

© Health Research and Educational Trust  
DOI: 10.1111/1475-6773.12304  
METHODS BRIEF

# Measuring Prices in Health Care Markets Using Commercial Claims Data

*Hannah T. Neprash, Jacob Wallace, Michael E. Chernew,  
and J. Michael McWilliams*

---

**Objective.** To compare methods of price measurement in health care markets.

**Data Sources.** Truven Health Analytics MarketScan commercial claims.

**Study Design.** We constructed medical prices indices using three approaches: (1) a “sentinel” service approach based on a single common service in a specific clinical domain, (2) a market basket approach, and (3) a spending decomposition approach. We constructed indices at the Metropolitan Statistical Area level and estimated correlations between and within them.

**Principal Findings.** Price indices using a spending decomposition approach were strongly and positively correlated with indices constructed from broad market baskets of common services ( $r > 0.95$ ). Prices of single common services exhibited weak to moderate correlations with each other and other measures.

**Conclusions.** Market-level price measures that reflect broad sets of services are likely to rank markets similarly. Price indices relying on individual sentinel services may be more appropriate for examining specialty- or service-specific drivers of prices.

**Key Words.** Health care finance, medical price indices, quantitative methods, MarketScan Research Data

---

Increasingly, policy makers and health services researchers are interested in measuring prices of health care services and understanding how the price of services varies as a function of quality, market structure, managed care penetration, public payer prices, and other factors (Dunn and Shapiro 2011; Gaynor and Town 2011; Clemens and Gottlieb 2013). Before any conclusions can be reached about determinants of price, price measures must be constructed and their construct validity assessed. Specifically, this Methods Brief explores different approaches to measuring price, presenting tradeoffs and considerations for various empirical settings. We do not attempt to address any particular question about price but instead focus on properties of the measures themselves. Given the growing interest in price measurement, understanding the properties of different measures is important.

One common approach in the existing literature is to focus on a single “sentinel” service or a very small group of similar services (Robinson 2011a, b). It is unclear, however, how much the price of a sentinel service tells us about the overall pricing dynamics in a market. For example, if all commercial prices are negotiated as a single multiplier on Medicare rates for all services, a sentinel service price may serve as a sufficient statistic for market pricing dynamics. Alternatively, if provider and purchasers negotiate rates for specific services or if some providers have more market power than others (e.g., specialists supplying less commonly used services), a broader price measure, inclusive of many services, may yield a more accurate picture of market-level pricing, albeit at the cost of obscuring important heterogeneity in prices for specific specialties or services (which a host of sentinel services could elucidate).

#### *Approaches to Measuring Health Care Prices*

We distinguish between three approaches to measuring health care prices: (1) a “sentinel” service approach based on a single common service in a clinical domain of interest, (2) a market basket approach, and (3) a spending decomposition approach. Approaches (1) and (2) measure prices directly, while (3) decomposes spending into aggregate quantity and an indirect measure of price.

*Sentinel Service Approach.* The sentinel service approach can be thought of as an extreme of the market basket approach, where the market basket consists of a single common service. We label the chosen service as “sentinel,” because it is selected to represent a larger category of services. This approach has several advantages. First, it avoids the missing data issues inherent in our other approaches, as sentinel services are by definition common and thus typically provided in most or all geographic markets. Second, it allows specific questions of substantive interest to be addressed more directly. For example, because market structure may vary differently across markets for different ser-

---

Address correspondence to J. Michael McWilliams, M.D., Ph.D., Department of Health Care Policy, Harvard Medical School, 180A Longwood Avenue, Boston, MA 02115-5899; e-mail: mcwilliams@hcp.med.harvard.edu. Hannah T. Neprash, B.A., Jacob Wallace, B.A., and Michael E. Chernew, Ph.D., are with the Department of Health Care Policy, Harvard Medical School, Boston, MA.

vices or specialties, examining prices for key services may be instructive. Third, it imposes the fewest data demands of the three approaches, requiring primary or secondary data on prices for one or a few services rather than the universe of claims for a population. The major drawback of the sentinel service approach, however, is that service-specific price measures are less representative and therefore may not address research questions about overall functioning of health care markets as well as broader measures of price.

*Market Basket Approach.* A common approach to measuring prices more broadly is to construct a price index using a representative market basket of many services defined by some criteria. For the geographic area of interest and the chosen basket of services, a price index is calculated to facilitate comparisons across areas and over time. The Laspeyres Index used in the construction of the Consumer Price Index is a natural choice.

The composition of the market basket has important implications. A market basket with many services will capture a higher share of total spending and generate price index measures that are highly representative of overall market pricing. However, as the market basket grows to encompass services that are less common, so must the geographic area for which the index is calculated grow, or else one is likely to encounter missing data that would require the exclusion of certain areas from analysis. Expanding the geographic unit of comparison may come at the cost of blurring true market boundaries and limiting variations in market structure. Moreover, larger baskets may obscure important dynamics affecting specific services.

*Spending Decomposition Approach.* An alternative to the market basket approach is to construct a medical price index by decomposing expenditure data into price and quantity components. This approach relies on observed spending and aggregate quantity at the market level and calculates an implied market-level average price for all services. Unlike the market basket approach, which compares prices across markets for the same set of services, the spending decomposition approach allows the composition of services to differ across markets. These differences may reflect either substitutions occurring as consumers respond to changes in relative price (competitive outcomes that may be of interest) or unmeasured differences in patient case mix (that may introduce unwanted error into an analysis).

*Other Considerations for Any Price Measure.* Beyond choice of methodology, other questions arise in the implementation and interpretation of any price measure. These include the following:

- What geographic units are feasible and appropriate for defining markets?
- How should certain vagaries of claims data and payment systems, such as separate treatment of facility fees, be handled in constructing price measures?
- How sensitive are price calculations to the use of the mean or median of price distributions?

We implemented and compared the results of all three price measurement approaches, as well as explored the impact of these other considerations, using Truven Health Analytics MarketScan Research Data for year(s) 2007–2012.

## METHODS

### *Data*

MarketScan is a database of inpatient, outpatient, and prescription drug claims submitted by both private health plans and employers. It captures medical spending for employees and all family members covered under the same health insurance plan. We analyzed noncapitated inpatient and outpatient claims from 2007 to 2012, dropping a small number of claims missing enrollment information.

*Unit of Analysis (Claim-Day).* Within the MarketScan data, there are frequently multiple claim lines for a single diagnosis-related group (DRG) or current procedural terminology (CPT) on a single day for a single enrollee. Multiple claim lines may represent professional and technical components of payments for the same service (e.g., imaging services) or may simply be quirks of the billing process. We used the “claim-day”—an aggregation of all spending for a given person on a given date with a given procedure code for a given claim type (DRG, inpatient CPT, outpatient CPT)—as the basis for all calculations. It should be noted that this approach errs on the side of higher price as opposed to greater quantity. For example, the claim-day observation for a patient who receives two routine office visits (CPT is 99213) on the same day is treated as a single office visit at a higher price.

*Geographic Market Definition.* We analyzed price indices at the level of Metropolitan Statistical Areas (MSAs). As mentioned above, there are tradeoffs inherent in choosing smaller versus larger geographic areas for defining markets. MarketScan is a convenience sample of claims and may be more representative of market dynamics in some MSAs than others. As such, we restricted our analyses to the 232 MSAs where MarketScan encompassed at least 15 percent of the total population covered by a commercial PPO plan, as quantified in the HealthLeaders Inderstudy data on insurer market structure. This yielded a sample slightly greater than 2 trillion inpatient and outpatient claim-days over 2007–2012.

*Treatment of Facility Fees.* In MarketScan, roughly 5–10 percent of outpatient claims during the study period lacked CPT codes, representing almost 20 percent of spending for any given year. In our main analysis, we excluded these claims. In a sensitivity analysis, we apportioned the spending from these claims to corresponding hospital outpatient department claims with CPT codes, interpreting them as facility fees that have been carved out of total payments for services rendered in outpatient facility settings (see Appendix for details).

### *Price Index Calculation*

*Sentinel Service Price Index.* The sentinel service and market basket approaches share a calculation methodology that closely resembles a Laspeyres index. Specifically, we calculated a MSA-level price index as:

$$INDEX_m = \sum_{i=1}^n \left( \frac{\bar{p}_{im}}{\bar{p}_i} \times \frac{p_i q_i}{\sum_{i=1}^n p_i q_i} \right) \quad (1)$$

where  $m$  indexes MSA,  $i$  indexes the set of services included in the market basket,  $\frac{\bar{p}_{im}}{\bar{p}_i}$  is the ratio of the market-level average service price to the national average service price, and  $\frac{p_i q_i}{\sum_{i=1}^n p_i q_i}$  is the national expenditure share for that service. An index value of 1 indicates that the bundle of goods in MSA  $m$  is equal to the national average price for that bundle.

For the sentinel service indices, this calculation reduces to the ratio of the MSA-level average service price to the national average service price. We calculated price indices for the following six sentinel services:

- CPT 99213 (Office/outpatient visit, established)
- CPT 70553 (MRI brain without and with contrast)

- DRG 470 (Major joint replacement)
- DRG 330 (Major small and large bowel procedures with comorbidity [e.g., colectomy])
- DRG 775 (Vaginal delivery without complicating diagnoses)
- DRG 195 (Simple pneumonia and pleurisy without comorbidity)

*Narrow and Broad Market Baskets.* In the market basket approach, we applied the above price index formula to a collection of services. We defined a narrow market basket and a broader market basket. The narrow market basket included roughly 150 services explaining large shares of spending (see Appendix for specific inclusion criteria). We also calculated a price index using a broader market basket defined as services that occur in every MSA with a MarketScan population of at least 15 percent of total PPO enrollees for a given year. Table 1 displays service counts and percent of spending captured by the various market baskets.

*Spending Decomposition.* This approach relies on observed spending and aggregate quantity at the market area level to calculate an implied price measure such that:

$$IMPLIED\_PRICE_m = \frac{\sum_{i=1}^n \hat{p}_{im} q_{im}}{\sum_{i=1}^n \bar{p}_i \times q_{im}} \quad (2)$$

where  $m$  indexes MSA, and  $i$  indexes services. The implied price measure  $IMPLIED\_PRICE_m$  is equal to observed market-level spending,  $\sum_{i=1}^n \hat{p}_{im} q_{im}$ , divided by the sum of the products of the national mean service price,  $\bar{p}_i$ , and the quantity of services in the market,  $q_{im}$ . By applying the national mean price to each service, the denominator serves as a measure of aggregate quantity and the implied price measure relies simply on the definition of spending as the product of quantity and price.

## RESULTS

### *Sentinel Service Price Index*

Correlations between pairs of market-level indices for the six sentinel services were consistently positive but varied in strength within a given year (see the

Table 1: Count of Services and Percent of Spending Captured in Market Baskets, 2007–2012

Market Basket	Count of Services	Percent of Total Spending on Market Basket Services					
		2007	2008	2009	2010	2011	2012
Sentinel service: office visit	1	4	4	4	3	3	3
Sentinel service: brain MRI	1	0.5	0.5	0.5	0.4	0.4	0.4
Sentinel service: joint replacement	1	1	1	1	1	1	1
Sentinel service: colectomy	1	0.3	0.3	0.3	0.3	0.3	0.3
Sentinel service: childbirth	1	0.9	1	1	1	1	1
Sentinel service: pneumonia hospitalization	1	0.09	0.07	0.08	0.06	0.06	0.05
Narrow market basket	122–134	39	41	40	40	41	42
Broad market basket	672–936	53	56	55	56	57	58

shaded portion of Table 2). We observed moderate correlations between services that generally occur in similar settings (i.e., inpatient or outpatient) and moderate to low correlations between services occurring in different settings. Most sentinel service-based price indices exhibited strong serial correlation ( $r > 0.8$ ) over the time period in question, though colectomy and childbirth had lower correlations from year to year.

*Market Basket Indices*

The price index constructed from a narrow market basket correlated strongly with the broad basket price index ( $r > 0.98$ ). This was not surprising, given the substantial overlap between these two indices. Both market basket indices exhibited moderate to strong correlation with the office visits and brain MRIs ( $r = 0.74$ – $0.84$ ) and weak to moderate correlation with predominantly inpatient services. Serial correlation within market basket indices was high ( $r > 0.95$ ).

*Spending Decomposition*

The implied price index using the spending decomposition methodology was moderately correlated with most sentinel services indices, showing the strongest correlations with office visits and brain MRIs and weakest correlations with pneumonia. The implied price index was strongly correlated ( $r > 0.94$ )





with the narrow and broad market basket indices. Serial correlation within the implied price index was high ( $r > 0.94$ ).

### *Sensitivity Analyses*

For each measure of price, we assessed the sensitivity of estimates to population weighting, size of MSA, apportionment, and choice of central tendency measure (mean vs. median). Correlations—both between and within methods—were largely unaffected by these tests for all but the sentinel service price measures. The sentinel service price measures were sensitive to the inclusion criteria for MSAs and the use of median rather than mean (see Tables SA1–SA5). This is indicative of considerable variation in service prices both within and between MSAs. Some of this variation is the outcome of a competitive process, but it may also result from measurement error. For example, corrective claims designed to address over- or undercharges due to processing errors will produce price variation that cannot be distinguished from genuine between-provider payment variation arising from negotiations between payers and providers. Similarly, payers may treat facility payments differently at the claim level, generating between-payer price variation that cannot be disentangled from between-provider price variation.

## DISCUSSION

Our findings suggest analytic tradeoffs between various approaches to measuring commercial prices in health care markets. Indices based on sentinel services exhibited weak to moderate correlations across different services, suggesting that they may be important signals of local service markets (e.g., general hospital care or imaging) rather than representative measures of market prices. As prices in the commercial insurance market are the result of negotiations between providers and insurers, weak correlations among sentinel services may also reflect specialty-level or service-level variation in market structure. For example, a market with many freestanding imaging centers might exhibit service-specific price competition that is unrelated to the market structure for acute medical, general surgical, and obstetrical care, in which case the price index for brain MRI would show little correlation with price indices for admissions in general hospitals. Likewise, we found only moderately strong correlations between price indices for sentinel services and indices based on larger market baskets of services. Thus, sentinel service prices

may not represent overall prices in a market well, while price indices based on broader market baskets may obscure important heterogeneity across markets in prices for specific services. As such, price indices relying on individual sentinel services may be more appropriate for examining specialty- or service-specific drivers of price or in cases of limited or missing data.

While all price indices were positively correlated, the strongest correlations occurred within the market basket approach and between the market basket and spending decomposition approaches. While the market basket approach compares prices across markets for the same set of services, the spending decomposition approach allows the composition of services to differ across markets. Composition may differ across markets as consumers substitute away from higher priced services. Our finding of strong correlations between these conceptually distinct market basket and spending decomposition approaches may be indicative of minimal substitution patterns during the study period.

Similarly, the very strong correlation between the narrow and broad market baskets suggests that both approaches capture the same underlying market characteristics and are likely to rank markets similarly, regardless of whether market basket services have been selected for their high share of spending or utilization. The ability to use a narrower market basket lessens computational demands and potentially allows more markets into the analysis.

Overall, our findings do not suggest that one method of price measure is preferred over others, but that researchers and policy makers should base their use of broad or narrow indices on the question of interest.

## ACKNOWLEDGMENTS

*Joint Acknowledgment/Disclosure Statement:* This study was supported by a grant from the Robert Wood Johnson Foundation/Health Care Financing Organization (71408). The authors have no financial conflicts of interest to disclose.

*Disclosures:* None.

*Disclaimers:* None.

## REFERENCES

- Clemens, J., and J. D. Gottlieb. 2013. *Bargaining in the Shadow of a Giant: Medicare's Influence on Private Payment Systems*, pp. 1–64. NBER Working Paper 19503. Cambridge, MA: National Bureau of Economic Research.

- Dunn, A., and A. H. Shapiro. 2011. *Physician Market Power and Medical-Care Expenditures*. Washington, DC: Bureau of Economic Analysis.
- Gaynor, M., and R. J. Town. 2011. "Competition in Health Care Markets." In *Handbook of Health Economics*, Vol. 2, edited by M. Pauly, T. McGuire, and P. P. Barros, pp. 499–637. Oxford, UK: Elsevier B.V.
- Robinson, J. C. 2011a. "Hospital Market Concentration, Pricing, and Profitability in Orthopedic Surgery and Interventional Cardiology." *American Journal of Managed Care* 17 (6): e241–8.
- Robinson, J. C. 2011b. "Variation in Hospital Costs, Payments, and Profitability for Cardiac Valve Replacement Surgery." *Health Services Research* 46 (6 Pt 1): 1928–45. doi:10.1111/j.1475-6773.2011.01288.x.

## SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article:

Appendix SA1: Author Matrix.

Appendix SA2: Measuring Prices in Commercial Health Care Markets.