Changing Mix of Medical Care Services:
Stylized Facts and Implications for Price Indexes*

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Abstract

The utilization of health care services has undergone several important shifts in recent years that have implications for the cost of medical care. We empirically document the presence of these shifts for a broad list of medical conditions and assess the implications for price indexes. Following the earlier literature, we compare the growth of two price measures: one that tracks expenditures for the services actually provided to treat conditions and another that holds the mix of those services fixed over time. Using retrospective claims data for a sample of commercially-insured patients, we find that, on average, expenditures to treat diseases rose 11% from 2003:1 to 2005:4 and would have risen even faster, 18%, had the mix of services remained fixed at the 2003:1 levels. This suggests that fixed-basket price indexes, as are used in the official statistics, could overstate true price growth significantly.

JEL Codes: O47, C43

I. Introduction

The utilization of health care services has undergone several important shifts in recent years that have implications for the cost of medical care. While inpatient care has been declining, surgeries at outpatient departments and other venues that do not require a costly overnight stay have been rising.[1] Anecdotal reports suggest that innovations in prescription drugs have also prompted changes in the utilization of non-drug care and recent studies suggest that cost-offsetting effects do occur.[2] Advances in medical equipment that minimize the need for professional administration and monitoring have made home care a more viable alternative to hospital care for some conditions.[3] Among patients with private insurance, the mix of medical care shifted towards outpatient services and pharmaceuticals during the period from 2001to 2006 (Bundorf et. al. 2009).

Changes like these in the way that care is delivered can potentially lower the expenditures needed to treat certain medical conditions; however, these shifts in utilization are not captured in official price indexes for medical care.[4] The official price indexes reflect what is happening to the provider prices of a fixed basket of goods and services. By design, these indexes do not take into account the effect on expenditures from shifts in the utilization of goods and services in treating medical conditions. If provider prices are increasing but patients are shifting from higher to lower cost services, a standard price index will only capture the effect of increased provider prices. Following Cutler et. al. (1998), we call these fixed-basket indexes "service price indexes," or SPIs. They answer the question "What would expenditures be today if patients received the same services today as they did in the past?"

Alternative indexes have been proposed that would also capture the effect of service shifts on costs (Schultze and Mackie, 2002). These indexes track the actual expenditures associated with an episode of care, without holding the service mix fixed. For example, if chronic episodes of depression are now treated with drug therapy — rather than the more costly talk therapy — the alternative index takes into account any cost reductions associated with the switch when quantifying what has happened to the

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[1] See Winter (2003) on the growth of outpatient surgery settings.
[2] See Chernew and Fendrick (2009) for a recent review.
[3] See, for example, http://aappolicy.aappublications.org/cgi/reprint/pediatrics;118/2/834.pdf for pediatric home care.

cost of treating depression. We call these "medical care expenditure indexes" (MCEs) to emphasize that they track the overall cost of care (all expenditures), not the costs of the individual services.

There exists a body of work that identified and quantified this problem for an important set of conditions—heart attacks (Cutler et. al., 1998), cataracts (Shapiro et. al., 2001), and depression (Berndt et. al.2001). They calculate quality-adjusted MCE indexes that take into account better health outcomes and find that they show slower price growth than quality-unadjusted SPIs. In most cases, both shifts in care and improved outcomes contribute to the gap between the indexes, suggesting that ignoring these shifts could cause an index based on SPIs to overstate overall price growth.[5] However, little is known about the potential importance of this issue beyond these studies, in part because of the enormous measurement difficulties.[6] Constructing MCE indexes requires measures of spending allocated by disease, which are not readily available; moreover, outcomes are difficult to measure without in-depth medical knowledge of each condition.

Building on this literature, we quantify the potential importance of service shifts for price indexes across a broad range of conditions by calculating and comparing price growth in the two types of indexes. While previous work relied on a case study approach and extensive medical expertise, our approach is computer and data intensive. We use computer algorithms called "episode groupers" to allocate spending by disease. We also develop a decomposition of spending that allows us to identify shifts in utilization from the data, without requiring a priori medical knowledge.

Using retrospective claims data for a sample of commercially-insured patients, we find that, on average in our three year sample, an MCE index grows at a compound annual growth rate of about 4 percent per year, about 2 percentage points slower than a SPI index. A literal interpretation of our result is that the expenditure growth in our sample would have been even higher in the absence of service shifts. More broadly, to the extent that our estimates apply to patients outside of our sample, our result suggests

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[4] See Berndt et. al. (2000) and Schultze et. al. (2002) for a full discussion of the issues.
[5] In at least one case (heart attacks), improvements in outcomes more than offset the shifts in care that raised expenditures.
[6] Beyond the case studies, there have been two attempts to get at this issue, with mixed results. Song et. al. (2009) found that differences in the indexes were not statistically significant when using a sample of

that this problem could cause inflation for the economy as a whole to be overstated by as much as 0.3 percentage points per year, with an understatement of real GDP growth of the same amount. The implications for the economy as a whole are large because the health sector makes up a large share of GDP.

Our decomposition shows that shifts in the utilization of services are pervasive across a broad list of conditions and quantifies the importance of several important service shifts: reduced reliance on inpatient care in favor of care at outpatient departments and venues that do not require an overnight stay, increased use of home care, and increased use of prescription drugs.

While we feel that this research is an important first step in demonstrating the relevance of the previous case studies for a broader range of conditions, we do not deliver "ideal" measures for price growth (as was done for selected conditions in previous papers). For that, we would need to factor in changes in outcomes to measure changes in quality, something very difficult to do when considering such a broad range of conditions. Similarly, for our services index, we consider technology fixed, so that an inpatient hospital stay in 2003 is treated as equivalent to an inpatient hospital stay in 2005. Finally, one would want to make adjustments for changes in patient case mix to account for the possibility that the severity of illness is changing.

The paper is organized as follows: Section 2 provides the decomposition that we use to trace differences in the MCE and SPI indexes back to service shifts. Section 3 discusses methodological issues and the data. Section 4 discusses the results and Section 5 concludes.

II. Service Shifts and Price Indexes

We compare the MCE and SPI indexes to quantify the presence of shifts in the utilization of services and to assess their importance and contribution to differences in the indexes. The previous literature used the concept of "episode of care" as the fundamental building block for MCE price indexes. This requires two things: first, one must link services to the diseases or conditions that are being treated. Second, it also requires that

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conditions in selected cities while Bradley et. al. (2010) found the opposite using data from the Medical Expenditure Panel Survey.

one choose a time frame — measuring costs over an episode of care or measuring costs incurred during a fixed period of time. In this paper, we use fixed periods of time to identify industry shifts.

Formally, we denote expenditures for the services used to treat condition d in period 2 as c_d^2. Operationally, it is calculated by totaling dollars spent on all services to treat the condition and dividing those dollars by the number of cases treated: $\Sigma_s c_{d,s}^2\, x_{d,s}^2\,/\,N_d^2$, where c is the cost, x is the quantity of the service provided (e.g., the number of encounters at physician offices or the number of inpatient confinements), and N is the number of cases treated.

The ratio of this price in period 2 to that of period 1 gives disease d's component for an overall MCE:

$$(1) \qquad MCE_d \;=\; c_d^2 / c_d^1 \;=\; \frac{\Sigma_s\,(c_{d,s}^2\, x_{d,s}^2\,)\,/\,N_d^2}{\Sigma_s\,(c_{d,s}^1\, x_{d,s}^1\,)\,/\,N_d^1}$$

An SPI index for this condition holds the basket of services in period 2 to that which was provided in period 1:

$$(2) \qquad SPI_d \;=\; \frac{\Sigma_s\,(c_{d,s}^2\, x_{d,s}^1\,)\,/\,N_d^1}{\Sigma_s\,(c_{d,s}^1\, x_{d,s}^1\,)\,/\,N_d^1}$$

i.e., the x's and N's are held at period 1 levels. The numerator tells you how much the services provided to patients treated in period 1 would have cost at period 2 prices.

Differences in the MCE and SPI arise when the level or mix of services change. Writing this down formally gives us an expression that we can use to quantify the overall importance of shifts across services. As shown in the appendix, the relationship between these two price measures may be written as:

$$(3) \qquad MCE_d \;=\; SPI_d \;+\; \Sigma_s\,\{\,SPI_{d,s}\,(dU_{d,s} - 1)\,\}\,,$$

In the last term, $SPI_{d,s} = (c_{d,s}{}^2 x_{d,s}{}^1) / \Sigma_s (c_{d,s}{}^1 x_{d,s}{}^1)$ is the contribution of service s to the SPI index for condition d (i.e., $SPI_d = \Sigma_s SPI_{d,s}$) and $dU_{d,s}$ gives the change in utilization per case for service s: $dU_{d,s} = (x_{d,s}{}^2 / N_d{}^2) / (x_{d,s}{}^1 / N_d{}^1)$. If there are no changes in the utilization of any of the services (all $dU_{d,s} = 1$), the two price measures coincide. In that case, the only expenditure growth comes from increases in provider prices.

Any change in utilization either augments or reduces the contribution of each service to expenditure growth. Consider the treatment of chronic depression when there are only two types of services, drug and talk therapy. The change in the annual cost of treating this condition can be measured with an MCE index:

$$(4) \qquad MCE \quad = \quad SPI$$
$$+ SPI_{drug} (dU_{drug} - 1)$$
$$+ SPI_{talk} (dU_{talk} - 1)$$

where subscripts denoting that these are all for depression only have been dropped. All else held equal, any shifts towards the lower-cost drug therapy would increase the number of prescriptions per patient ($dU_{drug} > 1$), accounting for the fact that per patient expenditures on drugs grew more than drug prices. Similarly, a drop in the number of office visits for talk therapy has the opposite effect: $dU_{talk} < 1$ and the talk therapy term accounts for the fact that expenditures on therapy grew slower than any change in the price of an office visit.

With just two services, the MCE will show slower growth if utilization shifts towards the lower-cost service or if utilization of all services declines. Shifts in the opposite direction would have the opposite effect. With more than two services, substitution of one service for another does not guarantee a gap between the MCE and SPI indexes: there could be changes in the utilization of other services that would offset that effect.

To aggregate over diseases, we take simple weighted averages of each term in (3), where the weights are the expenditure share for each condition in period 1. Defining

MCE= $\Sigma_d w_d^1$ MCE$_d$ and SPI = $\Sigma_d w_d^1$ SPI$_d$, the aggregate version of the disease-specific decompositions in (3) is:

$$(5) \qquad MCE \quad = \quad SPI \; + \; \Sigma_d w_d^1 \, \Sigma_s \{ \, SPI_{d,s} (\, dU_{d,s} - 1) \, \}$$

We interpret the aggregate MCE index as a weighted average of expenditure growth for underlying diseases, the SPI as the same for services , and the last terms as the average contributions of service shifts to differences in the two indexes. The choice of base period expenditure shares yields an SPI that is very similar to the official price indexes for medical care published by the BLS (see appendix). This is useful because it allows us to use (5) to make inferences about what the official price indexes would look like if they accounted for shifts in utilization.

III. Methodological Issues and Data

Measuring Spending by Disease

Constructing indexes and applying our decomposition requires measures of spending by disease. The development of methods to allocate spending by disease is a field unto itself and has not yet generated a consensus on which method is best. [7] Traditionally, studies have used encounter-level data and assigned each encounter to a disease. This is easiest to do with inpatient care, where the confinement is assigned to one condition, or diagnosis related group (DRG). For other types of care, however, encounters are typically associated with more than one diagnosis code and it is not clear how much spending to allocate to each condition.

There are four available methods to deal with this comorbidity issue. First, many studies in this literature use a "primary diagnosis" method that assigns the spending to the first-listed diagnosis (the seminal work is Scitovski 1964). Many have noted, however, that the first-listed diagnosis is often not the primary one and, more fundamentally, it is often difficult to identify a primary diagnosis in the face of comorbidities. More recently, Roehrig et. al. (2009) used a proportional method that allocated spending from claims with more than one diagnosis using the distributions of spending from claims with only

one diagnosis listed; Bradley et. al. (2010) used a similar proportional approach. These proportional methods use only the information on each individual claim to allocate the spending. In contrast, Rosen and Cutler (2007) advocate a regression-based approach that allows the data to do the allocation, rather than some a priori definition. Their approach is person-based and uses all available information on diagnoses in the patient's history.

Finally, there are also computer algorithms that were originally developed for physician profiling that are potentially useful for our purposes. Like the "primary diagnosis" method, these so-called "episode groupers" allocate all spending from individual claim records to a distinct condition . However, the groupers also use other information on the claim (e.g., procedures) and information from the patient's history to allocate the spending. An additional advantage of using the grouper is that it can use patients' medical history to assign diseases to drug claims, which typically do not provide a diagnosis.

This is the approach we take in this paper. It has the advantage that one does not need to have extensive medical expertise on each condition to obtain estimates of spending by disease and instead rely on the medical expertise that was used to develop the algorithm. However, a major drawback is that the algorithms are complex and viewed as a "black box," in large part because the methods they use to allocate spending — particularly with comorbidities — is not readily transparent.[8] Although one can certainly think of many cases where splitting spending from a claim will seem arbitrary ("is an ACE inhibitor taken by a person with diabetes who has had a heart attack being taken for the diabetes or the heart attack?" (Rosen and Cutler 2007)), one can think of others where using information in patients' histories and all information available on a claim could be useful in assigning medical expenditures to disease categories. Work continues to better understand the logic underlying these groupers and exactly how these algorithms make choices in the presence of comorbidities. For now, we take a literal read of the grouper's allocations as a starting point for learning about the importance of service shifts.

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[7] See Rosen and Cutler (2009) for a fuller review of the issues.
[8] A recent attempt to characterize these algorithms is MaCurdy et. al. (2009)

Data

Our sample, from the Pharmetrics, Inc. data set, contains over 700 million claim records from 21 Health Maintenance Organization (HMO), Preferred Provider Organization (PPO), and Point-of-Service (POS) plans covering about 10 million enrollees and their families over the period from 2003 to 2005 (table 1). Claims data sets like this have been used in some of the previous case studies that explored problems in price indexes (e.g., Berndt et. al. 2001, Song et. al. 2009) and in other studies that document shifts in utilization (Bundorff et. al. 2009, Chernew and Fendrick 2009).

The data are a "convenience" sample and are not designed to provide estimates that are representative for commercially insured patients. The bottom panel of table 1 provides information on the distribution of enrollees. Looking at the distribution of enrollees within a year, our sample has a higher proportion of females, prime age workers (35 to 54), and youth (0-18) than the population of individuals with private insurance coverage.[9] The disproportionately high number of youth in our sample (28 to 30 percent in our sample vs 27 percent in MEPS) and women (54 percent vs 51 percent in MEPS) suggests that the plans in our sample cover more families than is typical. Finally, while the data cover all regions of the US, our sample is more concentrated in the Northeast and Midwest than the overall population. To the extent that conditions and treatments for the enrollees in our sample are not representative for commercially-insured patients, our estimates will not be representative.

This lack of representativeness is the main drawback of convenience samples such as the one used in this paper. The advantage is that the large number of observations provides a better representation of spending at the high end of the spending distribution and the use of administrative records avoids undercount issues typical of household expenditure surveys (see Aizcorbe et. al. 2010).

Looking across the three years of data, there are small increases in the number of enrollees and patients submitting claims. However, the distribution of enrollees by gender, region, and age appears quite stable, lessening the need to control for case mix if one were to construct price indexes.

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[9] According to the Medical Expenditure Panel Survey (MEPS), 51% of individuals with private insurance coverage at any time in 2005 were women, 36% were prime age, and 27% were under 18 years old. With regard to region, 19.7 percent were from the North East and 24 percent from the Midwest.

An observation in the data corresponds to a line item in an "explanation of benefits" form, so each "claim" is made up of potentially many records and each encounter can be made up of potentially many claims. We aggregate over the individual records assigned to a particular condition to obtain the number of "encounters" and number of treated cases, designated with an "x" and an "N," respectively in the earlier section. For encounters that last only one day (e.g. pharmacy visit, office visit,), we define the service as a day of care from the provider for a particular condition. For inpatient stays, we define the service as the medical confinement.[10] We group providers by industry (using an identifier for the place of service), by the medical condition (using the disease codes assigned by the episode grouper), and by day.

We measure the number of cases treated as the number of patients that received treatment for a disease, d, in a given period. Expenditures are measured as the amount received by all providers of the services (including both out-of-pocket payments and amounts paid by insurance firms), a variable with a high response rate in the Pharmetrics data (94%).

Table 2 lists the nine types of services that contained at least one percent of total spending in the first quarter of 2003 (2003:1). Column 1 gives the expenditures per encounter, which varies widely across categories. Inpatient care, defined as the average expenditure for an inpatient confinement, averages about $4,300 per hospital stay; average expenditures for other services are substantially less because they do not involve an overnight stay. The category "pharmacy" contains the average price of a prescription and is among the least costly encounters.

The data were processed by Pharmetrics using the Symmetry grouper (version 6) that allocates each record into one of over 500 disease groups called "episode treatment groups" (ETGs). In table 3, we summarize these allocations at a higher level of aggregation that Symmetry calls "major practice categories," or MPCs. Of the $5.9 billion of total spending in 2003:1, about 90% is allocated to disease classes (MPC 1 to 19), 4 percent is allocated to non-disease MPCs—like preventative and administrative

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[10] Because our data begin in 2003:1, we will understate the cost of confinements that were in progress over the turn of that year. However, to the extent that our goal is to compare results from the two types of indexes, and that the understatement is the same in both of the indexes, our inferences about treatment shifts and their effect on cost savings should be valid.

care—and the remaining 4 percent (labeled "Other") is not allocated, owing to missing or invalid information.

Most of these allocations to MPCs ($5.7 billion vs. $5.9 billion) are done using some combination of diagnosis (ICD-9) and procedure codes (CPT-4) on the claim record or in the patients' histories (column 1). The second column gives spending that is allocated using the NDC codes on the pharmacy claims—this represents spending by patients with ongoing prescriptions with no other medical encounters (hence, no diagnosis or procedure codes). While this is small in the aggregate (about 4% of total spending), the share of spending assigned using NDC codes can be large for some categories (like psychiatric conditions).

In our analysis, we include only spending on disease classes (MPC 1 to 19), where the spending was allocated using disease and procedure codes—i.e., we exclude spending on the ongoing prescription group.[11]

IV Results

Chart 1 shows the growth in health care expenditures as determined by the Service Price and the Medical Care Expenditures indexes. The quarterly indexes are constructed relative to 2003:1. Slower growth in the MCE index indicates the presence of shifts from higher- to lower-cost services or declines in all utilization.

The MCE, which measures the cost of treating diseases and is illustrated by the dashed line, grew slower than the SPI which reflects the prices of the underlying treatments and is exhibited by the solid line. The difference in the two indexes is substantial: over the three year period, the SPI grew nearly 18 percent while the MCE only grew about 11 percent. The differences amount to about 1.5 percentage points on the compound annual growth rates — 6.1 percentage points versus 4.4 percentage points. Because our data are not representative it is not appropriate to generalize this finding to the aggregate economy. Despite this caveat, this result provides a sense of the potential importance of these differences. As noted earlier, health spending in 2009 was 16

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[11] This distinction is not numerically important; the results reported in the next section are numerically very similar to what one obtains when all spending is included.

percent of GDP, so if a difference of this magnitude held across all types of patients (i.e. the uninsured, Medicare and Medicaid patients), changing from the current deflator to the MCE index in the national accounts would substantially increase measured real GDP growth by about a quarter percentage point per year.

To explore the sources of these differences, the left panel of table 4 compares the growth in the two types of price indexes across the 19 major disease groups. The growth rates shown are for the entire 2003-2005 period and represent averages of the growth rates for the individual conditions underlying each group.[12]

Growth rates for the MCE and SPI indexes — in the first two columns — show that expenditures per patient and the average price of services increased for most major groups over this period. Expenditures for conditions under the cardiology category (line 8) were essentially flat, despite an increase in the prices of services used to treat these conditions. The third column compares the MCE and SPI indexes and shows that, for most conditions, expenditure per patient did not grow as fast as it would have had patients received the same bundle of services in 2005 that patients in 2003 received. There are two exceptions (chemical dependency and obstetrics) that, combined, make up about 10 percent of total spending and, therefore do not have much influence on the top line.[13] Nonetheless, these exceptions are examples where the cost of treating entire diseases rose faster than the cost of the individual treatments, owing to increases in utilization.

This suggests that shifts in the bundle of services are pervasive. To explore the sources of those shifts, the right panel of table 4 uses (5) to link the differences in the price indexes to shifts in the underlying services. As discussed above, a positive sign reflects an increase in service intensity and a negative sign the opposite. In general, a lot of what's going on seems related to declining utilization at hospitals, maybe related to surgeries done elsewhere.

Looking within specific disease classes, in the orthopedic and rheumatology group (line 18), there is an evident shift from treatment at hospitals and doctors' offices

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[12] Similar tables for the individual diseases are provided in the appendix.
[13] For obstetrics conditions, a look at data for the underlying conditions shows cost savings for uncomplicated conditions—normal pregnancies and uncomplicated neonatal management—and higher costs for conditions that involve complications.

towards home care and treatment at ambulatory surgical centers that held down expenditures by about 8 percentage points; expenditures per patient would have increased 18 percent — rather than the actual 11% increase — in the absence of these shifts. Similarly, for conditions in the gastroenterology and ophthalmology classes (lines 11 and 7), shifts towards care at ambulatory surgical centers appear to have held down expenditure growth. Finally, psychiatry, including depression and anxiety disorders (line 4), and endocrinology, including diabetes and obesity (line 2), show shifts towards the use of drugs, suppressing expenditure increases. [14]

For the other disease classes, the story is more nuanced. For example, many conditions in the cardiology group generally show large declines in inpatient care. These declines are coupled with declines in the intensity of other hospital treatment and office visits, and the numbers indicate the effect of these declines on expenditures is not offset by increases in other services. Similar issues pertain to other conditions.

V. Conclusion

Our empirical work suggests that there have been shifts in treatment intensity that have an important effect on expenditure growth and that, on average, those treatment shifts served to hold down expenditure growth for patients in our sample. These shifts appear to be numerically important and pervasive. As noted by health economists, standard price indexes provided by statistical agencies do not capture this effect and, thus, overstate how much of rising health care costs can be attributed to the rising cost of providing treatments.

Nonetheless, our work points to the potential importance of this issue and underscores the importance of further work to form more precise estimates with sufficiently broad coverage of patients to make inferences about the cost of treating diseases for the nation as a whole. While our focus in this paper is on creating an aggregate price index that covers all diseases, our methodology also allows for a disease by disease decomposition of price growth into within and between treatment groups. We

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[14] Some think that increased use of prescription drugs, not just new drugs, can reduce non-drug spending through more nuanced channels, but that evidence is mixed: For example, Lichtenberg (2001) finds that newer drugs involve bigger offsets while Duggan (2005) and Frank et. al. (2006) find the opposite.

leave any further analysis into changing utilization of treatments by disease for future work.

We feel this research presents a step toward a more ideal price index for medical care and there are a number of issues that would need to be resolved if one were to construct an ideal price index. While one can easily imagine controlling for observable demographics to control for changes in case mix, this approach will not allow resesarchers to fully disentangle pure price growth from increasing disease severity. Similarly, our somewhat coarse treatment indexes are a combination of pure price growth and improvements in technology. Finally, outcome measures are necessary in order to measure changes in quality.

While these issues are important for the construction of an ideal price index, they do not affect our comparisons of the MCE and SPI indexes or our ability to assess the source of any differences. As such, we are able to demonstrate the potential importance for official statistics of ignoring shifts in services that affect the expenditures needed to treat medical conditions. Although our results are for a select subset of the population, applying them broadly suggests that inflation may be overstated by as much as 0.3 percentage points a year.

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Appendix

A1. Derivation of (3): The MCE_d and SPI_d indexes were defined in (1) and (2) as :

$$(1) \quad MCE_d = \{ \Sigma_s \; c_{d,s}{}^2 \, x_{d,s}{}^2 / N_d{}^2 \} / \{ \Sigma_s \, c_{d,s}{}^1 \, x_{d,s}{}^1 / N_d{}^1 \}$$

$$(2) \quad SPI_d = \{ \Sigma_s \, c_{d,s}{}^2 \, x_{d,s}{}^1 \} / \{ \Sigma_s \, c_{d,s}{}^1 \, x_{d,s}{}^1 \}$$

We want to derive (3), which boils down to showing that

$$(3') \quad MCE_d - SPI_d = \Sigma_s \, SPI_{d,s}(dU_{d,s} - 1),$$

with $SPI_{d,s} = c_{d,s}{}^2 \, x_{d,s}{}^1 / \{ \Sigma_s c_{d,s}{}^1 x_{d,s}{}^1 \}$ (i.e., $SPI_d = \Sigma_s SPI_{d,s}$) and $dU_{d,s} = (x_{d,s}{}^2 / N_d{}^2) / (x_{d,s}{}^1 / N_d{}^1)$.

To show this, we restate the two indexes in terms of $SPI_{d,s}$ and $dU_{d,s}$ and then take the difference in (3'). Beginning with MCE_d, first multiply each term in the numerator by **[($x_{d,s}{}^1 / N_d{}^1$) / ($x_{d,s}{}^1 / N_d{}^1$)]** and restate it as:

$$MCE_d = \{ \Sigma_s \, c_{d,s}{}^2 \, x_{d,s}{}^2 / N_d{}^2 \, \mathbf{[(x_{d,s}{}^1 / N_d{}^1) / (x_{d,s}{}^1 / N_d{}^1)]} \} / \Sigma_s \, c_{d,s}{}^1 \, x_{d,s}{}^1 / N_d{}^1 \}.$$

Next, factor out $1 / N_d{}^1$ from the numerator and denominator, switch the x's and N's in the numerator (specifically, $\mathbf{x_{d,s}{}^1}$ for $\mathbf{x_{d,s}{}^2}$ and $\mathbf{N_d{}^1}$ for $\mathbf{N_d{}^2}$), and note the definitions of $SPI_{d,s}$ and $dU_{d,s}$ to obtain a term that is the numerator of the SPI_d multiplied by a utilization term:

$$MCE_d = \{ \Sigma_s \, c_{d,s}{}^2 \, x_{d,s}{}^1 \, [dU_{d,s}] \} / \{ \Sigma_s \, c_{d,s}{}^1 \, x_{d,s}{}^1 \} = \Sigma_s \, SPI_{d,s} \, dU_{d,s}$$

As noted above, the SPI index can be written as $SPI_d = \Sigma_s SPI_{d,s}$ so that the difference in the two indexes is as given in (3').

A2. SPI in equation (5) can also be written as a weighted average of service indexes.

Official price indexes for medical care begin with price indexes for each service and then aggregate up over all services using expenditure shares from period 1 (i.e., Laspeyres weights). Define a service price index for service s as $SPI_s = \Sigma_d c_{d,s}^2 x_{d,s}^1 / \Sigma c_{d,s}^1 x_{d,s}^1$. Although we don't normally express these in terms of the underlying conditions, this is not too far from what the BLS actually does. For inpatient care, for example, they choose certain DRGs, like heart surgery, and track the price of that DRG over time. With office visits, they choose a representative bill (a visit for a mix of conditions) and price that over time. The link is more tenuous for drugs because BLS prices by medication class (i.e. NDC) while an SPI for drugs, as defined above, prices drugs for specific conditions — to the extent that drug prices vary across conditions, then the SPI index above would diverge from the way BLS actually prices pharmaceuticals.

To show the connection between a weighted average of SPIs for services and the SPI defined in equation (5), let the expenditure share for service s in period 1 be $\Sigma_d c_{d,s}^1 x_{d,s}^1 / \Sigma_s \Sigma_d c_{d,s}^1 x_{d,s}^1$ and form the weighted average:

$$\Sigma_s w_s \, SPI_s = \Sigma_s \frac{\Sigma_d c_{d,s}^1 x_{d,s}^1}{\Sigma_s \Sigma_d c_{d,s}^1 x_{d,s}^1} \, SPI_s = \frac{\Sigma_s \Sigma_d c_{d,s}^2 x_{d,s}^1}{\Sigma_d \Sigma_s c_{d,s}^1 x_{d,s}^1}$$

The ratio of double sums in the last term is exactly what one obtains if one takes a weighted average of SPIs for individual conditions, as defined in (5):

$$SPI = \Sigma_d w_d \, SPI_d = \Sigma_d \frac{\Sigma_s c_{d,s}^1 x_{d,s}^1}{\Sigma_s \Sigma_d c_{d,s}^1 x_{d,s}^1} \, SPI_d = \frac{\Sigma_d \Sigma_s c_{d,s}^2 x_{d,s}^1}{\Sigma_d \Sigma_s c_{d,s}^1 x_{d,s}^1}$$

Table 1. Descriptive Statistics for Pharmetrics Sample

		2003	2004	2005
Number of enrollees (mil)		10.9	11.1	11.3
Gender				
	Female	54.5%	54.0%	53.9%
	Male	45.5%	46.0%	46.1%
Age				
	0 to 18	29.7%	28.4%	28.0%
	19 to 24	6.6%	6.7%	6.7%
	25 to 34	13.9%	13.9%	13.7%
	35 to 54	37.1%	37.5%	37.1%
	55 to 64	10.8%	11.9%	12.9%
	over 65	1.9%	1.8%	1.7%
Region				
	E	22.5%	24.8%	24.3%
	MW	26.1%	26.5%	27.8%
	S	31.5%	29.2%	30.4%
	W	19.8%	19.5%	17.4%
Plans				
	HMO	29.2%	27.6%	25.9%
	PPO	54.6%	55.8%	56.7%
	POS	16.3%	16.7%	17.4%

Table 2. Spending by Place of Service, 2003Q1

Place of Service	Spending/ Encounter	Total Spending (millions)	(pct)
Inpatient Hospital	$4,332	$1,488	25.0%
Office Visits	$105	$1,461	24.6%
Pharmacy	$87	$1,326	22.3%
Outpatient Hospital	$337	$822	13.8%
Unknown	$314	$306	5.1%
Emergency Room-Hospital	$370	$181	3.1%
Ambulatory Surgical Center	$1,079	$92	1.5%
Home Care	$281	$84	1.4%
Other inpatient hospital care	$432	$81	1.4%
Independent Lab	$54	$63	1.1%
		$5,944	100.0%

Table 3. Allocation of Spending by Disease, 2003Q1
(million dollars)

| MAJOR PRACTICE CATEGORY | SPENDING ALLOCATED USING: | | Total Spending | |
	Diagnoses and Procedure Codes	Drug Codes (NDC)	millions	percent
1 INFECTIOUS DISEASES	$53.0	$8.1	$61.1	1.0%
2 ENDOCRINOLOGY	$319.4	$36.7	$356.1	6.0%
3 HEMATOLOGY	$134.9	$2.0	$136.9	2.3%
4 PSYCHIATRY	$278.0	$36.8	$314.9	5.3%
5 CHEMICAL DEPENDENCY	$34.2		$34.2	0.6%
6 NEUROLOGY	$308.8	$20.8	$329.6	5.5%
7 OPHTHALMOLOGY	$98.1	$0.3	$98.4	1.7%
8 CARDIOLOGY	$543.4	$11.3	$554.8	9.3%
9 OTOLARYNGOLOGY	$426.9	$24.4	$451.3	7.6%
10 PULMONOLOGY	$269.5	$13.5	$283.0	4.8%
11 GASTROENTEROLOGY	$475.4		$508.1	8.5%
12 HEPATOLOGY	$135.9		$135.9	2.3%
13 NEPHROLOGY	$57.7		$57.7	1.0%
14 UROLOGY	$167.3	$3.0	$170.3	2.9%
15 OBSTETRICS	$263.3		$263.3	4.4%
16 GYNECOLOGY	$384.4	$0.4	$384.8	6.5%
17 DERMATOLOGY	$225.7	$6.7	$232.4	3.9%
18 ORTHOPEDICS & RHEUMATOLOGY	$865.6	$8.9	$874.5	14.7%
19 NEONATOLOGY	$115.8		$115.8	1.9%
20 PREVENTIVE AND ADMINISTRATIVE	$172.5	$45.3	$217.8	3.7%
21 LATE EFFECTS, ENVIRONMENTAL TRAUMA AND POISONINGS	$32.1		$32.1	0.5%
22 ISOLATED SIGNS & SYMPTOMS	$80.1	$8.3	$88.4	1.5%
OTHER	$241.9		$241.9	4.1%
	$5,684.0	$259.3	$5,943.3	100.0%

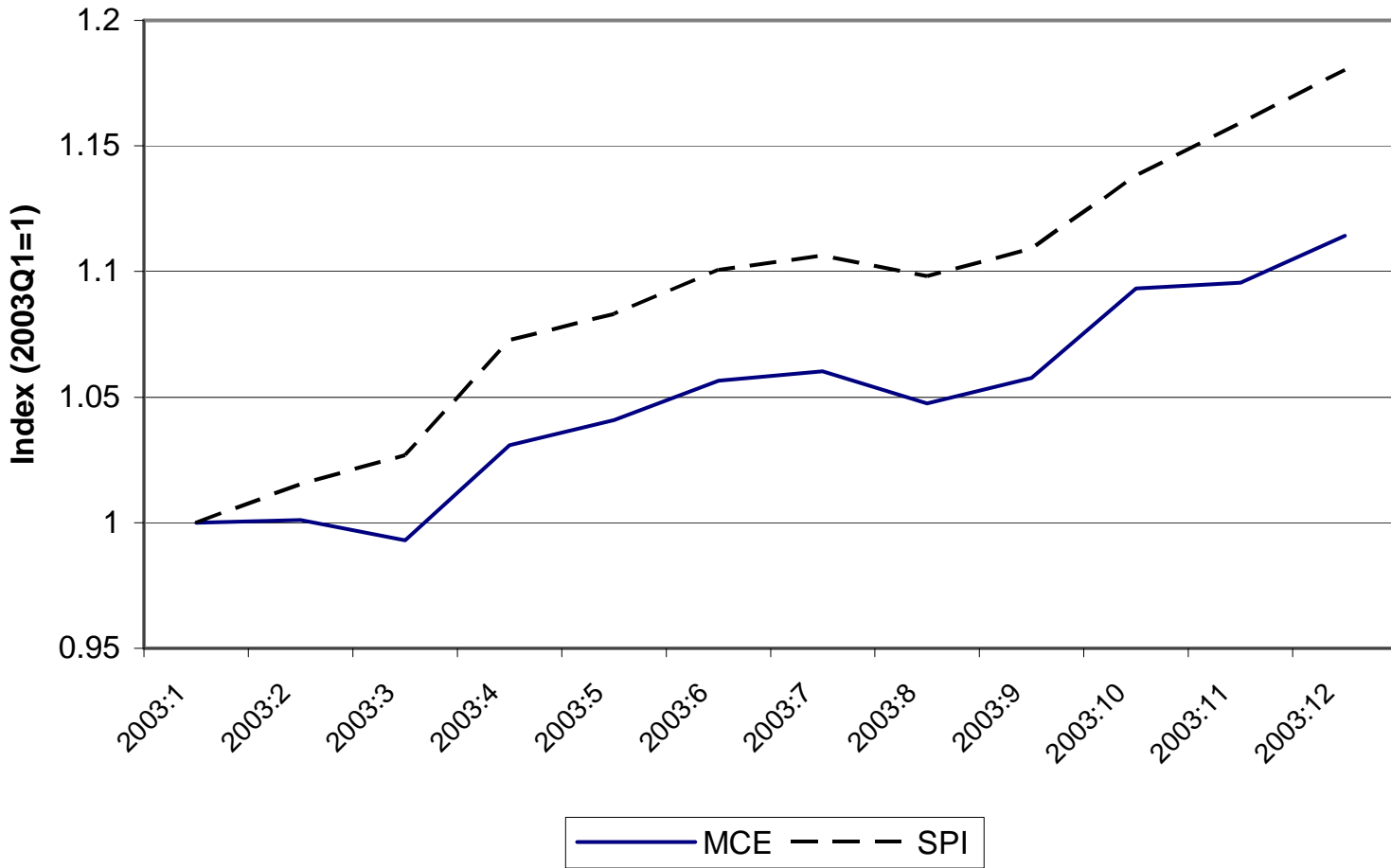**Chart 1. Aggregate MCE and SPI Price Indexes for Medical Care Expenditures**

Table 4. Comparison of Price Indexes and Sources of Differences, 2003Q1-2005Q4

| | Price Indexes | | | Contribution to Differences in MCE and SPI (percentage points) | | | | | | | | |
| | | | | Hospital | | Office | | | | Home | | |
Major Practice Category	MCE	SPI	MCE-SPI	Inpatient	Outpatient	Visits	Pharmacy	ER	Lab	Care	ASC	Other
1 INFECTIOUS DISEASES	36.3%	36.7%	-0.4%	-1.5%	-0.7%	-0.8%	1.3%	0.3%	0.2%	0.7%	0.0%	0.1%
2 ENDOCRINOLOGY	10.8	14.8	-4.1	-3.9	-1.0	-2.1	3.0	-0.1	-0.1	0.5	-0.1	-0.3
3 HEMATOLOGY	18.1	24.1	-6.0	-4.1	-2.3	-1.2	-0.3	0.0	0.1	0.1	0.0	1.6
4 PSYCHIATRY	1.6	7.6	-6.0	-2.1	-0.3	-5.3	2.3	0.0	0.0	0.0	0.0	-0.7
5 CHEMICAL DEPENDENCY	15.7	12.0	3.7	-0.2	-2.3	-2.0	3.5	2.9	0.1	0.0	0.1	1.5
6 NEUROLOGY	11.7	20.6	-9.0	-3.8	-1.9	-2.8	0.5	-0.2	0.0	0.0	0.0	-0.8
7 OPHTHALMOLOGY	8.3	11.0	-2.7	-0.4	-2.1	-0.6	-0.4	-0.1	0.0	0.3	0.9	-0.2
8 CARDIOLOGY	0.3	19.1	-18.8	-15.0	-1.6	-1.4	-0.1	0.1	0.1	0.1	-0.1	-0.9
9 OTOLARYNGOLOGY	8.9	14.8	-5.9	-0.2	-2.5	-2.0	-0.8	-0.2	0.1	0.2	0.0	-0.3
10 PULMONOLOGY	15.3	20.7	-5.4	-2.6	-1.5	-1.7	0.1	-0.5	0.0	0.3	0.0	0.5
11 GASTROENTEROLOGY	15.6	22.5	-6.9	-3.3	-2.5	-1.9	-0.4	-0.1	0.2	0.1	0.7	0.4
12 HEPATOLOGY	8.3	13.7	-5.4	-3.2	-1.4	-0.5	-1.6	0.2	0.0	0.0	0.2	1.0
13 NEPHROLOGY	1.9	9.9	-8.0	-2.4	-5.4	-0.5	0.5	0.0	0.1	-0.2	-0.1	0.0
14 UROLOGY	7.0	16.9	-9.9	-4.3	-3.4	-1.8	0.2	-0.2	0.2	0.1	-0.1	-0.5
15 OBSTETRICS	17.0	16.4	0.6	0.7	-0.5	0.0	-0.4	0.2	0.2	0.1	-0.1	0.3
16 GYNECOLOGY	11.0	21.4	-10.4	-3.8	-2.8	-3.0	-0.5	0.1	0.0	0.0	-0.4	0.0
17 DERMATOLOGY	15.7	19.8	-4.1	-0.6	-1.3	-1.6	-0.9	-0.3	0.3	0.3	-0.6	0.6
18 ORTHOPEDICS & RHEUMATOLOGY	10.8	18.3	-7.5	-2.5	-2.7	-1.4	-0.1	-0.2	0.0	0.6	0.2	-1.4
19 NEONATOLOGY	17.1	17.7	-0.6	-1.0	-0.1	0.6	-0.1	0.0	0.0	-0.2	0.0	0.1