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RESEARCH BRIEF
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A Comparison of Bureau of Economic Analysis and Bureau of Labor Statistics Disease-Price Indexes

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Background

National health expenditures and health care prices are routinely measured according to type of service, such as hospital care, physician care, or prescription drugs. The official National Health Expenditure Accounts (NHEA) maintained by the Centers for Medicare & Medicaid Services (CMS), and the National Income and Product Accounts (NIPA) maintained by the Bureau of Economic Analysis (BEA) both track spending in this way. Health care prices, maintained by BLS, are also measured by type of service. Within this framework, the drivers of health spending tend to be analyzed in terms of service volumes and prices.

While BEA continues to measure health spending by type of service within the NIPA, they have recently introduced a new set of accounts that estimate health spending by disease category. Within this framework, BEA also introduced the Medical Care Expenditure (MCE) Index to measure the change over time in the costs of treatment within these disease categories. BLS has also developed a disease price index known as the Experimental Disease Price (EDP) Index. The purpose of this paper is to compare and contrast these two indexes and to suggest areas for future improvements.

Disease Price Index Definition

The motivation for producing disease-based price indexes derives from a long line of literature, which started with Anne Scitovsky (1964). Her work was followed by several others showing the importance of focusing on total treatment expenditures, rather than the price of a specific service. These papers include Berndt et al. (2002) – Depression, Cutler et al. (1998) – Heart Attacks, and Shapiro et al. (2001) – Cataracts. This literature emphasized the importance of measuring the price of outputs or treatments in the health care sector, rather than focusing on the prices of specific services.

There are a variety of reasons to focus on the total expenditure for treating a condition. First, it is well documented that treatment substitution patterns have shifted across services, products, and locations, which can have a great impact on treatment costs. In fact, we continue to see shifts within hospital care from inpatient to outpatient services and also from hospital services toward physician services. These types of shifts are not captured by more traditional price indexes that focus on a particular service. Second, from the perspective of an individual, an insurer, or a health system, inflation is viewed as the total expenditure for treatment, regardless of the location of the treatment. Third, many papers have shown that technology and quality have improved dramatically for the health care sector in the past several decades. Many health economists argue that it will be easier to account for these quality changes by focusing on the treatment, rather than particular services.

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Based on this literature, there have been numerous recommendations by the academic community to pursue the development of disease-based price indexes (e.g., Berndt et al. (2001), Schultze and Mackie (2002), and National Research Council (2010)). Both the BEA and BLS have responded by pursuing research agendas with the goal of developing disease-based price indexes.[1] Thus, for both agencies, the disease price index is intended to measures changes over time in the price for the entire treatment of a particular disease that accounts for all the inputs (e.g., inpatient hospital, prescription drug, and other goods and services), including all expenditures associated with each input. While the basic target index of the two agencies is the same, the different research paths followed by the two agencies have led to distinct disease-based price indexes.

Before discussing the indexes at the two agencies, it is helpful to first consider the features of a disease-based price index that satisfies the key requirements of both agencies. For simplicity, when describing this target index, we will focus on a single condition and a simple formulation of the index.[2] For a particular disease in year t, let the target price index from year (t-1) to (t) be:

$$(1) \qquad Disease\ Price\ Index\ (DPI) = \frac{price\ to\ treat\ a\ patient_t}{price\ to\ treat\ a\ patient_{t-1}}$$

There are two critical assumptions for the price index: (1) the severity of the patient must be identical across periods; and (2) the expected outcomes or quality of the treatments have not changed (or severity and quality are accounted for in the index). It should also be noted that this target index could be written in terms of its components. Let P_s be the price of health care service, s, (E.g., inpatient, outpatient service, or prescription drug), and let Q_s be a measure of quantity of that service used to treat a patient. In that case, one possible measure of the $price\ to\ treat\ a\ patient_t = \sum_s P_{s,t} \cdot Q_{s,t}$ and using this measure the index in (1) becomes:

$$(2) \qquad DPI = \frac{\sum_s P_{s,t} \cdot Q_{s,t}}{\sum_s P_{s,t-1} \cdot Q_{s,t-1}}$$

While both agencies are targeting a similar index, there are several factors that have led the research at the two agencies down different paths. First, the two agencies require different features from their indexes. The timeline of the index is especially important for BLS because it is mandated to produce indexes on a monthly basis without regular revisions. In contrast, BEA produces quarterly indexes that are regularly revised as new and better data sources become available. A second reason for developing different price indexes at the two agencies is that the agencies didn't receive just one recommendation, but actually a variety of them (See Schultze and Mackie (2002) and National Research Council (2010)). The varied recommendations actually reflect the current state of academic literature, which has not settled on a single methodology for measuring disease-based prices. Currently, there is no single methodology that is preferred by the agencies or the academic literature. Finally, by following distinct paths there is greater opportunity for the agencies to learn about the strengths and weaknesses of different approaches. Indeed, following different paths has led to a deeper understanding of disease-based price indexes, and has helped the agencies identify possible improvements to their methods.

Both the BEA and BLS acknowledge the longer term goal of adjusting this measure for changes in the quality of treatment, so that the indexes would measure changes in the price of achieving a given level of success in disease treatment. But for now, the indexes are not accounting for changes in quality.

The next two sections will discuss the indexes at the two agencies and, for each index, highlight ways in which they differ from the target index. This is followed by a direct comparison of the two indexes.

[1] It should be noted that this is a challenging task because it is not possible to sample a price for the entire treatment of a disease or condition. To treat a medical condition in the health care market, individuals do not typically pay a single price for treating a condition, but instead receive a variety of goods and services for treatment. The prices for the individual goods and services are set for individuals inputs (e.g., prescription drug or office visit), which are currently measured by the BLS, while the quantity of services received depends on the treatment choices of individuals and their physicians.

[2] There are a variety of price index formulas and a number of theoretical and empirical factors to consider when constructing an index, but for simplicity this report focuses on a very basic formula.

BEA Disease Price Index (MCE)

The BEA disease price index, labeled the Medical Care Expenditure (MCE) Index, represents a straightforward application of the DPI definition given in equation (1). The price to treat a patient is computed directly as the average expenditure to treat a patient for a disease including all input sources. Specifically, it is calculated as the ratio of expenditures for treatment in one period to expenditures for treatment in a prior period. This approach follows the recommendation from National Research Council (2010) and the methodology of Aizcorbe and Nestoriak (2011).

The MCE actually comes in two varieties. One version is based entirely on Medical Expenditure Panel Survey (MEPS) data. The MEPS survey is a nationally representative survey of around 32,000 individuals each year, with information on health care expenditures, including the diagnosis associated with those expenditures. A second version of the MCE is referred to as the "blended" account, and supplements MEPS with some large claims data for selected subsets of the population. The "blended" version of the MCE was developed to address the relatively small sample sizes observed in the MEPS data. Much of what follows will focus on the version that uses only MEPS. While the featured index at BEA is from the blended account, this comparison will primarily focus on the MEPS index. This allows for a more direct comparison with the MEPS-based BLS index.

There are several potential differences between the MEPS-based MCE and the "target" index.

- **Severity–**A key assumption of the target index is that the severity of the patient remains constant. However, when applying the index formula to real-world data, it is possible that average severity of patients will differ from year to year, thus impacting the accuracy of the MCE relative to the target index.
- **Timing–**MEPS data are not very timely, generally two to three years out of date. To illustrate, MEPS data for 2014 were released in September 2016. Given the time required to incorporate new data, the most current MCE as of this writing (March 2017) is for 2013.
- **Volatility–**The target index reflects the true expenditure for treatment in the population, but in reality, the MCE is an estimate and contains some noise. The MEPS sample size is not large enough to smooth out the substantial variances in spending per person when looking at specific disease conditions. Thus the MCEs can be quite noisy year-to-year. The blended version of the MCE uses large claims databases to help address this issue.
- **Decomposition–**Analysts and policy makers might wonder if a disease price went up because the prices of specific services went up or there was a shift to more expensive mix of services. The MCE currently does not publish the breakouts needed to address such questions.
- **Annual vs. treatment period–**While the target index focuses on the expenditures per treatment, for practical purposes the MCE index actually measures the cost of treatment over a one year period. This difference doesn't appear to affect the index in general, but could theoretically lead to differences.

BLS Disease Price Index (EDP)

The BLS disease-price index, labeled the Experimental Price Index (EDP), was developed in response to a recommendation from the Committee on National Statistics (Schultze and Mackie (2002)) to build an index that would be updated using existing BLS price indexes for the services (and goods). The BLS existing producer and consumer price indexes (PPIs and CPIs) would be combined with data on the service mix utilization to account for the changing mix of services. In other words, rather than focus on the total expenditures for treatment and compute the cost of disease treatment directly, the index is built from the price and quantity components specified in equation (2) above. More specifically, for different categories of services (and goods), there is a distinct price component, $P_{s,t}$, and a quantity component, $Q_{s,t}$.

This paper focuses on an annual version of the EDP to aid in comparison to the MCE, which is an annual index. The service price component in the initial or base year is computed as the price per encounter/event for each service. The price in future periods is computed by inflating the base year price using the appropriate PPI or CPI. The quantity component is based on the number of encounters per person with the associated condition in the MEPS data. Because the most current MEPS data are about three years out of date, encounters are measured with a three-year lag.

The discussion below highlights some difference between the EDP and the target disease price index. Many of these points are similar to those noted for the BEA index. However, because the EDP is estimated from price and quantity components, some points are specific to the EDP.

- **Severity–**Similar to the BEA methodology, it is possible that the severity of patients change over time. In particular, more severe patients may require more encounters, increasing the quantity component of the EDP. This would create a deviation away from the target. Importantly, if the severity of a patient causes them to seek higher price services, these changes would not be reflected in the BLS price index. One advantage of the EDP is that the price component of the index is built from the BLS PPI index, which prices identical goods across periods (e.g., the price of x-ray from the same physician's office over two periods).
- **Timing–**While our analysis focuses on an annual EDP measure, the EDP is a very timely index and updated on a monthly basis. The timelines of the index is created using current PPIs/CPIs and lagged quantity measures from MEPS. While the timeliness of the index is a desirable feature, it is possible that lagged quantity changes may not reflect current quantity changes, leading to potential deviations from the target index.
- **Volatility–**The PPIs and CPIs used in the construction of the EDP have very little volatility, but the quantity component of the index comes from the MEPS data. The MEPS is not large enough to smooth out the substantial variances in encounters when looking at specific condition categories. Thus the EDPs at the level of the condition category can be quite noisy.
- **Decomposition–**By explicitly decomposing spending by disease into service components, and then further decomposing spending into price and volume subcomponents, the EDP provides the opportunity to analyze disease prices in terms of changes in the mix of services as well as the prices and volumes of services.
- **Annual vs. treatment period**–Similar to the MCE index, rather than focusing on the number of encounters per treatment or episode, the EDP index measures the number of encounters per patient over a one year period.
- **Matching service price and quantity**–For the EDP to match the target, the price and quantity measures must correspond to the same unit. However, the BLS PPI measures specific procedures (E.g., MRI or x-ray), while the quantity measure from the MEPS is an encounter. In this case, a deviation from the target index will occur if there is a change in the number or intensity of procedures per encounter. For instance, if physicians substitute an MRI for an X-ray, the target disease price index would increase, but the EDP would not change. Indeed, there is some evidence in the literature that the intensity per office visit has increased over time.[3]
- **Matching price and disease –** The PPI and CPI price indexes used in the construction of the EDP are not disease-specific. This may be problematic in cases where the disease-specific prices deviate greatly from the average. For example, when Lipitor went off patent, the prescription drug price for the disease it treats (hyperlipidemia) dropped dramatically at the same time that overall prescription drug prices were rising. Thus, even if the EDP is accurate when averaged across all diseases, it could be inaccurate for particular diseases.

Empirical Comparison of the MCE and EDP

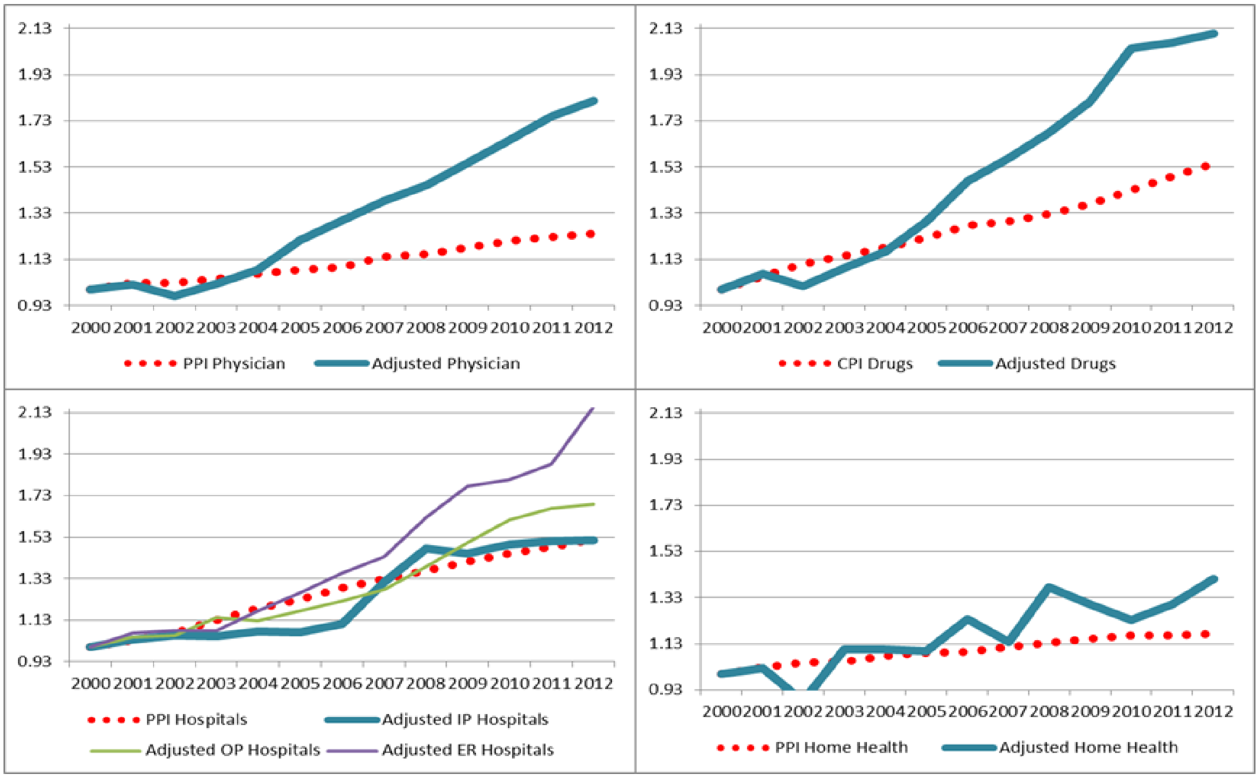
The differences in data sources and methods between the MCE and EDP will necessarily lead to differences in the historical behavior of the two indexes. For the MCE, the annual change in the disease price is measured as the annual change in what is spent per person with the

[3] See Dunn, Liebman, and Shapiro (2014).

disease according to MEPS data. For the EDP, the annual change depends upon the change in the various BLS service price indexes and in the number of service encounters using MEPS (with a lag).

Researchers from BLS and BEA computed the cumulative growth in disease prices from 2000 to 2012 and found that the MCE grew nearly twice as fast as the EDP (57.5% cumulative growth from the MCE vs. 24.4% from the EDP). They traced the source of this differential to the price component, showing that the BLS service price indexes grew much more slowly than the average price of a service encounter in MEPS, particularly for physician services and prescription drugs (see below).

Figure 1: Comparison of BLS Price Indexes and MEPS Encounter Prices for Selected Services



Note: Adjusted results are based on MEPS encounter prices. Estimates are from Bradley, Dunn and Rittmueller (2016).

This finding matches the results from Dunn, Liebman, and Shapiro (2014), which used MarketScan claims data and showed that the growth in service price per encounter rose substantially faster than service price per procedure. This result was caused by an increase in the intensity of services per encounter. This suggests that the current EDP methodology, which does not account for changes in the intensity of service per encounter, would greatly understate growth and move the EDP away from the MCE index.

Recommendations

This section provides some suggested modifications to the MCE and EDP that would bring them both closer to the target index, and closer to one another. It should be noted that some of these suggestions draw from work that BLS and BEA researchers have already begun[4] and are not necessarily "new" ideas. The following issues are addressed:

- cumulative growth
- volatility
- timeliness and lags
- disease-specific service price growth
- severity adjustments
- quality adjustments

Cumulative growth. The large differences in cumulative growth between the MCE and EDP occurs because, for most services, the price of MEPS encounters grows much faster than the associated BLS price index. Thus the MEPS encounters (numbers of visits, prescriptions, hospital stays, etc.) are not the same as service units whose prices are measured by the PPIs and CPIs. One possible solution is to replace MEPS encounters with an implicit measure of service quantity that matches the units whose prices are measured by the BLS price indexes. One approach is given below in recommendation #1.

> *Recommendation #1*: For each service, create an implicit service quantity index (QI_s) such that the product of the BLS price index for that service (P_s) and QI_s grows at the same rate as service spending per person with the disease. Let α represent the annual growth rate in service spending per person with the disease, and β represent the growth rate in P_s. Set QI_s = 1.0 in the base year and increase it over time according to the following formula:
>
> $$(3) \qquad QI_{s,t} = QI_{s,t-1} \text{ x } (1+\alpha) / (1+\beta)$$
>
> The growth rate in P_s x QI will be equal to the growth rate in service spending per person with the disease, thus eliminating the primary cause of the gap in cumulative growth between the EDP and MCE. This recommendation is an endorsement of the idea originally proposed by staff at the agencies in Bradley, Dunn and Rittmueller (2016).

Volatility. Both indexes suffer from volatility due to the relatively small MEPS sample sizes. BEA has addressed this in their blended version which supplements MEPS with large claims data sets.

> *Recommendation #2*: Have BEA provide BLS with estimated service spending per person, by disease, from their blended data, and use these estimates to form the implicit service quantity index in equation (3). This will result in a less volatile EDP.

Timeliness and Lags. Because of delays in the availability of MEPS data, the most recent MCE is roughly three years out of date. The EDP is current but its calculation depends upon service quantities that are lagged three years. Recommendation #3 (below) presents an approach that BEA could use to estimate MCEs for the three most current years in which MEPS data are not yet available. These MCEs would be subject to revision over time as new MEPS data come available. Note that the recommended approach to estimating these more timely MCEs is based largely upon the EDP formula but uses projected service quantities rather than three year lagged actuals.

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[4] See Bradley, Dunn and Rittmueller (2016).

> *Recommendation #3*: Create a time series of implicit service quantity indexes as described above in Recommendation #1. Analyze the trends in this series and apply the results to develop projections forward to the current year. Combine these results with the BLS service price indexes to project service spending by disease up to the current year. Add across services to create projections of total spending per person with the disease and then apply the usual MCE formula to project MCEs to fill in each year of the three year gap.

This recommendation provides for an up-to-date MCE, though the most recent three years would be preliminary and subject to revision.

The problem of three year lags in service quantities used in the EDP could technically be solved using this same approach. In the historical data through the latest year of MEPS, the EDP could use service quantities matched to the actual year of the index rather than lagged three years. Projected quantities would be use for more recent years. Using the implicit quantity measure from Recommendation #1, this would result EDP and MCE being very close in value. However, this approach requires three years of preliminary estimates subject to revision and BLS seeks to avoid such revisions.

Disease-specific service price growth. For any given service, the associated BLS price index (PPI or CPI) represents an average across all diseases. A key question is the extent to which there is disease-specific variation in service price inflation. If this variation is minimal, the BLS price indexes will be relatively accurate indicators for specific diseases but when there is large variation, the indexes may miss the mark for many diseases (see Appendix).

The greatest variation seems likely to be in the service category of prescription drugs. In any given year, a high-cost high-use drug may lose patent protection and relatively quickly be replaced by a much lower cost generic equivalent. When this occurs, prescription drug prices for the impacted disease category will be pushed downward even though the prescription drug CPI shows positive overall growth. In such cases, the EDP, which uses the prescription drug CPI for all diseases, will tend to overstate price growth for the impacted disease.

While the situation described above for prescription drugs undoubtedly occurs, further research is needed to determine how much variation actually exists from year to year, for prescription drugs and for the other service categories.

> *Recommendation #4*: Conduct research into variation across diseases in service-specific annual price growth.

> *Recommendation #5*: investigate the feasibility of adding disease categories to the BLS service price indexes, so that variations across disease in price growth can be captured in the data.

The appendix to this paper presents some simple simulations showing that impact of such variation on the accuracy of the EDP. It concludes that the EDP will be most accurate when there is high variation in price growth across different services but, for each service, low variation in price growth across diseases.

Severity adjustments. Both the MCE and EDP are intended to reflect changes over time in disease prices holding patient severity constant. As an illustration, if the average person with diabetes in MEPS is more severely ill in the current year than in the past year, both the MCE and EDP could be biased upward. This is because greater severity leads to greater levels of service utilization and this drives up both indexes. Recommendation #6 represents a first step toward adjustment for differences in average severity over time.

> *Recommendation #6*: Estimate regression models relating spending per person with a disease to patient characteristics including age, sex, and comorbidities. For each disease, apply these models to each year’s population with the disease to create a time series severity index. Use the information gained to estimate how much of the annual change in the disease price index could be due to annual differences in severity.

Quality adjustments. Advancements in the effectiveness of medical services, drugs, and devices have the potential to improve outcomes associated with disease spending. For example, the new hepatitis C drugs first released in late 2013 represent, for the first time, an actual cure. At the same time, the 2014 MCE would likely show a resulting increase in the (non-quality-adjusted) price of the disease category in which hepatitis C is mapped.

Recommendation #7: Conduct research into data and methods for measuring changes in the quality of disease treatments over time.

Recommendation #8: As estimates of quality indexes come available, analyze the extent to which disease prices should be adjusted. This will be quite difficult and it is recommended that the unadjusted prices continue to be published along with the adjustments.

APPENDIX: THE ISSUE OF DISEASE-SPECIFIC DIFFERENCES IN PRICE GROWTH FOR THE SAME SERVICE CATEGORY

This analysis focuses on the implications of differential price growth across diseases for the same service category. To simplify the analysis, it is assumed that the EDP is annual, that prior year spending by service category is known, and quantities of services per person are constant. For each disease, the EDP estimates current year spending by service category using BLS service price indexes to inflate prior year service category spending. The target disease price index (DPI) would differ from the EDP by applying disease-specific service price inflation factors instead of the BLS indexes that are averaged across all diseases.

When the EDP will closely track the DPI: If service-specific price changes are identical across diseases, the EDP will exactly match the DPI. Explanation: The EDP will be identical to the DPI when the EDP prediction of Y2 spending per patient is perfectly accurate. Under the simplifying assumptions of this section, the accuracy of the EDP Y2 spending per patient prediction depends solely on the accuracy of service price predictions. The EDP predicts services prices based upon price indices computed without regard to a specific disease. If prices change by the same amount for every disease, then the disease specific price change will be the same as the change in the price index for that service. Thus the EDP prediction of disease-specific services prices will be perfectly accurate and the EDP will exactly match the DPI.

When the EDP will deviate from the DPI: Variations in disease specific price growth for given services will result in less accurate EDP approximations to the DPI.

Explanation: Suppose prices for every service for a particular disease were to fall by 5% while overall service prices, averaged across all diseases, rose uniformly by 5%. Then the EDP approximation would be 10% above the DPI for this disease.

Simulation Results: To confirm these deductions, consider a simple simulation model with two diseases and two categories of services and generated synthetic data for alternative scenarios. The model specifies, for each disease, the base year (Y1) number of patients, volume of services per patient (S1, S2), and services prices (which can vary by disease). Alternative Y2 scenarios are generated by varying the rate of change, for each disease, in the number of patients, service volume per patient, and service prices. The first scenario illustrates conditions that are conducive to an accurate EDP approximation while subsequent scenarios illustrate conditions that are not conducive to such accuracy.

Simulation Model Initial Parameters

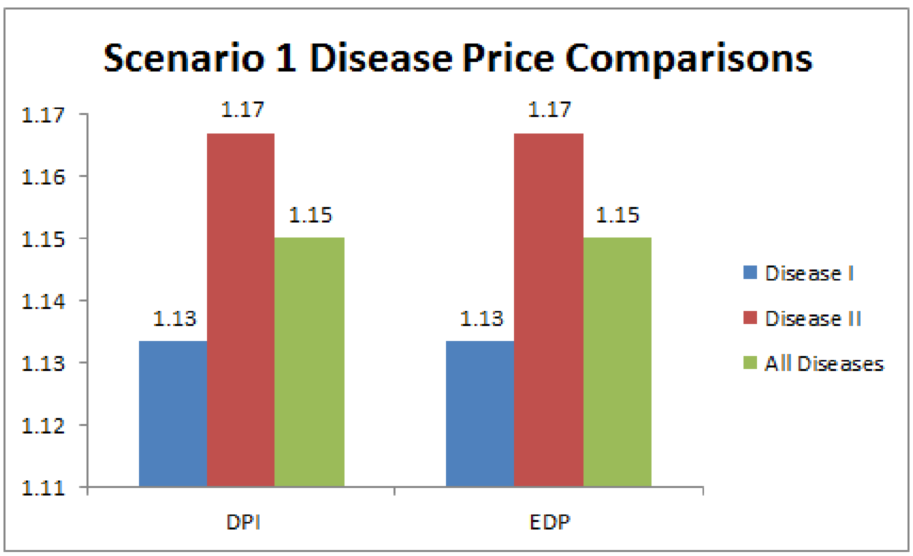
	Disease I	Disease II
# patients Y1	1.0	1.0
S1 price Y1	1.0	1.0
S2 price Y1	1.0	1.0
S1 volume per patient Y1	2.0	1.0
S2 volume per patient Y1	1.0	2.0
growth in patients	0%	0%
S1 price growth	0%	0%
S2 price growth	0%	0%
S1 volume growth	0%	10%
S2 volume growth	0%	-10%

Scenario 1: No change in service volumes per patient while service price increases differ across services but, for each service, is the same across diseases.

Simulation Model Scenario 1 Parameters

	Scenario 1	
	Disease I	Disease II
# patients Y1	1.0	1.0
S1 price Y1	1.0	1.0
S2 price Y1	1.0	1.0
S1 volume per patient Y1	2.0	1.0
S2 volume per patient Y1	1.0	2.0
growth in patients	0%	0%
S1 price growth	10%	10%
S2 price growth	20%	20%
S1 volume growth	0%	0%
S2 volume growth	0%	0%

Under this scenario, prices of service 1 were increased by 10% for both diseases and prices of service 2 were increased by 20% for both diseases. There were no changes in numbers of patients or service volumes per patient. The exhibit below compares the resulting DPI and EDP indexes for each disease and in the aggregate and shows that the EDP perfectly predicts the DPI. Indexes were set to 1.0 for Y1. In Y2, both the DPI and EDP show an index of 1.13 for disease 1 and 1.17 for disease 2. This differential is because, in Y1, disease 1 was assumed to be relatively heavy in the use of service 1 while disease 2 was relatively heave in the use of service 2. Since the price of service 2 increases faster than that of service 1, the price of disease 2 rises faster than the price of disease 1.

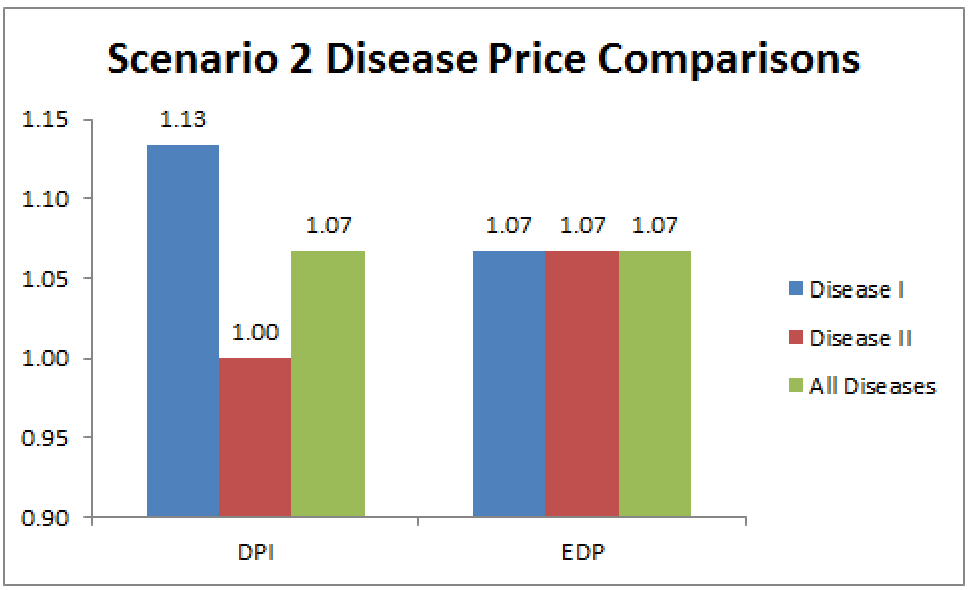


Scenario 2: No change in service volumes per patient, service prices for disease 1 increase by 10% for service 1 and 20% for service 2 while service prices remain constant for disease 2.

Simulation Model Scenario 2 Parameters

	Scenario 2	
	Disease I	Disease II
# patients Y1	1.0	1.0
S1 price Y1	1.0	1.0
S2 price Y1	1.0	1.0
S1 volume per patient Y1	2.0	1.0
S2 volume per patient Y1	1.0	2.0
growth in patients	0%	0%
S1 price growth	10%	0%
S2 price growth	20%	0%
S1 volume growth	0%	0%
S2 volume growth	0%	0%

This scenario differs from scenario 1 in that service price growth is set to zero for disease 2 (they remain at scenario 1 growth rates for disease 1). This causes the price indexes for both services to increase from 1.0 in Y1 to 1.07 in Y2. Because the EDP uses these price indexes to estimate disease spending in Y2, the EDP in Y2 is 1.07 for both diseases while the DPI shows an index of 1.13 for disease 1 (due to service price growth) and 1.0 for disease 2 (due to no service price growth. The EDP does match the DPI in the aggregate.



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