averages would suggest, and show heterogeneity in their underlying preferences towards outcomes from surgery, there is a potential Pareto improvement by allowing them to make their own choice, even if the choice is ultimately to defer to the physician's choice. In the cases considered above, society gains: patient welfare is improved, and expenditures on health care are reduced.

VII. Discussion and Conclusion

Regions across the United States appear to have adopted much different strategies for treating Medicare patients. In this paper, we compare expenditures and ICU utilization across these hospital referral regions (HRRs) for elderly people in their last six months. We choose people in the last six months of life because they are all quite sick, and thus we can partially control for geographical differences in the underlying levels of disease. Medicare expenditures in the last six months of life are twice as high in Miami as in Minneapolis, and the average number of specialist visits is nearly 5 times higher. We have argued that these differences are unlikely to be explained simply on the basis of differences in health status or even preferences. In sum, we find little support for our Theory 1 (that variation in health care treatment simply reflects differences in preferences or in underlying health status) and much more support for the notion that the variation in health status is to some extent exogenous (Theory 2).

Variation in Medicare spending alone does not necessarily imply inefficiency in the distribution of health care. After all, sick people in regions with more intensive treatment patterns may be survive longer, thus (possibly) justifying the extra expenses. However, using two much larger samples of individuals, one a 20 percent sample of all Medicare enrollees, and the other a 5 percent sample of Medicare patients hospitalized with AMI, stroke, GI bleeding, and cancer, we find no evidence that higher levels of spending translates into extended survival. But it may still be the case that people in the high-intensity areas prefer the more intensive treatment. And while we do not know conclusively that people in such regions would prefer more intensive health care, we do know that patients living in other areas, if provided with information to make their own choices, generally prefer less, not more, intensive health care. Thus we conjecture that on the basis of economic efficiency, Miami may fall short of Minneapolis.

Our results may appear inconsistent with recent evidence documenting the striking secular gains in survival rates following heart attacks (e.g., Cutler, et. al., 1996).[15] However, our test for the effectiveness of health care relates solely to regional differences in the intensity of care in a given year, and hence for a given body of medical knowledge.

One question we are not yet able to answer is, why do physicians and hospitals in Miami adopt such an intensive strategy for health care, and Minneapolis a much less intensive approach? One reason could be the sheer amount of resources in Miami; more hospital beds per thousand (3.2 versus 2.6), and more specialists (146 per 100,000 versus 100). [16] Another explanation could be the much higher ratio of for-profit hospital beds in Miami, 56 percent versus less than 2 percent in Minneapolis; we argued above that such differences could account for at least some of the difference between the two regions. But there is still a substantial residual left unexplained even after accounting for supply factors. And even these "causal" factors are suspect, since for-profit hospital chains or physicians may be most likely to locate where practice styles are most aggressive.[17]

Perhaps the for-profit hospitals in Miami exerted a larger impact on the not-for-profits because of more dense markets in Miami causing the not-for-profits to imitate the behavior of the for-profits, in the sense of Cutler and Horwitz (1997). Alternatively, the key to explaining why Miami is so different could be in the

[15] We are grateful to Frank Lichtenberg for pointing this out to us.

[16] There are also more primary care physicians in Miami (83 versus 68 per 100,000) although as noted above, primary care physicians are not correlated with Medicare spending in the last 6 months of life.

[17] Even if physician supply, for example, is increased in Miami because of the more intensive practice style, we can still view the resulting treatment intensity as exogenous from the point of view of a production function.

structure of physician groups rather than the hospitals.[18] The interaction between patient demand and physician behavior is also important in understanding the practice of medicine in Miami; perhaps elderly patients come to expect numerous referrals as the norm, and would suspect physicians who do *not* refer them to other physicians.

The differences in practice patterns between these two cities (and across the U.S. more generally) appear to be real, but are somewhat resistant to an entirely economic structural explanation. Ultimately, some part of the story may be the (random) emergence of small group of entrepreneurial physicians who set the practice style for the entire area. A recent Wall Street Journal article, for example, identified a single aggressive cardiology physicians group as the reason for why Lubbock, TX had one of the highest per capita rates of angioplasty in the country (Anders, 1996).[19] Whether regional differences in Medicare utilization can ultimately be explained in a structural model of medical practice, or whether these regional differences are the outcome of a "path-dependent" process originating with a few entrepreneurial physicians, is a topic for future research.

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[18] One conference participant suggested that fraud could also play a part in the high number of physician visits in Miami. Ironically, were the difference attributed to fraud, the efficiency considerations would be much more benign. Fraud is simply transfers from the government to physicians without any real resource cost except the effort of signing forms and filing them. There is a real resource cost, the alternative activities of the physician, if the doctor is actually visiting the patient.

[19] The group expanded by advertising in The New England Journal of Medicine for cardiologists seeking potential incomes in excess of $1 million.)

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	Regression excluding health resource variables		Regression including health resource variables	
	Coefficent	t-statistic	Coefficient	t-statistic
AMI	-170.8	2.9	-93.0	2.0
Stroke (CVA)	53.9	0.6	83.4	1.2
GI Bleeding	770.2	5.1	341.9	2.8
Lung Cancer	1185.4	4.1	-23.9	0.1
Hip Fractures	-514.1	3.8	-343.9	3.1
Hosp. Beds			1146.2	8.8
Specialist MD			38.4	7.2
Primary MD			-8.0	0.7
For Profit Ratio			1426.2	3.5
Constant	4505.6	3.2	1609.5	1.4

Table 1: Regression Explaining Medicare Part A Reimbursements in the Last Six Months of Life, by Hospital Referral Region

The dependent variable is the price-adjusted average Medicare reimbursements per person in their last six months of life. In the first regression $R^2 = 0.18$, in the second $R^2 = 0.54$. Each observation corresponds to a hospital referral region (HRR), of which there are 306. All regressions are weighted by the number of Medicare enrollees in the HRR. All of these variables (except the percent nonprofit) have been adjusted for age-sex-race differences, thus we do not include these variables into the regression.

Variable	Odds Ratio	95% Lower B.	95% Upper B.	Significance
Spending in Last 6 mos.	1.001	0.999	1.003	0.408
ICU Days in Last 6 mos.	1.008	1.003	1.014	0.002

Table 2: Logistic Regressions of Mortality in the Medicare Population

In the Table above, the dependent variable is whether the individual lived or died in the benchmark year of 1990. The logistics odds ratio is shown for price-adjusted expenditures in the last 6 months of life, or for the average number of days spent in an ICU in the last 6 months of life. These variables (for 1994-95) are calculated for each Hospital Service Area, of which there are 3,436 in the U.S. Thus the level of analysis is at a finer level of geography than for the standard Hospital Referral Region used in most of the other statistical analysis. There are more than 5 million observations in the regression. This regression is adopted from Fisher et al (1997). Covariates include age-sex-race specific cells, and from the Census: median family income (for blacks and whites separately) in the population over 65, percent of population 65+ below the poverty level, education (less than grade 12, high school graduates, and college graduates), percent in rural areas, percent in urbanized areas, percent with work disabilities, self care limitations, and mobility limitations (all 65+).

Mortality Variable	Odds Ratio	95% Lower B.	95% Upper B.	Significance (p-value)
6-month (full sample)	0.998	0.986	1.010	0.762
6-month*** (full sample)	1.015	0.986	1.045	0.321
90-day (full sample)	0.994	0.981	1.007	0.348
6-month (AMI)	0.989	0.968	1.011	0.333
6-month (Stroke)	0.994	0.974	1.015	0.566
6-month (Hip Fract.)	1.019	0.991	1.048	0.187
6-month (GI Bleed)	1.003	0.972	1.034	0.173
6-month (Cancer)	0.997	0.949	1.047	0.892

Table 3: Logistic Regressions of Mortality in the Medicare Population for Five Specific Health Conditions

The dependent variable is whether the individual lived or died within the 6 month (or 90 day) period, conditional on having been admitted to hospital for one of the five initiating conditions during the years 1992-93. The logistics odds ratio is shown for price-adjusted expenditures in the last 6 months of life (in units of $1,000) by HRR or (in Row 2, denoted by ***) the average number of ICU days in the HRR, again in the last 6 months of life. The overall sample size is 53,564. Average 6-month mortality rates are 22.6 percent, average 90-day rates are 18.7 percent.

Independent Multivariate Predictors of Choosing Prostatectomy (Logistic Regression; n = 347 Men With Complete Data on All Predictors*)		
Variable	OR	95% CI
Symptom score		
Mild	0.09	0.01, 0.72
Moderate		
Severe	1.48	0.6, 3.6
Rating of symptoms		
Positive/mixed		
Negative	7.0	2.9, 16.6
Rating of impotence		
Positive/mixed		
Negative	0.20	0.08, 0.48

OR, odds ratio: CI, confidence interval.
* Thirty-two of these men underwent a prostatectomy

Table 4: Factors Predicting Choice of Surgery for Benign Prostatic Hyperplasia

The table presents the results of a logistic regression model to predict choice of surgery. Symptoms are whether the patient experiences difficulty with urinating. Although in the univariate model patients with severe symptoms were 2.4 times more likely to choose surgery than those who were moderately symptomatic, only 21% of those with severe symptoms actually choose surgery. In the multivariate model, the odds ratio dropped to 1.48 and was no longer significant. By contrast, the ratings patients gave to their symptoms (i.e. how much they were bothered by them) and concern about impotence were strong predictors of choice. Source: Barry et al (1995).

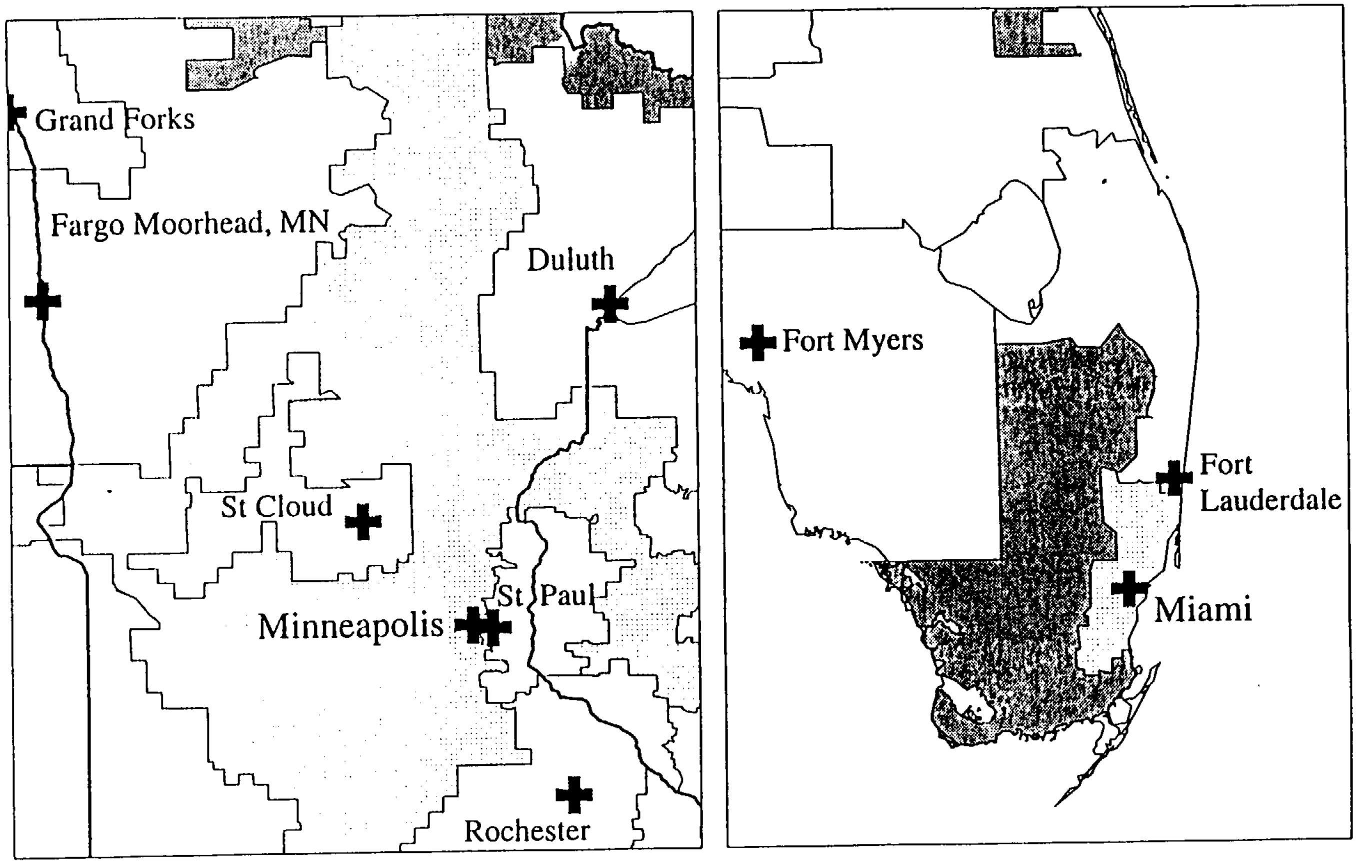

Figure 1: The Miami and Minneapolis HRRs

Because hospitals in Miami, and particularly Minneapolis, are magnets for surrounding areas, the actual HRRs for the two cities are quite a bit larger than the actual city boundaries. Note that even if a citizen of Miami, for example, received treatment in Fort Lauderdale, the utilization data is counted in Miami.

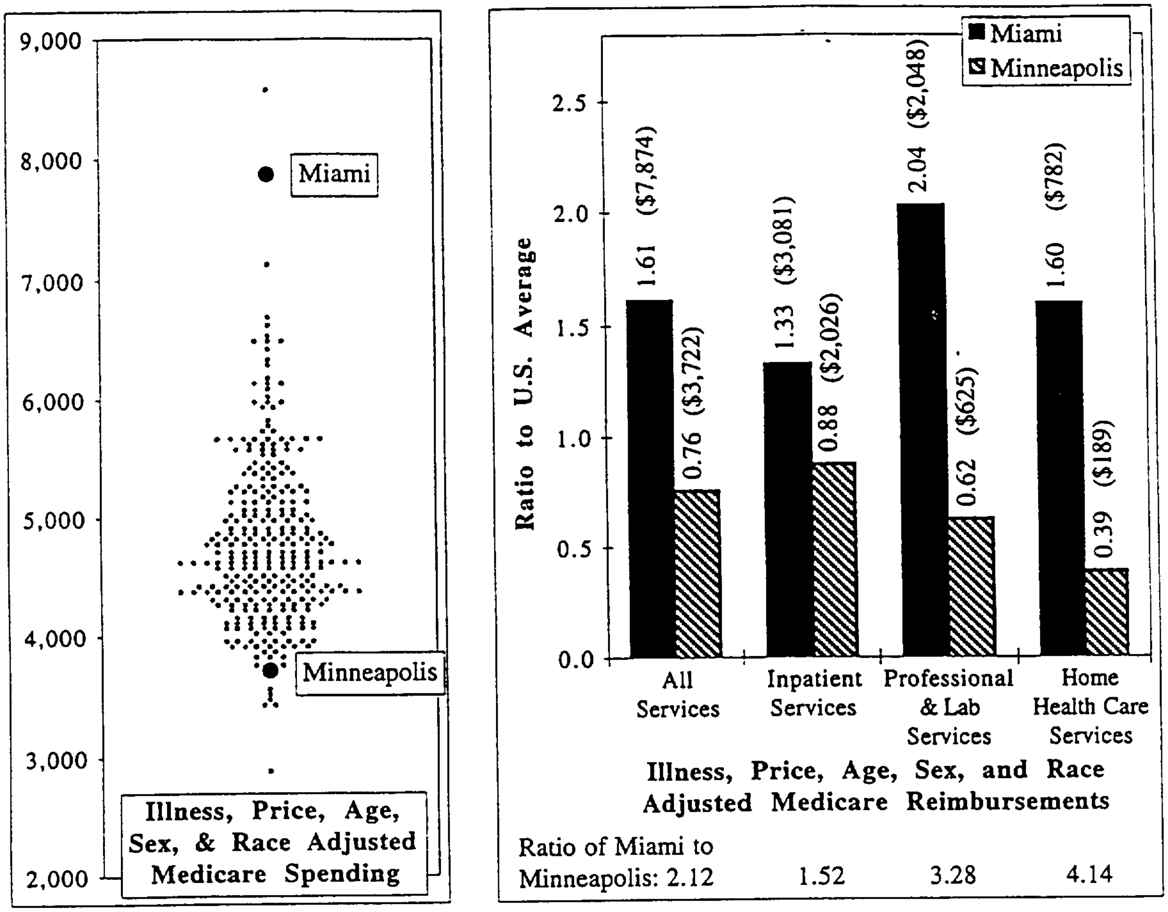

Figure 2: Medicare Reimbursements per Enrollee, Miami and Minneapolis

The figure on the left gives the age, sex, race, price and illness adjusted per person spending by the Medicare program in 1995 for the 306 hospital referral regions studied in the Dartmouth Atlas of Health Care. Spending varies nearly three fold from the lowest to the highest region. Total spending for residents of Miami is 2.1 times greater than Minneapolis on a per person basis. Inpatient reimbursements are 52% higher; those for professional and laboratory services more than 3.2 times greater; home health spending is more than four times greater.

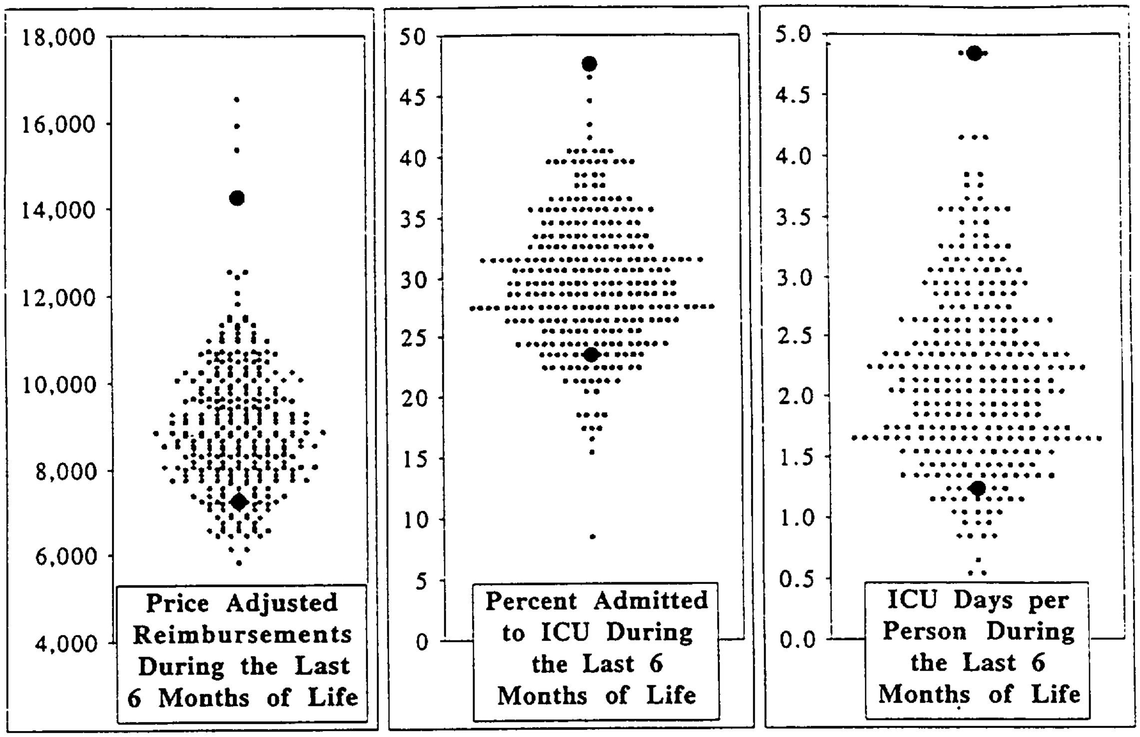

Figure 3: Intensity of Care in the Last Six Months of Life in Miami and Minneapolis

Miami is the higher dot, Minneapolis the lower dot. Among the regions, reimbursements for inpatient care varied more than 2.8 fold, from $5,831 to $16,571. Reimbursements for residents of Miami is about 2 times greater than Minneapolis (left) The percent of enrollees spending one or more days in intensive care varied from a low of about 9% to more than 45%. Miami is 2.1 times greater than Minneapolis (center) The numbers of days spent in intensive care varied more than 9 fold. Miami enrollees spent 3.7 times more days in the ICU than Minneapolis enrollees. (right)

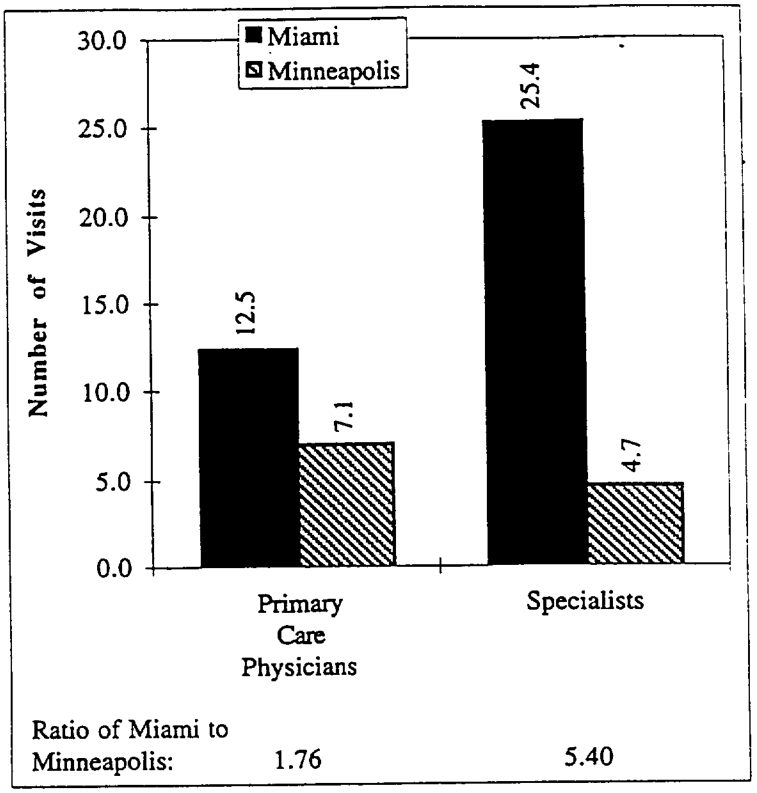

Figure 4: Average Number of Primary and Specialist Visits (per patient) in the Last Six Months of Life, Minneapolis and Miami

The average number of primary care physicians is higher in Miami than in Minneapolis (12.5 visits versus 7.1), a difference of 76 percent. The average number of specialist visits is substantially higher in Miami (25.4 visits versus 4.7), a difference of 440 percent. Note that these averages are for the non-HMO population only, and a larger fraction of Miami residents are in HMOs.

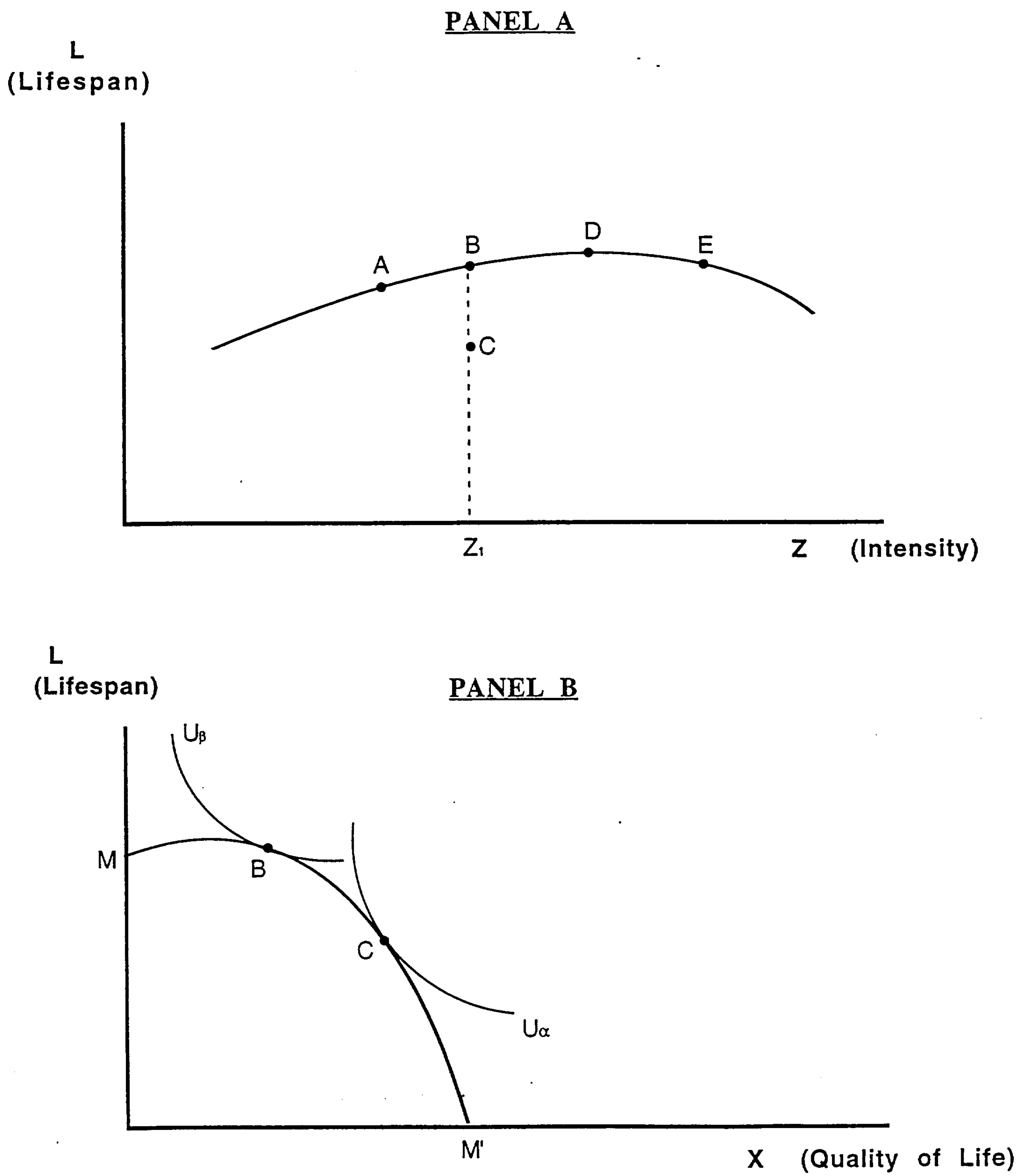

Figure 5: A Diagrammatic Representation of Efficiency in Health Care

In Panel A, the tradeoff between the (dollar) intensity of inputs into health care is contrasted with community-level expected lifespan. Point D, for example, corresponds to the maximal level of lifespan given existing medical technology. In Panel B, a tradeoff is shown between lifespan and quality of life.

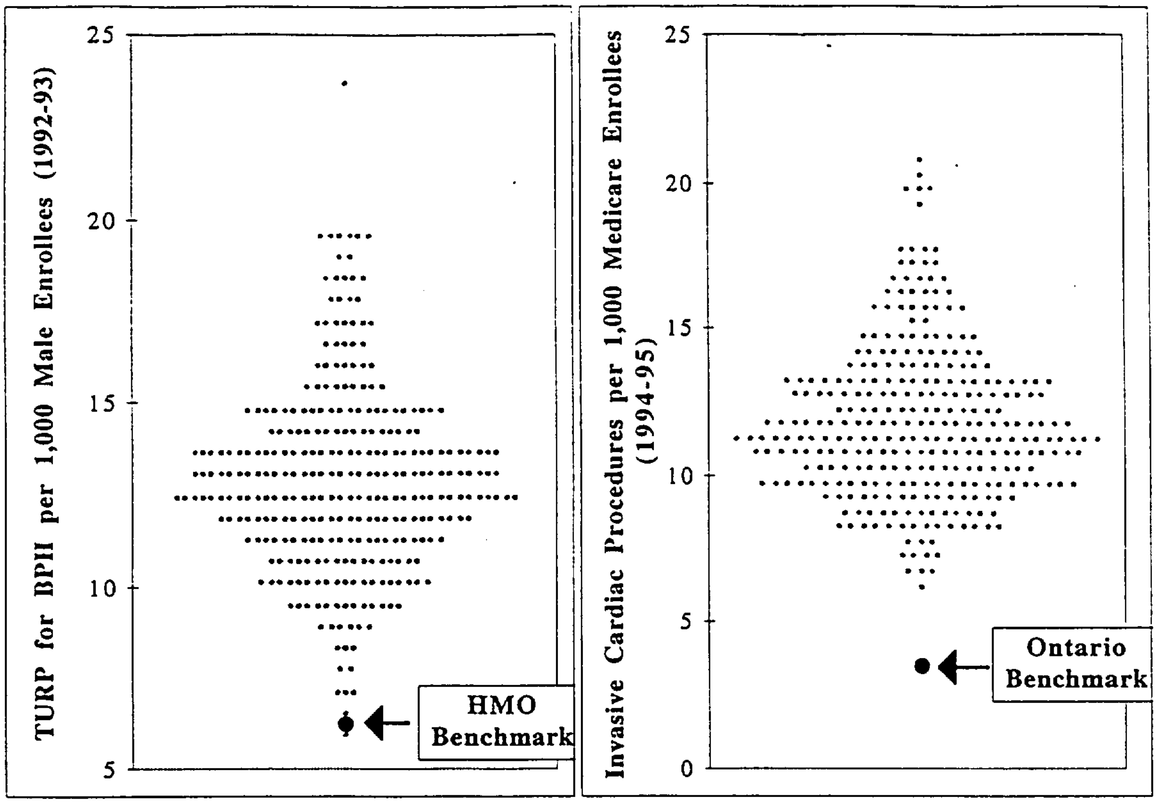

Figure 6: Actual and Desired Rates of Surgery for BPH and Angina

The distribution of rates on the left is for surgery for benign prostatic hyperplasia (BPH) among Medicare enrollees living in the nation's 306 hospital referral regions. The distribution on the right is for coronary artery revascularization. A study of the effects of involving patients directly in their choice of surgery was conducted among patients with BPH in two staff model HMOs and among patients with angina in Toronto, Canada. In the BPH study, when patients were fully informed about the risk and benefits of alternative treatments and encouraged to participate actively in the choice of treatment, the population based rate of surgery dropped 40% compared to controls. In the Ontario study, the rate dropped about 24%, even though the baseline rate in Ontario was substantially less than any rate observed in the United States. Sources: Wagner et. al. (1995), Morgan et. al. (1997).

Appendix A.1: Logit Regression Explaining Mortality (from all causes) in the Medicare Population

	Coefficient [95% Conf. Interval]		Coefficient [95% Conf. Interval]
Medicare Spending in the Last 6 Months of Life*	.0015 [-.001, .004]	Percent in Nursing Home	.0540 [.048, .060]
AMI /100	.0347 [.021, .048]	Percent Hispanic	-.0126 [-.017, -.008]
CVA (Stroke) /100	.0345 [.021, .048]	Percent Single	.0218 [.0159, .0277]
Hip Fracture /100	.0296 [.012, .047]	Percent High School Dropout	.0440 [.037, .051]
Colon Cancer / 100	-.0128 [-.043, .018]	Percent High School Graduate	.0386 [.033, .044]
Lung Cancer / 100	-.0364 [-.098, .026]	Medicare HMO Percentage	.0016 [.001, .002]
Percent with Income $15,000-$20,000	-.0240 [-.035, -.012]	Percent Employed (> Age 16)	.0531 [.048, .059]
Percent with Income >$20,000	-.0265 [-.042, -.011]	Percent With Working Disability	.0352 [.027, .044]
Percent in Poverty	-.0041 [-.011, .003]	Percent with Self Care Limitation	-.0083 [-.022, .005]
Percent Moved	-.0010 [-.006, .004]	Percent with Mobility Limitation	.0213 [.007, .035]
Percent Rural	-.002 [-.004, -.000]	Per Capita MD s 150-200 per 100,000	.0123 [.001, .023]
Percent in City	.0052 [.004, .007]	Per Capita MD s > 150-200 per 100,000	.004 [-.009, .017]

* In thousands of dollar per person.

The reported coefficient are for the logit regression index and are not odds ratios These results control for age-sex-race dummy variables (i.e., a dummy variable for a non-black female age 70-74) and regional dummy variables (coefficients not reported). The number of age-sex-race-zip code cells is 311, 146.

Appendix A.2: Logitistic Regression Explaining Mortality for a Cohort in the Medicare Population with Specific Diseases

	Coefficient [95% Conf. Interval]		Coefficient [95% Conf. Interval]
Medicare Spending in the Last 6 Months of Life*	0.998 [0.986, 1.010]	Male Age 75-79	1.802 [1.608, 2.021]
AMI /1000	2.474 [2.314, 2.645]	Male Age 80-84	2.475 [2.204, 2.778]
CVA (Stroke) /1000	2.323 [2.179, 2.476]	Male Age 85-90	3.533 [3.106, 4.019]
GI Bleeding /1000	1.077 [0.999, 1.161]	Male Age 90+	6.039 [5.168, 7.056]
Lung & Colon Cancer / 1000	1.014 [0.914, 1.125]	Female Age 70-74	1.176 [1.044, 1.324]
For Profit Ratio	1.094 [0.984, 1.217]	Female Age 75-79	1.483 [1.325, 1.659]
Males Age 65-69	0.964 [0.852, 1.092]	Female Age 80-84	1.922 [1.723, 2.144]
Male Age 70-74	1.311 [1.167, 1.474]	Female Age 85-89	2.576 [2.305, 2.879]
		Female Age 90+	3.829 [3.407, 4.302]

* In thousands of dollar per person.

Reported coefficients are the logistic odds ratios. Sample size = 53,564. Excluded categories are female age 70-74 and hip fracture.