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2012 CAS Spring Meeting

Impact of Changes to Physician Fee Schedules in Workers Compensation

Evidence From 31 States

Frank Schmid

May 20–23, 2012
Phoenix, Arizona

The Research Questions

- What is the impact of changes to physician fee schedules in workers compensation on…
  - The actual price level of physician services?
  - The level of consumption of physician services?
- How can the combined impact on price and quantity levels be quantified as a function of state characteristics, such as…
  - The difference between price levels at fee schedule and paid prices?
  - The price level at fee schedule relative to neighboring states?

The Findings

- In response to a fee schedule increase, severity rises by about 80 percent of the legislated price level change, on average
  - The magnitude of this response varies with the difference between fee schedule prices and actual prices (price departure)
  - Alternatively, the magnitude of this response can be interpreted as varying with the price difference between the state's fee schedule and the fee schedules of its neighbors
- In response to a fee schedule decrease, severity declines by about 50 percent of the legislated change

The Approach

- Build monthly state-level price and utilization indexes of physician services in workers compensation
  - These indexes are Fisher indexes,(1) which allow for an accurate decomposition of changes in expenses into changes in prices and quantities
  - Further, there is a price index at fee schedule prices that comprises all transactions subject to the fee schedule—this is a Laspeyres index
- Define the response as the change in the price index at fee schedule, weighted by the transaction volume subject to the fee schedule
- Estimate the effect on the price, utilization, and severity indexes using a statistical impulse-response model

(1) The Fisher index is obtained as the geometric mean of Laspeyres and Paasche indexes (which are detailed in the appendix)
The indexes comprise all AMA categories (except Anesthesia) and state-specific codes (where not included in AMA categories)
AMA: American Medical Association

Utilization and Severity Indexes

- We calculate a utilization index by means of normalizing the Fisher quantity index by the number of active claims(1)
  - In this context, a claim is considered active (in a given service category or overall) if there was a transaction (in a given service category or, when overall, in any given service category) associated with this claim included in the price index for the month
- The severity index is the product of the Fisher price index and the utilization index
  - In approximation, the CAGR (compound annual growth rate) of the severity index equals the sum of the CAGRs of the price and utilization indexes
  - The severity index reflects a concept of contemporaneous severity, as losses are not developed
  - To the degree that the consumption of physician services is front-loaded in the lifetime of a claim, the severity index may decline in response to a systematic increase in claim duration

(1) The number of active claims was calculated using the "month (t) to month (t–1) ratio," as underlies the price index concept

Possible Utilization Responses

- There are two competing economic hypotheses on how the supply of medical services by physicians responds to price changes
  - The textbook response to an increase in price is an increase in supply (classical economic theory)
  - There is the hypothesis of income targeting, put forward by Camerer et al. in a study of New York City taxi drivers(1)
    - An increase in price causes a decline in supply, as the target income can be reached with a lesser quantity

(1) Camerer, Colin, Linda Babcock, George Loewenstein, and Richard Thaler (1997) "Labor Supply of New York City Cabdrivers: One Day at a Time," *Quarterly Journal of Economics* 112(2), 407-441

Previous Studies

- There are several studies on physician responses to Medicare fee schedule changes using micro-level data
  - The evidence obtained from these studies favors the hypothesis that physicians increase supply in response to (inflation-adjusted) fee schedule increases, as suggested by classical economic theory(1)
  - Yet, there are a number of analyses that argue in favor of income targeting based on correlations and *ad hoc* regression approaches
    - These studies have been criticized for spurious correlation—upward trends in utilization (overall or for individual CPT codes) may be mistaken as responses to fee schedule decreases

(1) For a recent study, see Jack Hadley, James Rechovsky, Catherine Corey, and Stephen Zuckerman (2009) "Medicare Fees and Volume of Physicians' Services," *Inquiry* 46(4), 372-390. For a survey on the literature, see Jack Hadley and James Rechosky (2006) "Factors Affecting Physicians' Medicare Service Volume: Beneficiaries Treated and Services per Beneficiary," *International Journal of Health Care Finance and Economics* 62(3), 131-150

Partial Versus General Equilibrium

- A general equilibrium model of fee schedule changes has to include a hypothesis of the behavior of the fee schedule setting entity
  - Prices (and, possibly, quantities) respond to fee schedule changes, but fee schedules may also respond to actual paid prices (and consumed quantities)
  - Although such a general equilibrium model is beyond the scope of this analysis, factoring in the behavior of the fee schedule setting agency would lead one to conclude that, in the very long haul, the rate of inflation of actual prices moves in lockstep with the rate of inflation implied by the fee schedule changes
  - On the other hand, differences in the rates of inflation between actual prices and fee schedule prices may persist for many years—Georgia is a case in point

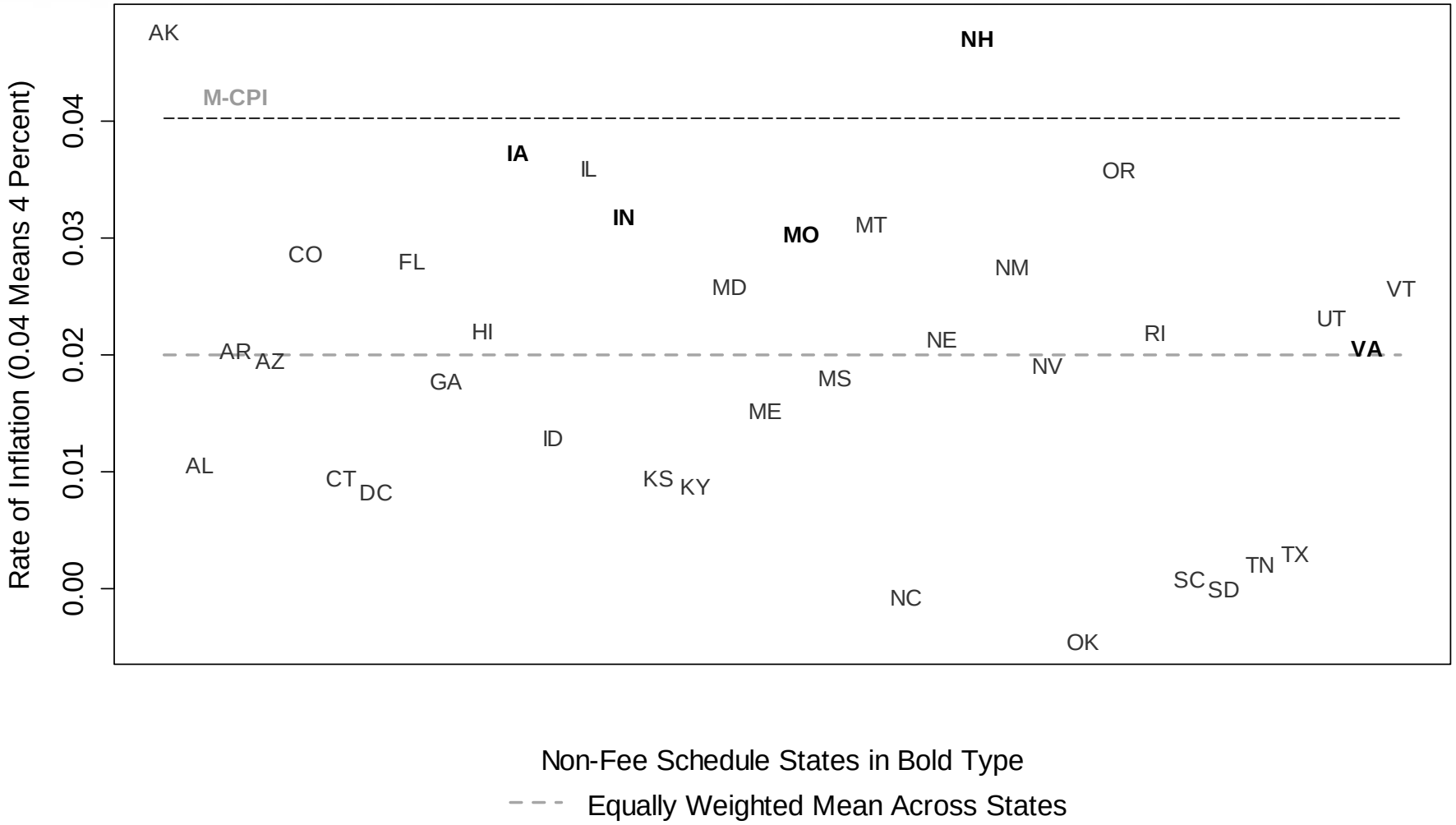
The Data Set

- The data set comprises transactions of workers compensation physician services(1) of 31 states(2) for the time period 2000 through 2010
  - Services provided by hospitals and ambulatory surgical centers are excluded(3)
  - The jurisdiction state criterion and provider zip code information is used when linking transactions to states
- We have information on the medical fee schedules in place at the time
- We edited the data set by drawing on expert knowledge, and we cleansed the data using statistical tools of outlier detection
  - For details on some of the employed data cleansing tools, see the appendix

(1) A service is defined by the CPT (Current Procedural Terminology) code and, where the modifier is part of the fee schedule, by the combination of CPT code and modifier
(2) The states are AK, **AL**, **AR**, AZ, CO, **CT**, DC, **FL**, **GA**, HI, **ID**, **IL**, KS, KY, MD, ME, MS, MT, **NC**, **NE**, NM, **NV**, OK, **OR**, **RI**, SC, **SD**, **TN**, **TX**, **UT**, and **VT**. For the 17 states printed in bold type, the start date of the study pre-dates the first fee schedule considered in the analysis
(3) Exclusion is by provider type, not place of service

Price Inflation

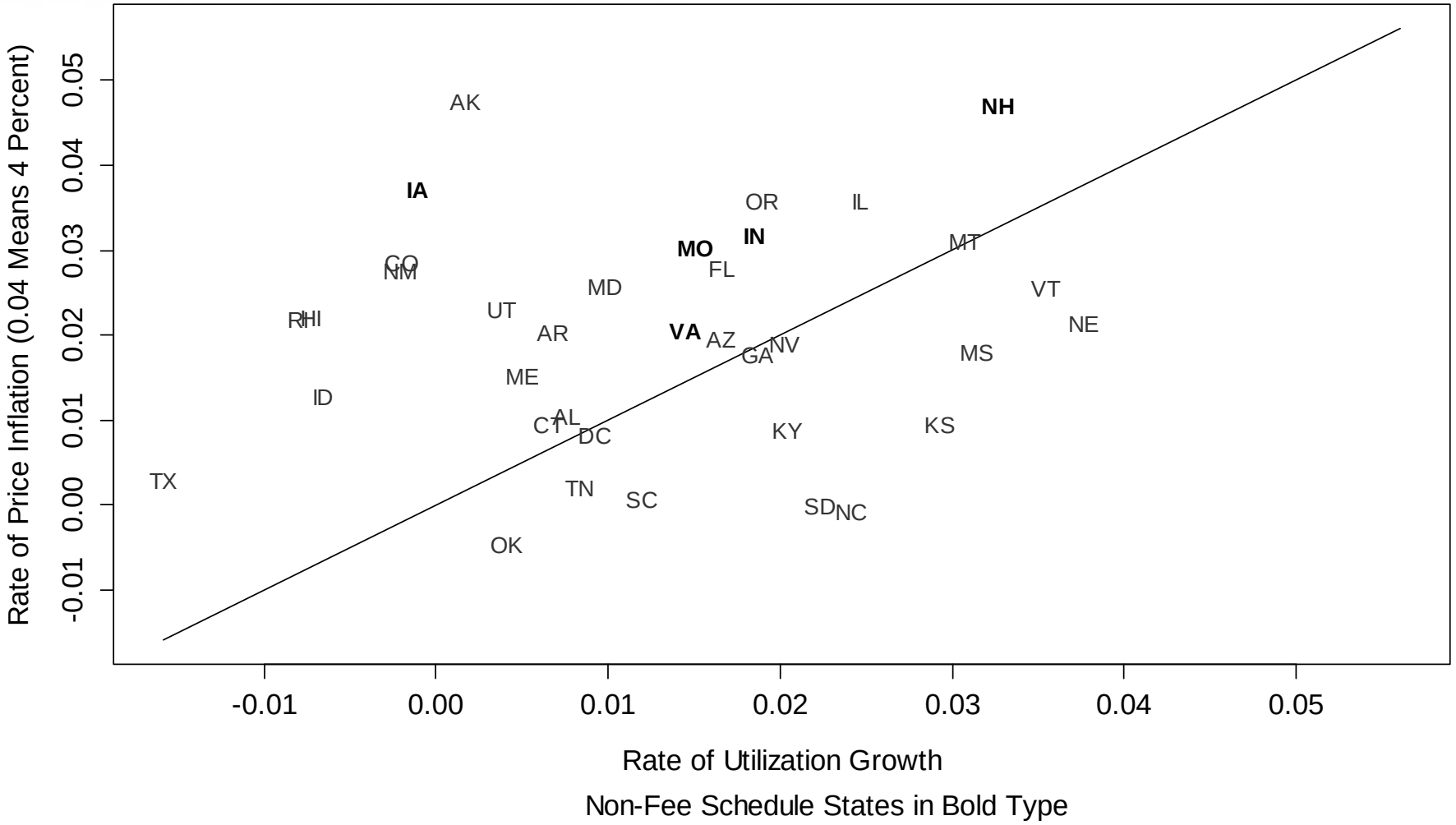
Physician Services, 36 States, 2000–2010



M-CPI: Medical Care component of the Consumer Price Index, www.bls.gov/cpi/cpifact4.htm
The price index of physician services is a Fisher price index, which is computed at actual prices, and comprises all CPT codes
Non-fee schedule states are states that do not use a fixed-value MAR (Maximum Allowable Reimbursement) for the relevant physician services at any point during the time period covered by the analysis. This does not preclude these states from having in place price regulation based on the charged amount or based on what is considered usual and customary, nor does it preclude these states from having fee schedules for hospitals or other non-physician entities
All growth rates shown are CAGRs; the first observed price indexes are as of February 2000

Utilization Increases Versus Inflation

Physician Services, 36 States, 2000–2010



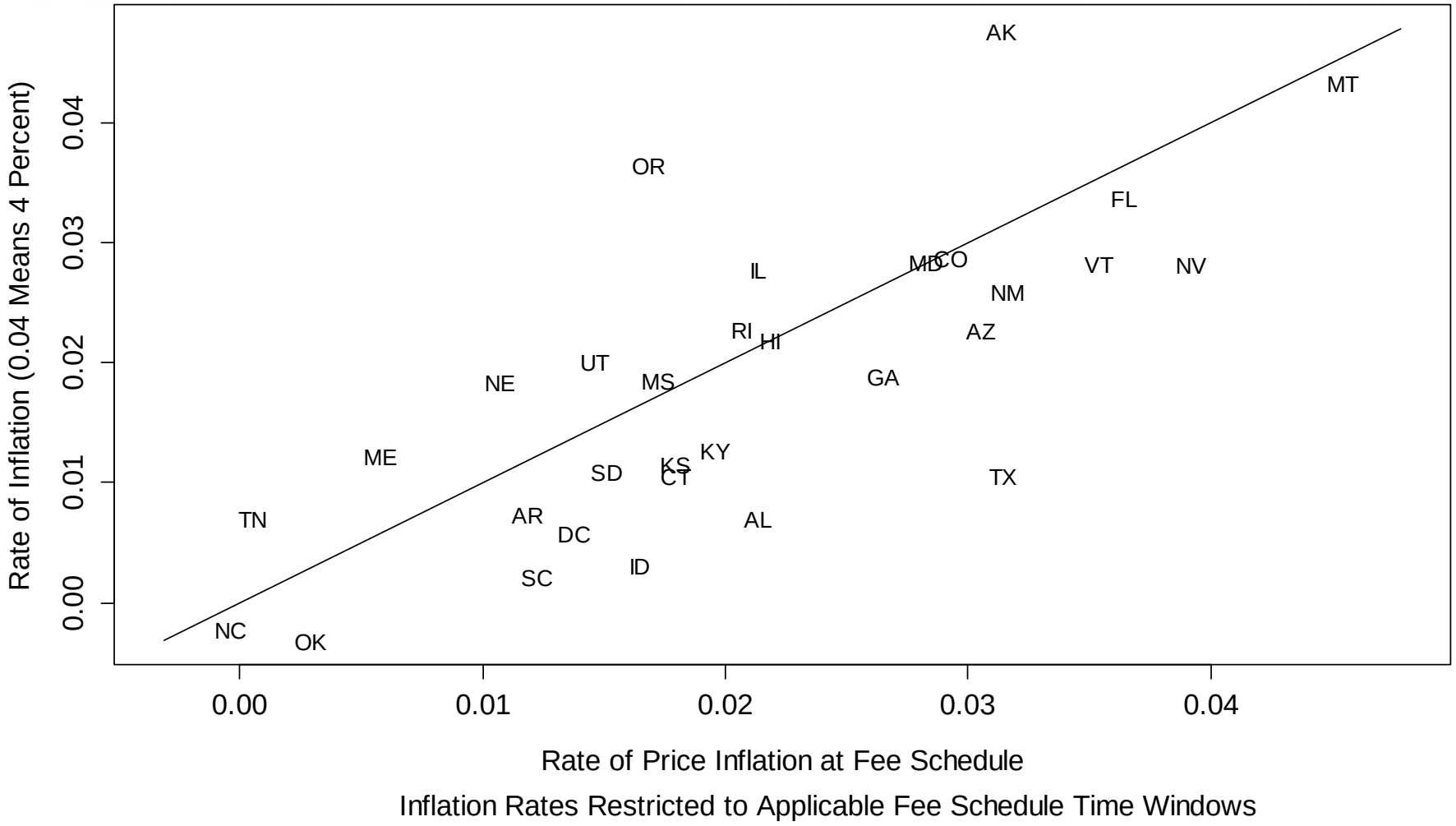
The price and utilization indexes are Fisher indexes, which are computed at actual prices, and comprises all CPT codes; the severity index is the product of the Fisher price index and the utilization index

Non-fee schedule states are states that do not use a fixed-value MAR for the relevant physician services at any point during the time period covered by the analysis. This does not preclude these states from having in place price regulation based on the charged amount or based on what is considered usual and customary, nor does it preclude these states from having fee schedules for hospitals or other non-physician entities

All growth rates shown are CAGRs; the first observed indexes are as of February 2000

Fee Schedule Versus Actual Inflation

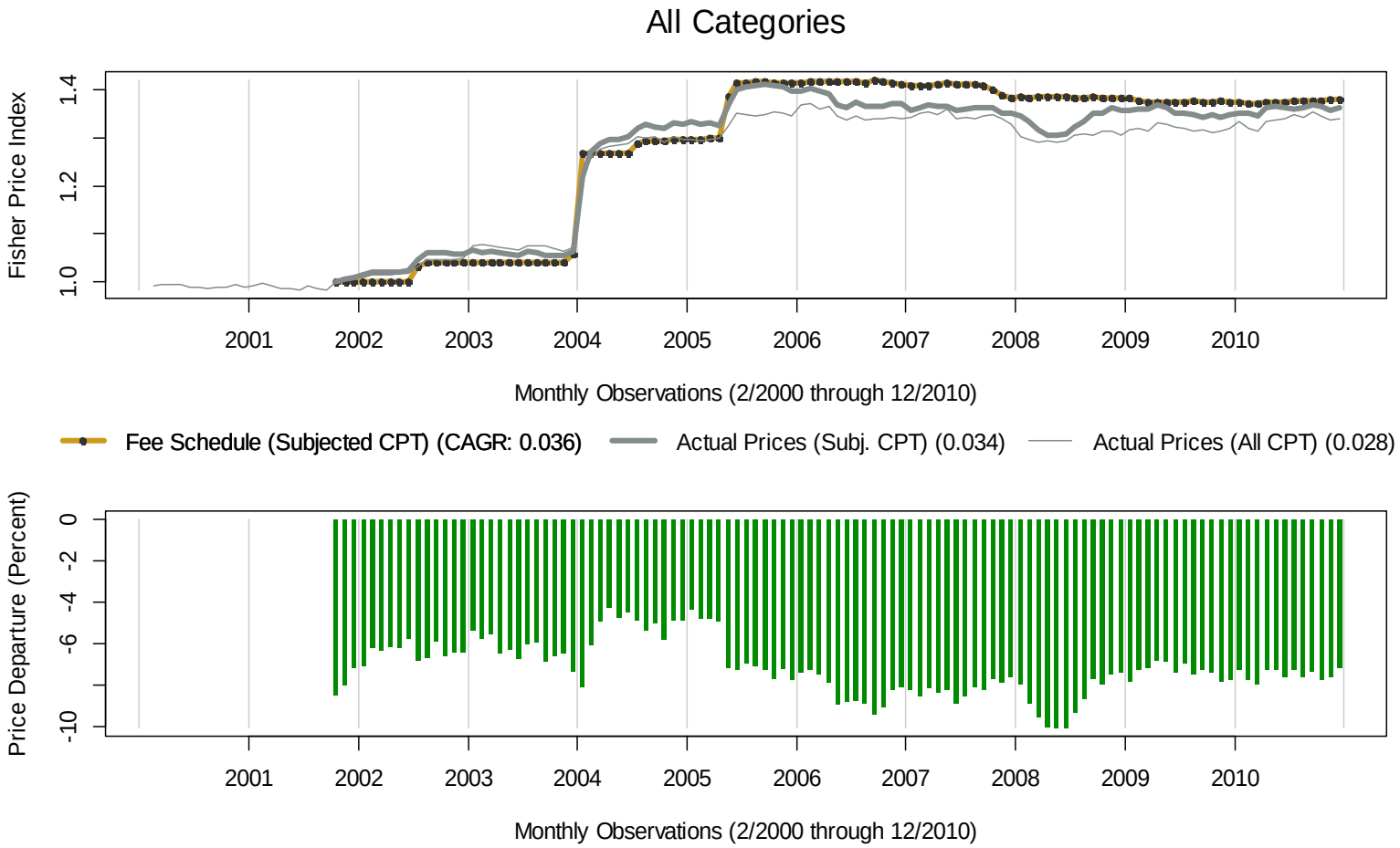
Physician Services Subject to Fee Schedule, 31 States, 2000–2010



The price indexes are Fisher indexes; these indexes are computed at actual prices and at MAR, respectively, and comprise only CPT codes subject to a fixed-value MAR. No non-fee schedule states are displayed. Non-fee schedule states are states that do not use a fixed-value MAR for the relevant physician services at any point during the time period covered by the analysis. This does not preclude these states from having in place price regulation based on the charged amount or based on what is considered usual and customary, nor does it preclude these states from having fee schedules for hospitals or other non-physician entities. All growth rates shown are CAGRs; the first observed price indexes are as of February 2000. The fee schedule time window starts with the third month following the first fee schedule considered in the analysis

Florida

Fee Schedule, Price Level, and Price Departure

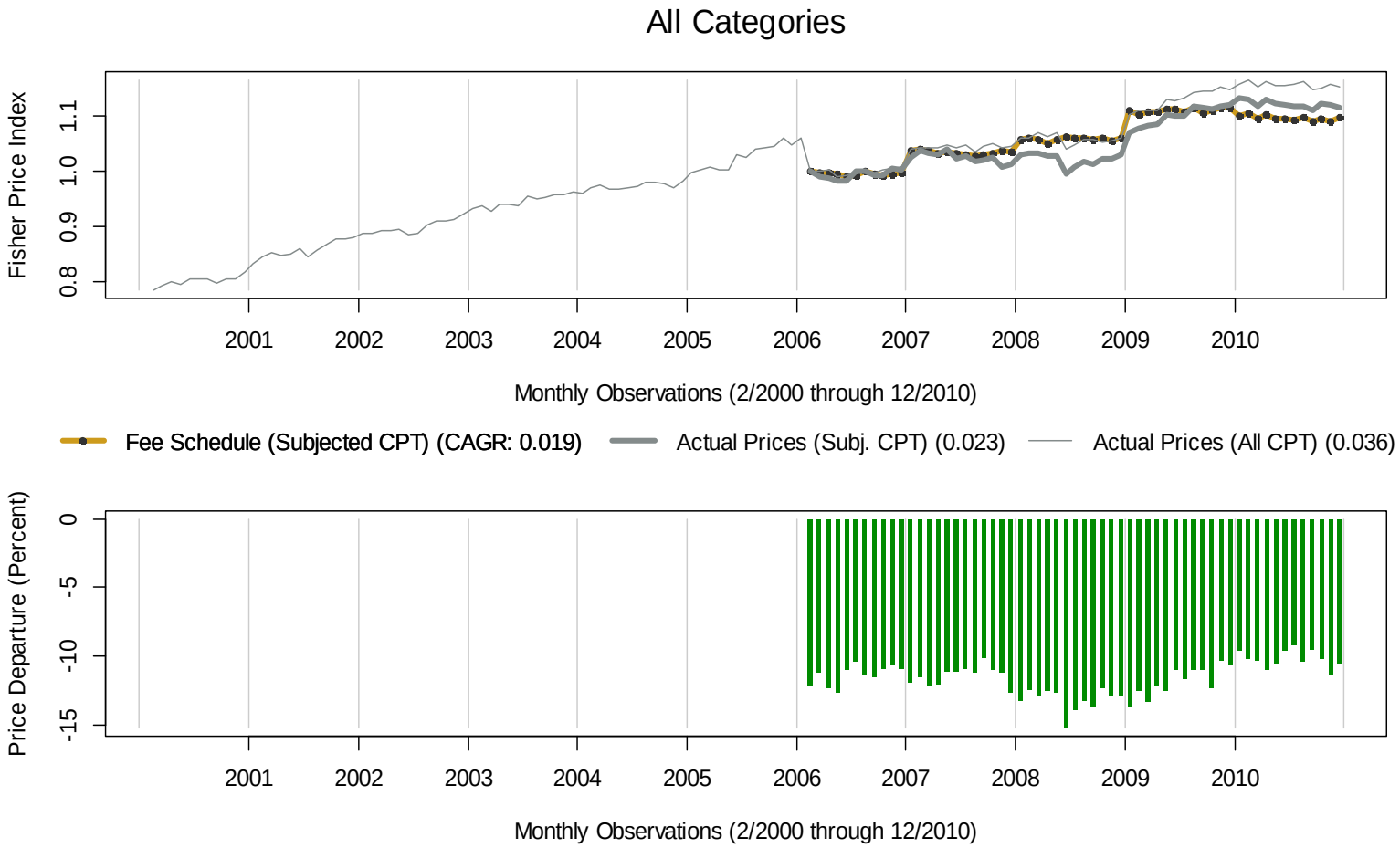


Price indexes are shown at actual and at fee schedule prices. Two types of price indexes at actual prices are shown: (1) comprising only CPT codes subject to a MAR stipulated in dollar terms (fixed-value MAR, for short) and (2) comprising all CPT codes. Price departure is the relative difference between actual and fee schedule prices. The price departure computation is based on all CPT codes, implicitly assuming no price departure for CPT codes that are not subject to a fixed-value MAR

Price indexes change only if prices change. Price departure, on the other hand, may change without prices changing

Illinois

Fee Schedule, Price Level, and Price Departure



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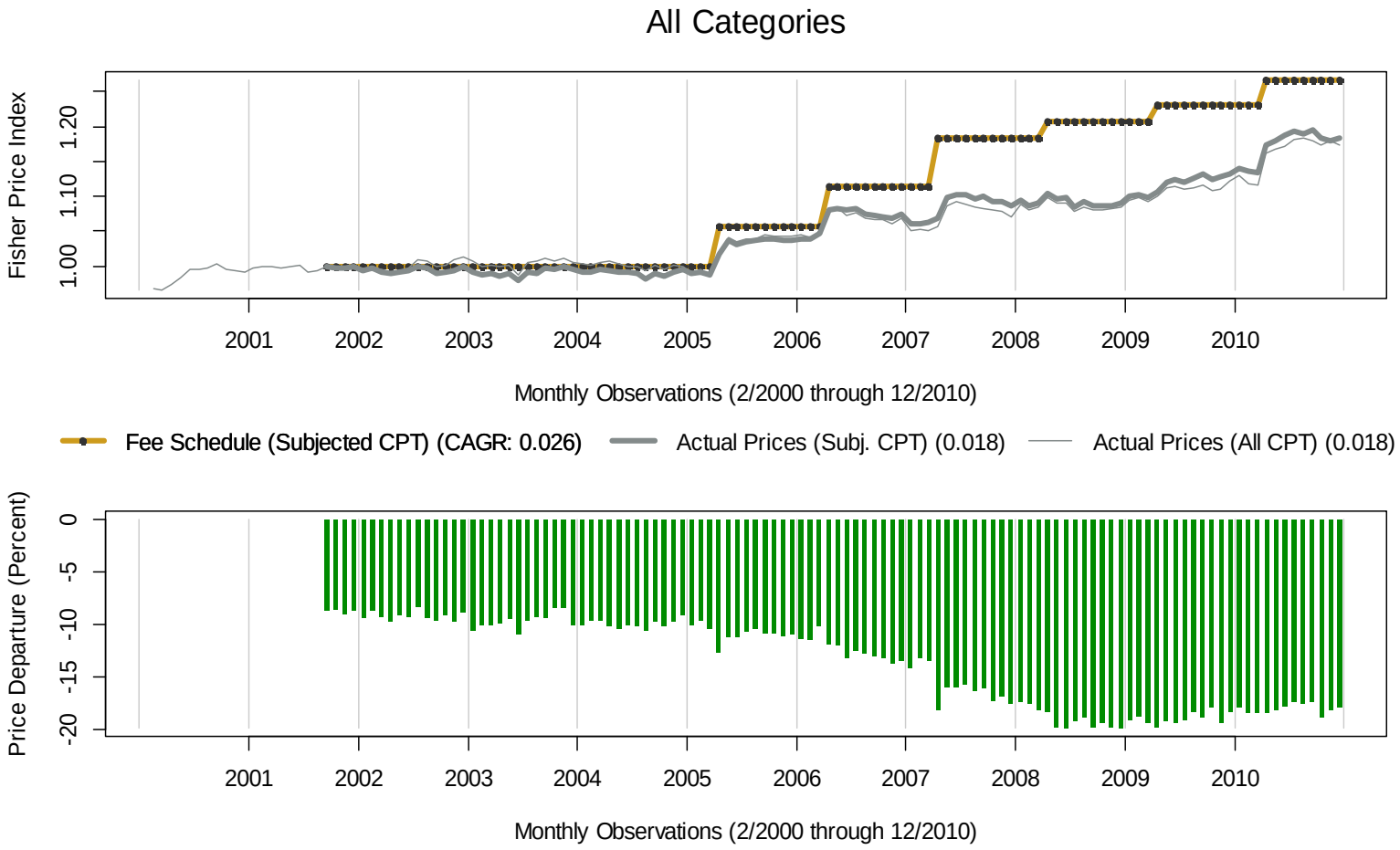
Georgia

Fee Schedule, Price Level, and Price Departure



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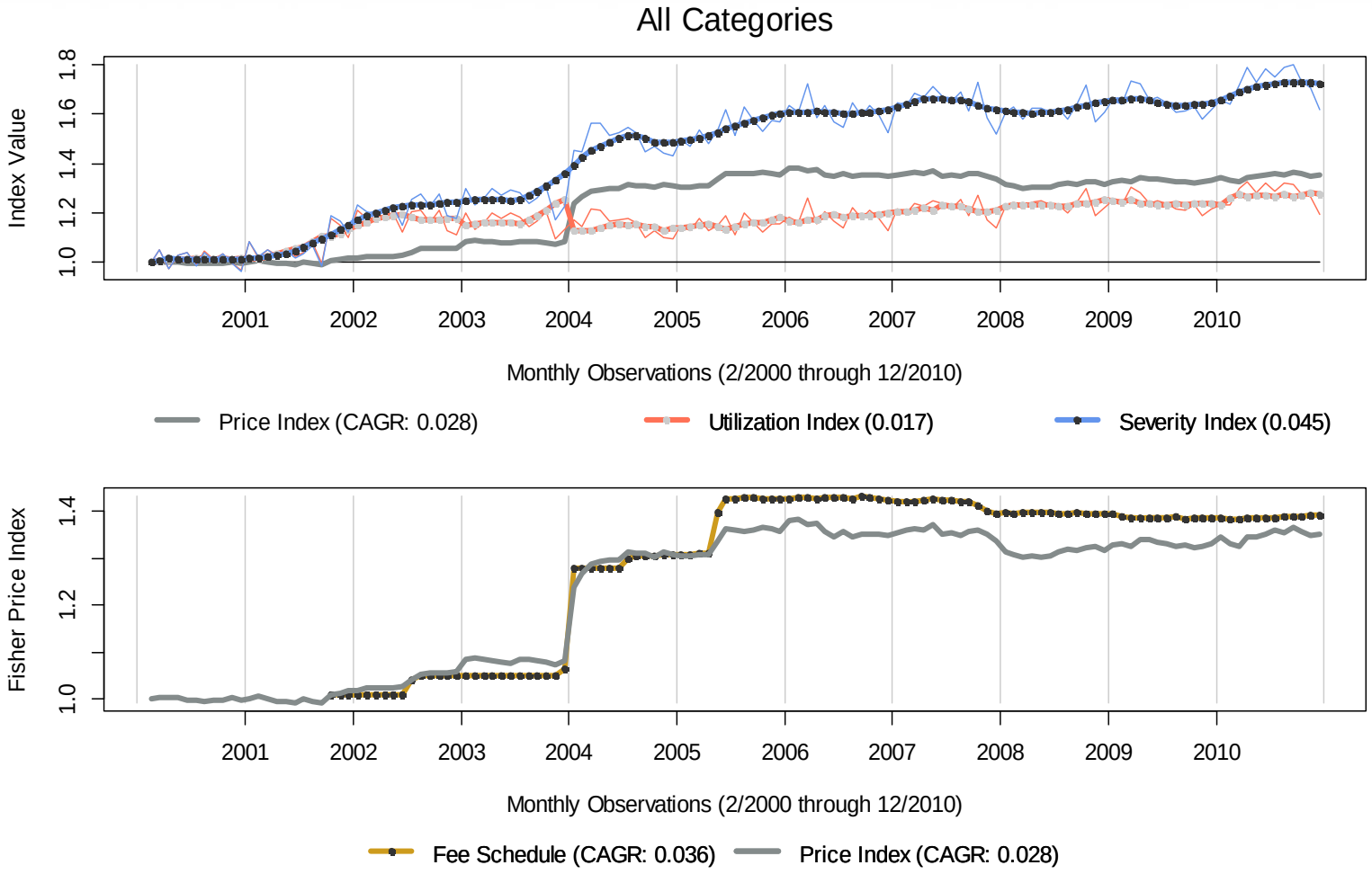
Price indexes change only if prices change. Price departure, on the other hand, may change without prices changing

Florida

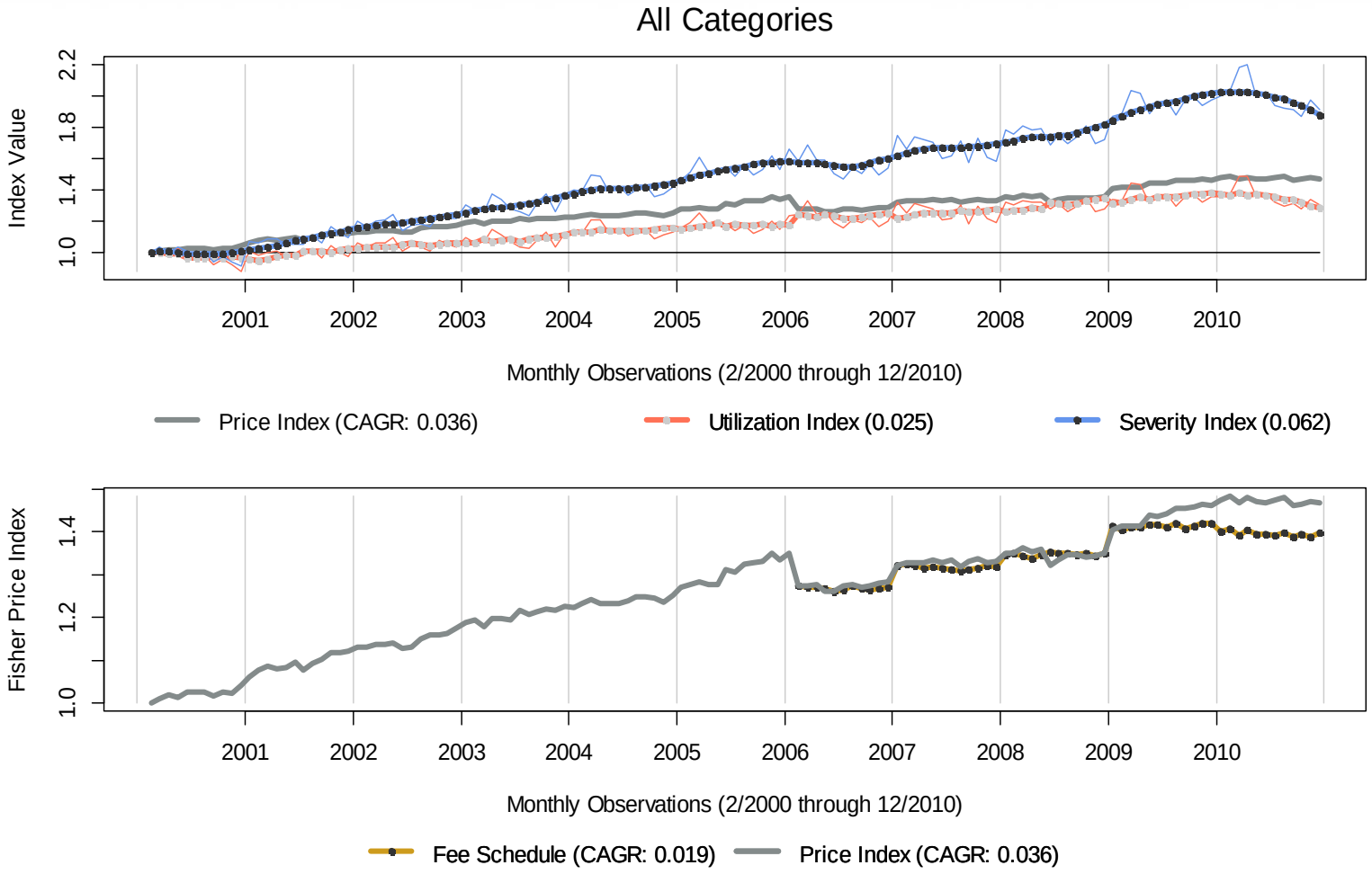
Price Level, Utilization, and Severity



The severity index is the product of the Fisher price index and the utilization index. The utilization index equals the Fisher quantity index, normalized by the number of active claims. In this context, a claim is considered active (in a given service category or overall) if there was a transaction (in a given service category or, when overall, in any given service category) associated with this claim included in the price index for the month. The Fisher price index is computed at actual prices and comprises all CPT codes. The indexes in the top panel are shown as original values (thin gauge) and smoothed (thick). Close to the endpoints, the smoothed values have to be interpreted with caution as there are no neighbors to the right that weigh on the direction of the trajectory generated by the smoother

Illinois

Price Level, Utilization, and Severity



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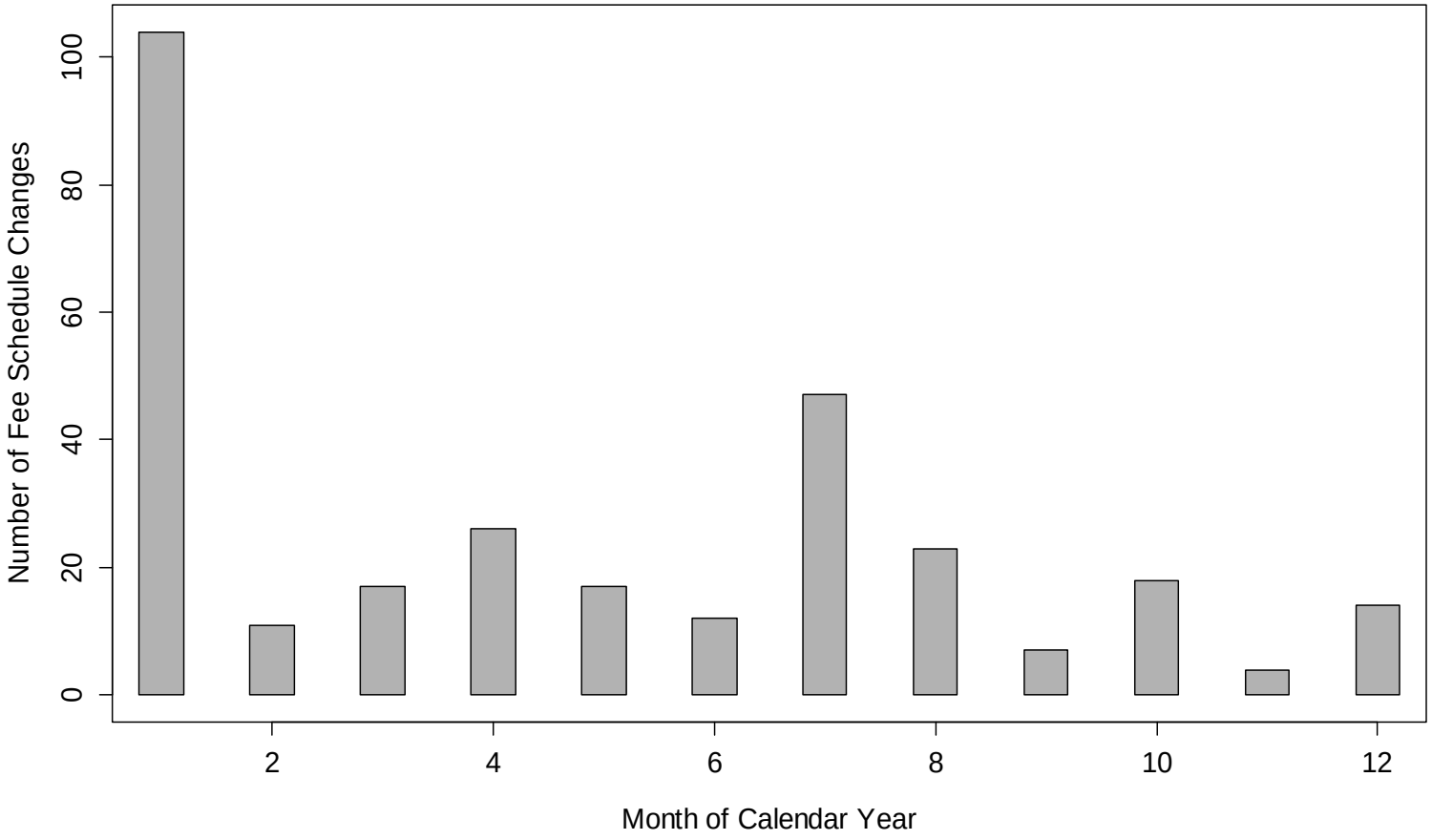
Seasonal Adjustment

Census Bureau Approach

- In many states, the severity index (and, hence, the utilization index) exhibits a seasonal pattern
- For this reason, the utilization index is seasonally adjusted using the X-12-ARIMA software (Version 0.3, 2011) of the Census Bureau; a seasonally adjusted severity index is then calculated as the product of the price index and the seasonally adjusted utilization index
- Because fee schedule changes themselves exhibit a seasonal pattern, there is a risk of tempering the quantity responses to fee schedule changes
  - The statistical model was applied to non-seasonally adjusted data in a sensitivity analysis—the overall impact is little changed
  - On the other hand, without seasonal adjustment, a correlation of seasonal increases of utilization with the seasonality of fee schedule changes may cause an overestimation of the effect of fee schedule changes

Seasonality of Fee Schedule Changes

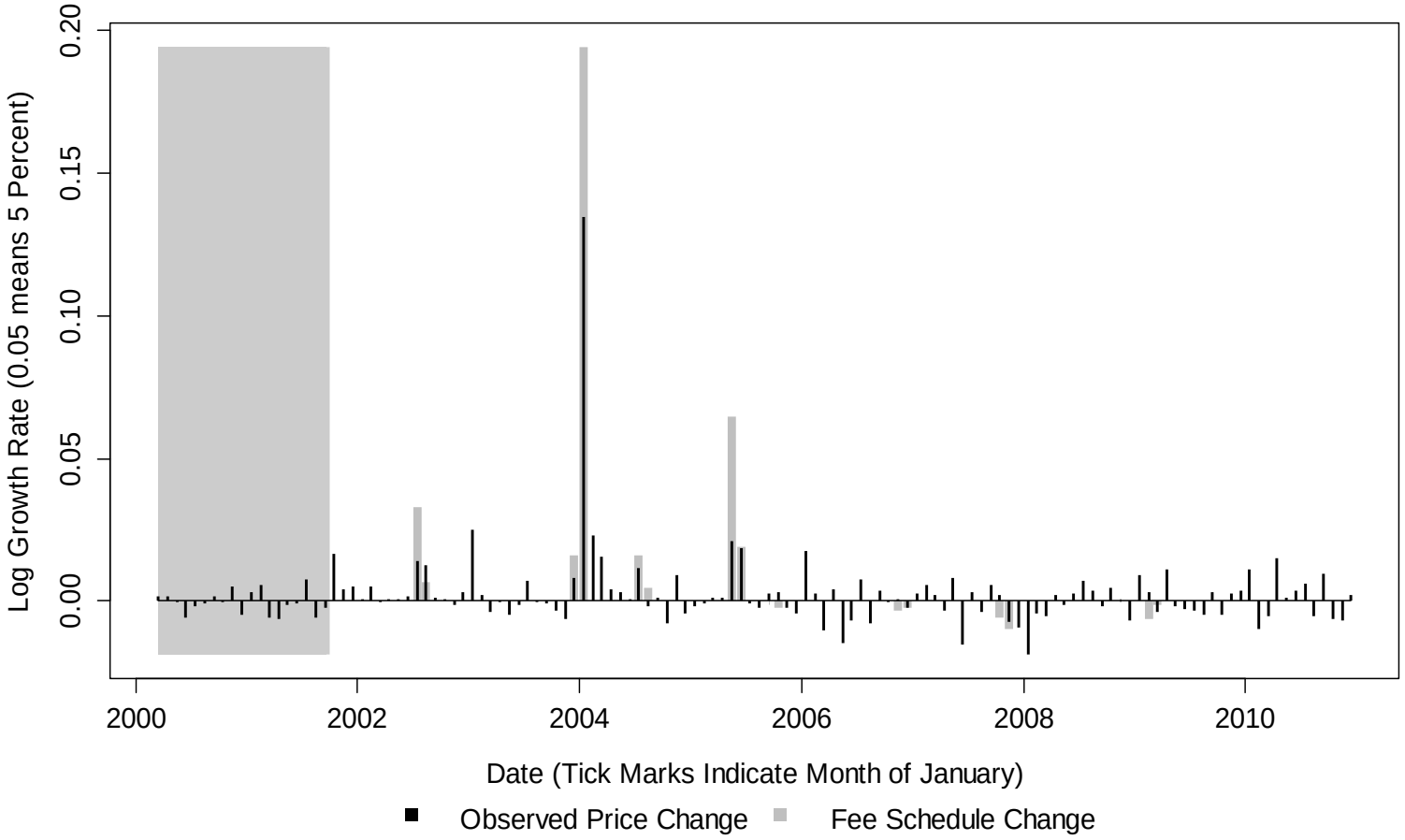
31 States, 300 Fee Schedule Changes, February 2000 – December 2010



There were 219 increases, 54 decreases, and 24 instances where the fee schedule change did not affect the maximum reimbursement of physician services; the 17 fee schedules that became effective after the beginning of the study without having had a precedent in the data, do not count toward the number of fee schedule changes (see the appendix for a list of these 17 instances)

Florida

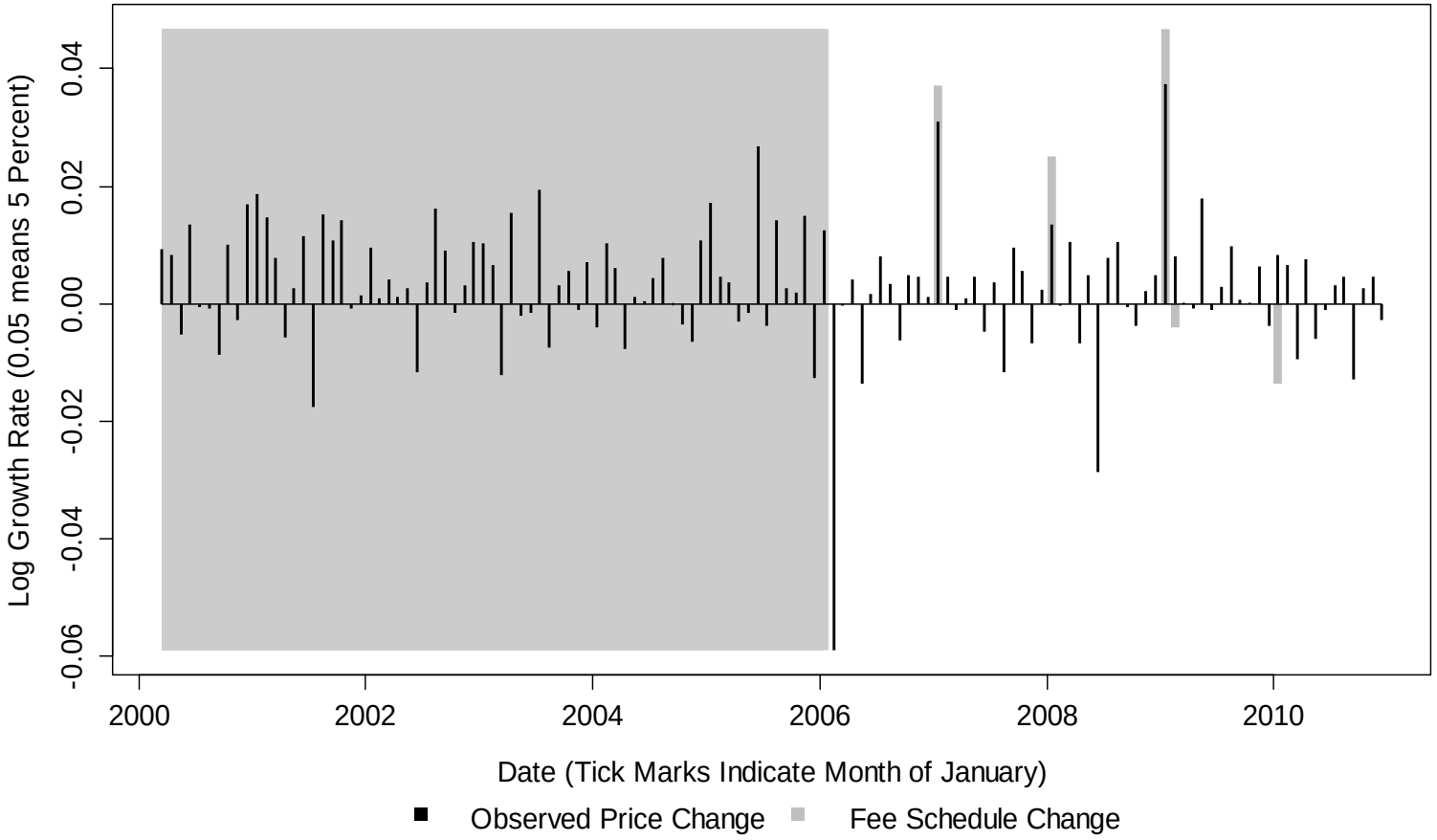
Fee Schedule Change and Price Level Response



The first month to the right of the shaded area is the first complete month to which the first fee schedule considered in the analysis applies; if this fee schedule took effect mid-month, then the incomplete month is included in the shaded area. The fee schedule change is measured using a Laspeyres index (fixed-value MAR only); this index also responds to changes in place of service where such changes alter the average MAR for a given service. The impulse is the product of the change in the Laspeyres index and the proportion of volume affected by changes in fixed-value MAR. A fee schedule impulse extends over two neighboring months if the fee schedule change did not occur on the first day of the month
The log growth rate is defined as the first difference in natural logarithms

Illinois

Fee Schedule Change and Price Level Response



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The log growth rate is defined as the first difference in natural logarithms

Statistical Models

- After establishing stationarity in the price and severity changes, two Bayesian impulse-response models were estimated
- Both models quantify the logarithmic rates of change(1) in the severity index in response to fee schedule changes (and to an autonomous component, i.e., drift)
- The impulse originating in the fee schedule change was quantified as the product of a Laspeyres price index and the transaction volume affected by the fee schedule change
  - A Laspeyres index evaluates the prior month's quantities at the current month's prices (numerator) and the prior month's prices (denominator)—this way, the index isolates the price effect of a fee schedule change
    - If a fee schedule change occurs mid-month, the impulse extends over two time periods
  - The transaction volume, which serves as a weight, dates from the same month as the quantities in the corresponding Laspeyres index

(1) The log rate of change is defined as the first difference in natural logarithms

Statistical Models

Potential Time Lag in Response

- The response to an impulse may spread out over several months
  - One way of modeling such lagged responses is to impose a specific functional form—this is to avoid the proliferation of regression coefficients where impulses are highly correlated over time
  - Due to the comparative sparseness of fee schedule changes in a data set of monthly observations, there is little potential for correlation among the covariates in an unstructured lag
  - Further, with unstructured lags, there is no risk of imposing a potentially inappropriate functional form on the impulse
- The unstructured lag has a length of 11 months
  - By allowing a full calendar year for the effect to manifest itself in the data, it is ensured that seasonal effects (which may be present even after a seasonal adjustment) do not adversely affect the estimated response
  - In part, fee schedule increases serve the re-alignment of prices with operating costs—if the latter increase continually, the discontinuous nature of fee schedule increases may lead to temporary supply changes

Impulse-Response Model I

Discerning Price, Utilization, and Severity Responses

- The first statistical model is a three-equation approach that quantifies the responses of the price, utilization, and severity indexes to fee schedule changes
- The three responses are estimated simultaneously
  - The statistical model incorporates a constraint that stipulates that the predicted ("fitted") values of the severity response be equal to the sum of the predicted values of the corresponding price and utilization responses(1)
- The results provide little evidence for lasting utilization responses to fee schedule changes

(1) The log rate of change of the severity index equals the sum of the log rates of change of the price and utilization indexes. This constraint was implemented in JAGS (Just Another Gibbs Sampler) by modeling a sum of distributions; mcmc-jags.sourceforge.net/

Impulse-Response Model II

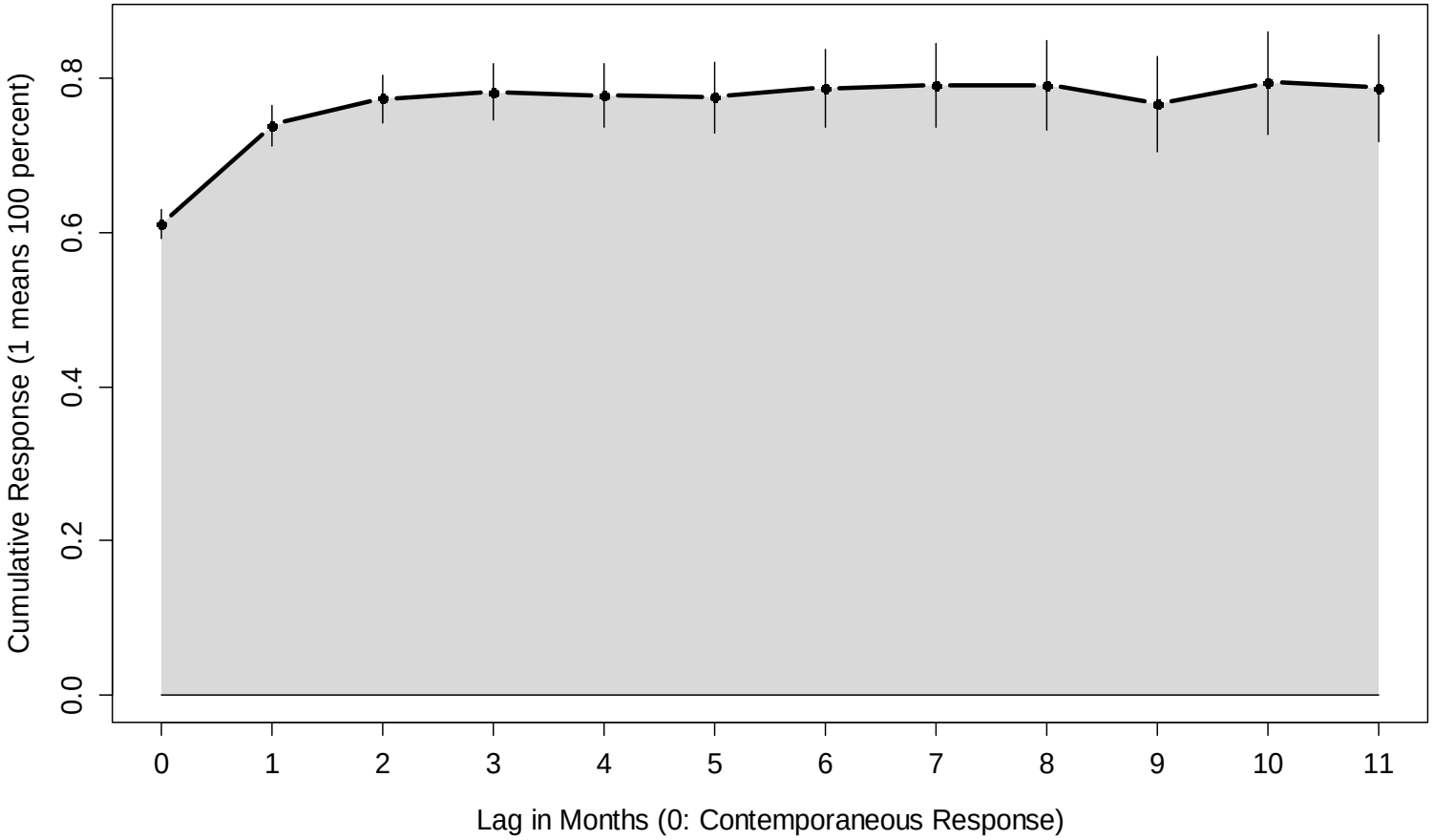
Investigating the Role of Covariates

- The second statistical model, which is again a three-equation approach, quantifies the responses of the severity index only
- The first equation has no covariates—the response parameters of this equation are shared by the other two equations
- The second equation accounts for the influence of the price departure that is present in the month prior to the fee schedule change
- The third equation accounts for the influence of the price difference between the state's fee schedule relative to the fee schedules of neighboring states, as observed in the month prior to the fee schedule change
  - This price difference was calculated by means of a Lowe index, using the star method(1)
- Including both covariates in a single equation caused an inflation of the variance in the price departure parameter estimate

(1) See Peter Hill, "Lowe Indices," presented at the 2008 World Congress on National Accounts and Economic Performance Measures for Nations, Washington DC, May 13-17, 2008, www.indexmeasures.com/dc2008/papers/Lowe%20indices%20revised.doc

Fee Schedule Increase

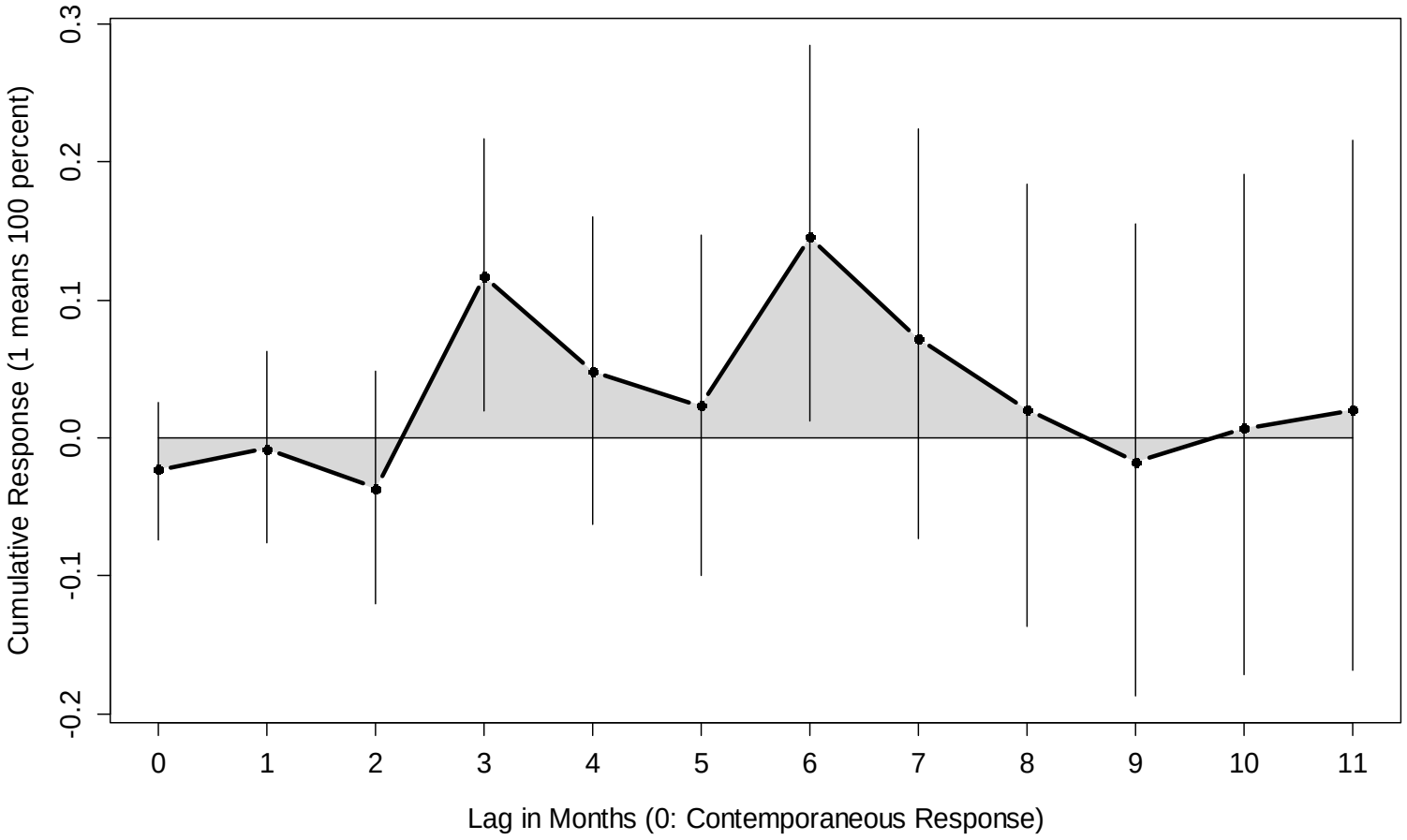
The Price Response Is Around 80 Percent of the Impulse



The Fisher price index is computed at actual prices and comprises all CPT codes
The vertical bars indicate 80 percent credible intervals

Fee Schedule Increase

There Is No Lasting Utilization Effect



The utilization index equals the Fisher quantity index, normalized by the number of active claims. In this context, a claim is considered active (in a given service category or overall) if there was a transaction (in a given service category or, when overall, in any given service category) associated with this claim included in the price index for the month
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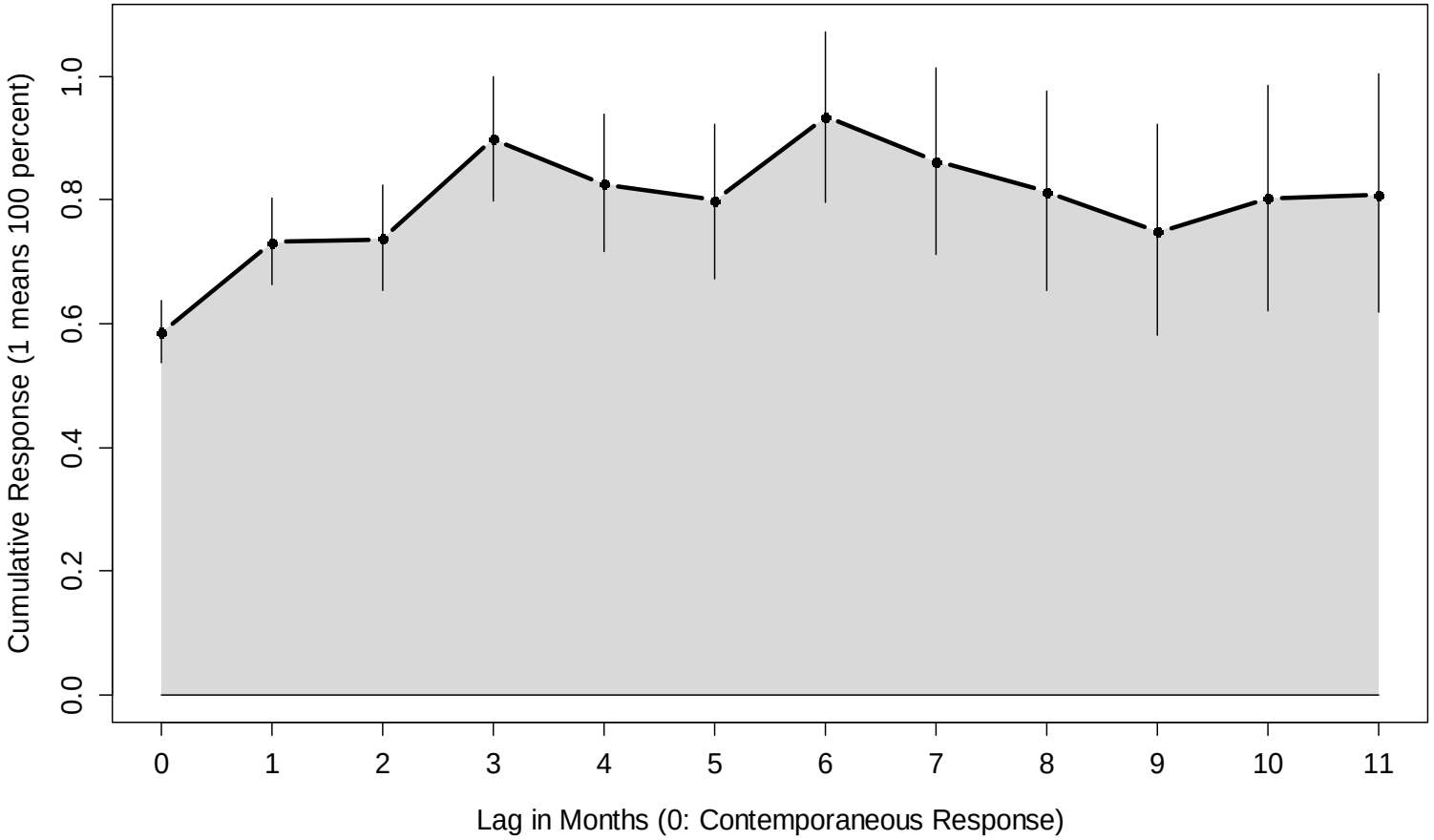
Fee Schedule Increase

The Severity Response Is Around 80 Percent of the Impulse



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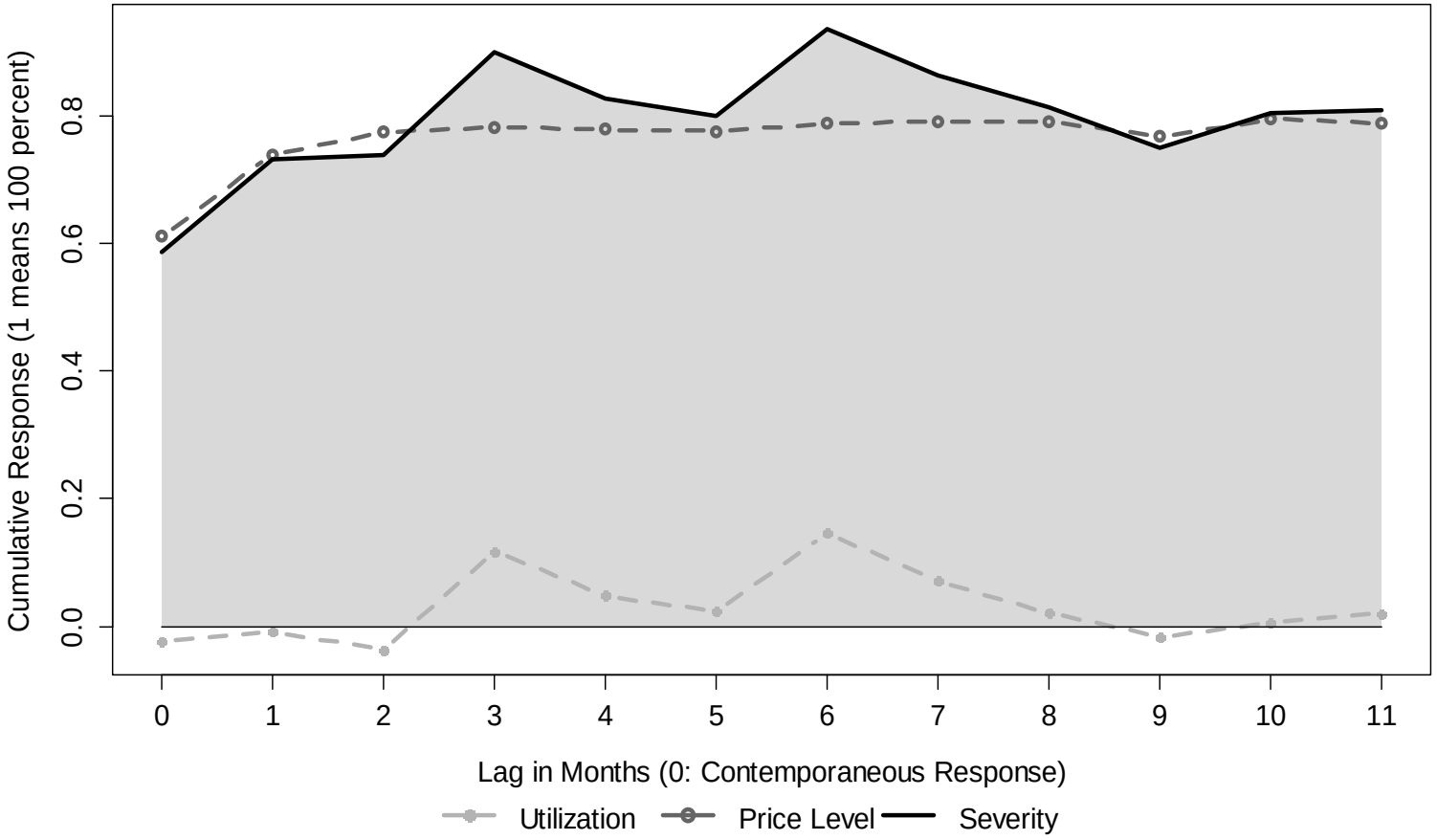
Fee Schedule Increase

Utilization, Price Level, and Severity



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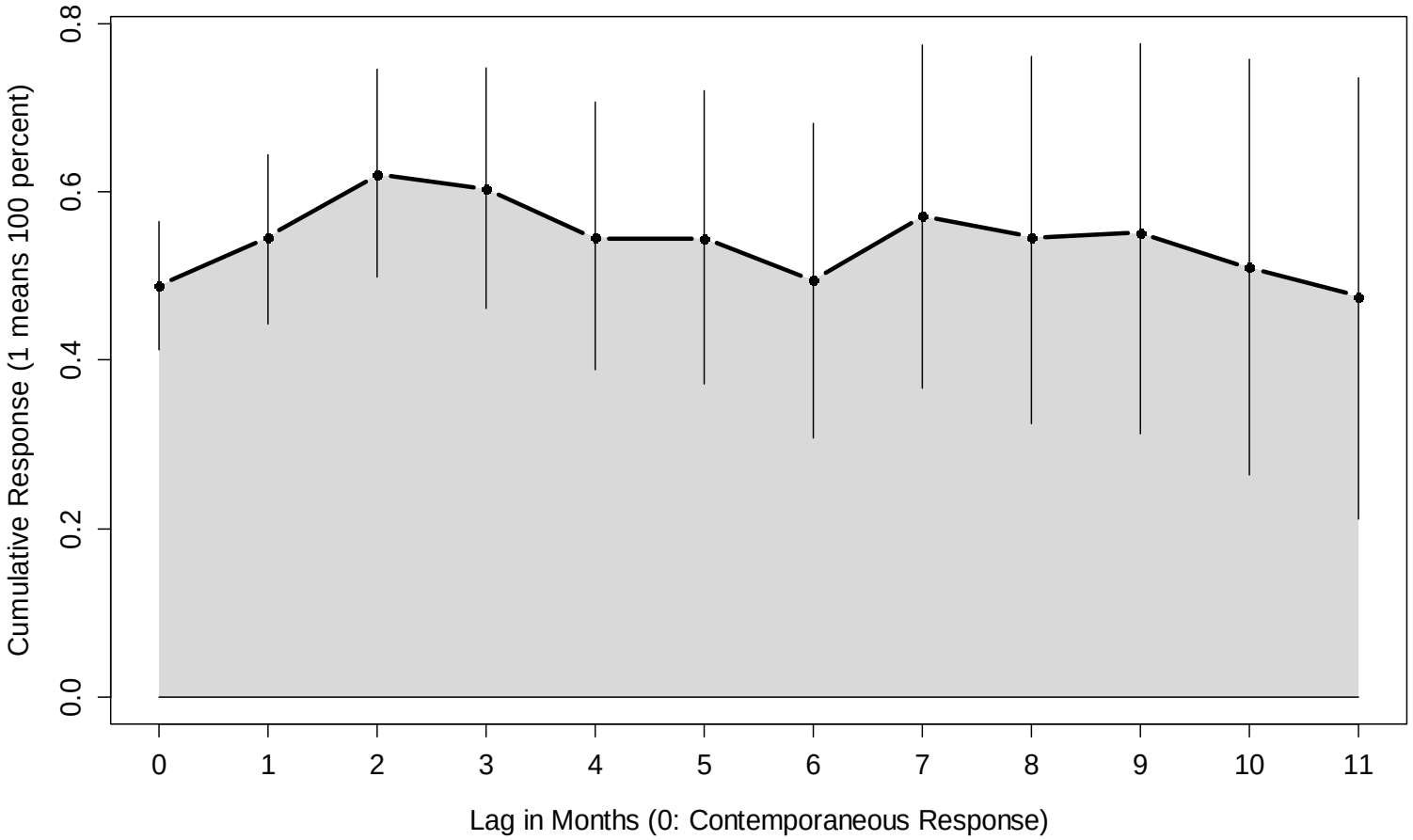
Fee Schedule Decrease

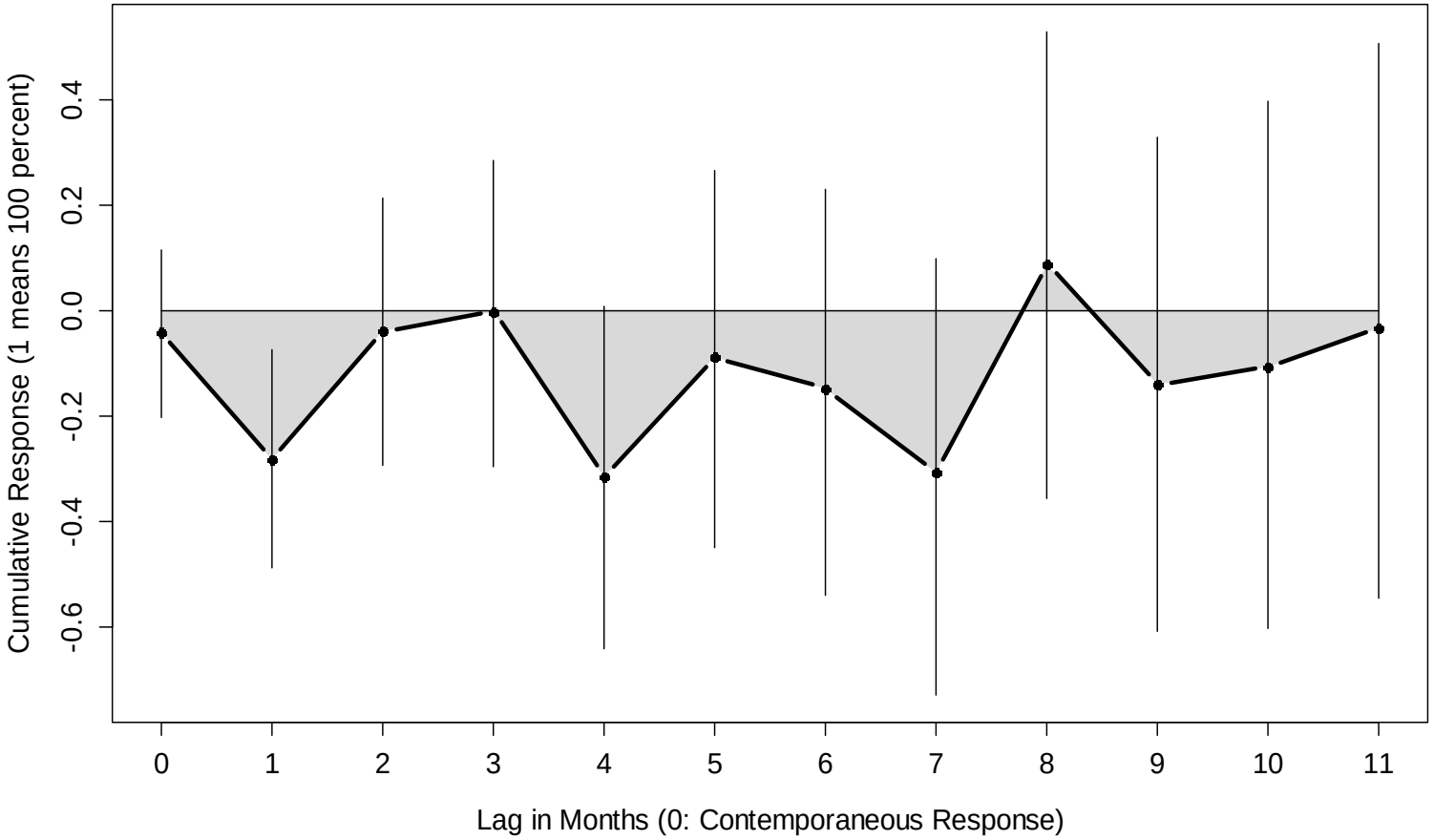
The Price Response Is Close to 50 Percent of the Impulse



The Fisher price index is computed at actual prices and comprises all CPT codes
The vertical bars indicate 80 percent credible intervals

Fee Schedule Decrease

There Is No Lasting Utilization Effect



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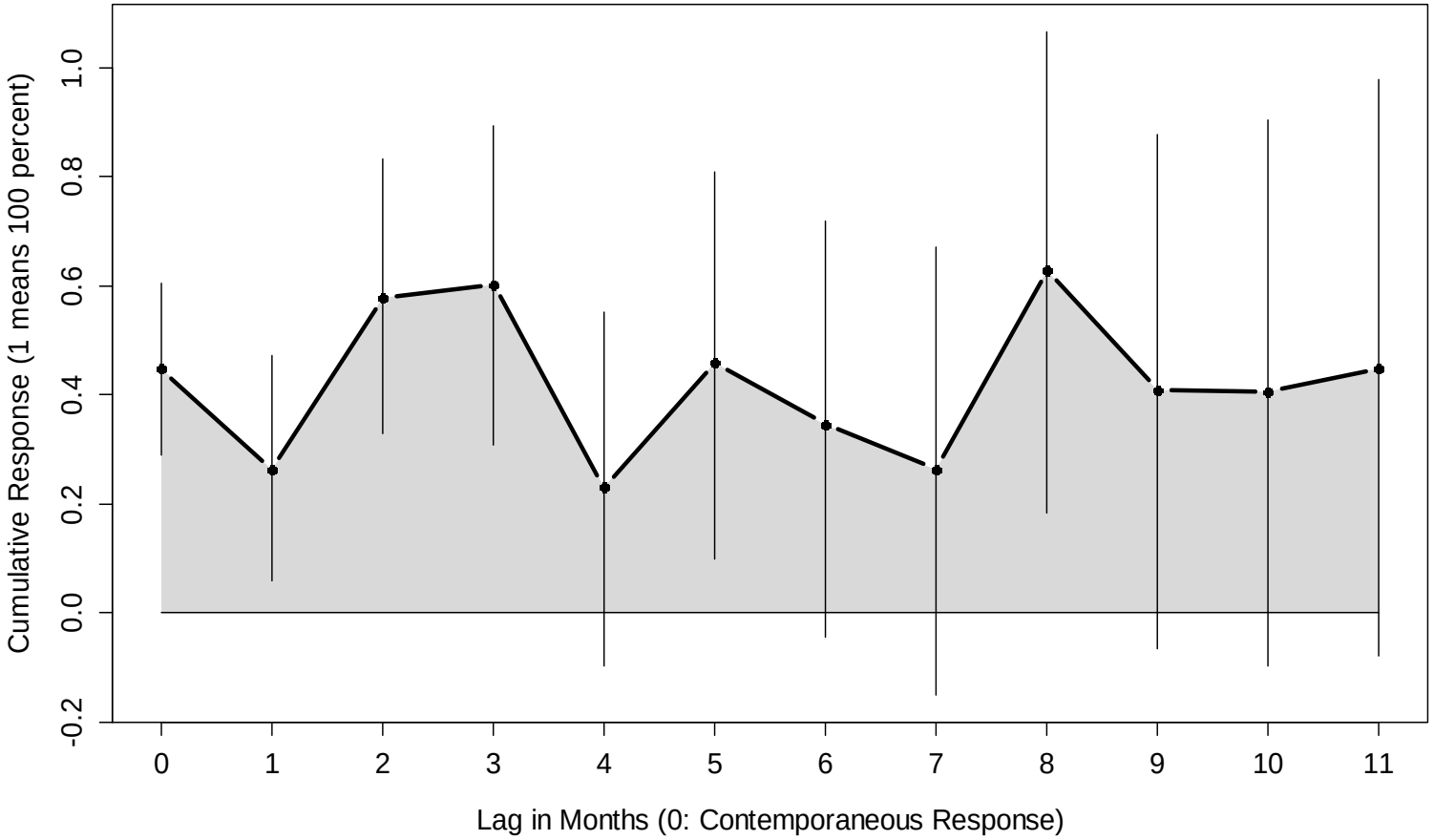
Fee Schedule Decrease

The Severity Response Is Close to 50 Percent of the Impulse



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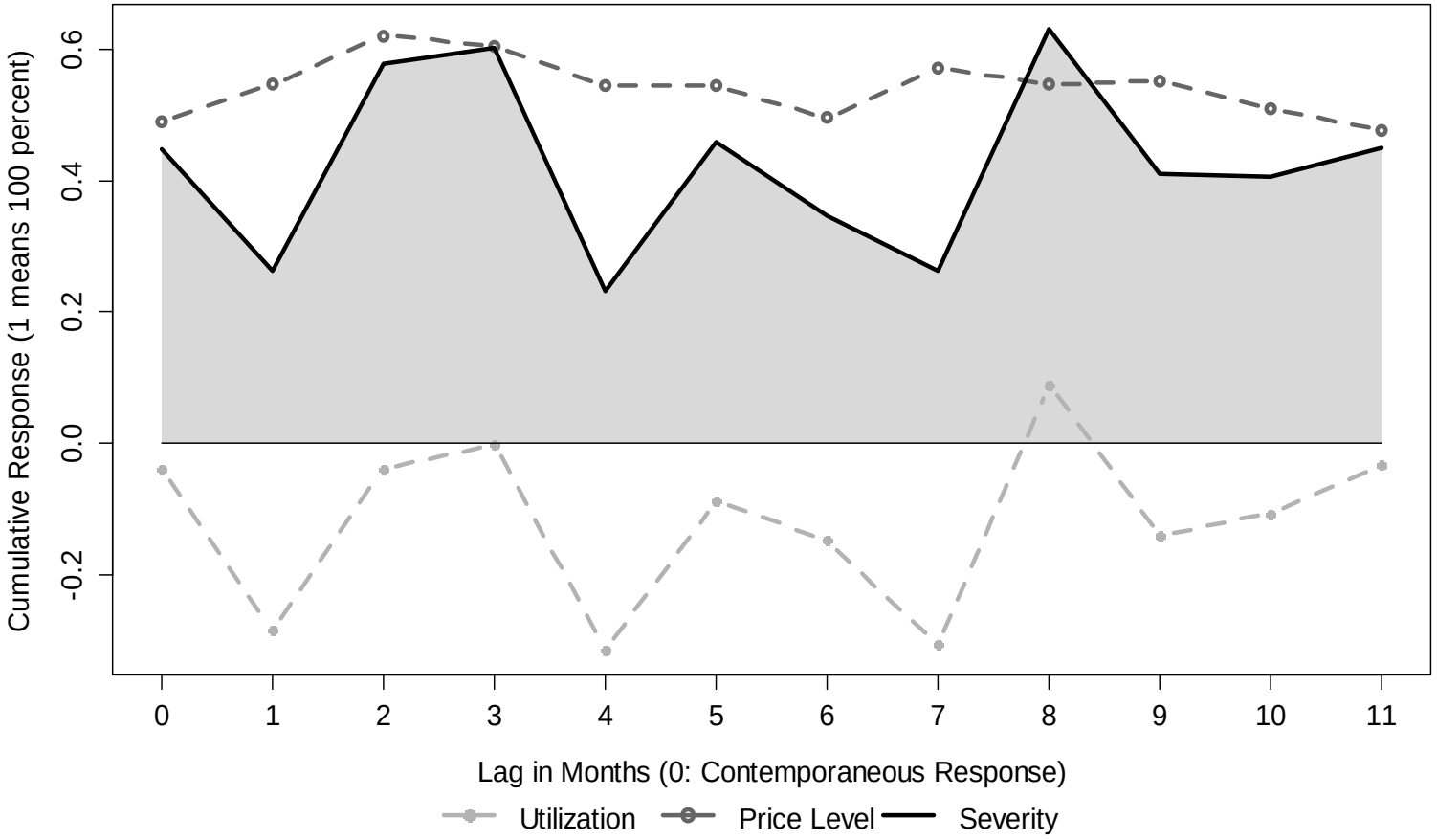
Fee Schedule Decrease

Utilization, Price Level, and Severity of the Impulse



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The Findings

- There are alternative ways of quantifying the impact of fee schedule changes on severity (that is, price and utilization combined), depending on the amount of information available
  - Percentage of the fee schedule increase that translates into a severity increase:
    - 80.6
    - $80.6 \times (1.043 + 1.172 \times \text{Price Departure})$[(1)]
    - $80.6 \times (0.800 - 1.183 \times \text{Fee Schedule Relative to Neighbors})$[(1,2,3)]
  - Percentage of the fee schedule decrease that translates into a severity decrease:
    - 47.8 percent[(4)]

(1) The regression coefficients in this approach are only identified up to a proportionality constant; hence, the simultaneous estimation with the approach that makes no use of the Price Departure and Fee Schedule Relative to Neighbors covariates
(2) Using both covariates causes undesirable variance inflation in the Price Departure coefficient
(3) In the data, most states have fee schedules that are lower than the equally-weighted average of the fee schedules of their neighbors; such a situation may arise where the larger states have the higher fee schedules
(4) There were not enough observations in the data for a reliable quantification of the influence of the two covariates (Price Departure and Fee Schedule Relative to Neighbors) in the context of fee schedule decreases

Sensitivity Analysis

No Seasonal Adjustment

- We repeated the analysis without seasonally adjusting the utilization and severity indexes
  - In the event of a fee schedule increase, the percentage severity response amounts to 83.7 percent of the impulse (compared to the seasonally adjusted estimate of 80.6 percent)
  - When there is a fee schedule decrease, 54.0 percent of the impulse manifests itself in a severity change (compared to the seasonally adjusted estimate of 47.8 percent)
- As discussed, without seasonal adjustment, there is a risk of spurious correlation (between the seasonality of severity changes and the seasonality of fee schedule changes)

Conclusion

- The study is a comprehensive analysis of the price level and severity responses of physician services to fee schedule changes
  - Severity and price level respond to fee schedule increases more strongly than they do to fee schedule decreases
  - There are three alternative formulas for the evaluation of the effect of fee schedule increases on severity, depending on the amount of information available to the decision maker
  - Due to the comparatively small number of fee schedule decreases, the severity response could not be reliably calibrated to state characteristics

Appendix

Definition: Price Departure

- Price departure is based on the ratio of fee schedule prices to actual prices, weighted by the observed quantities(1)
  - The numerator of this ratio equals the quantity of consumed physician services evaluated at actual prices, which is simply the (data-cleansed) observed dollar volume
  - The denominator equals the quantity of consumed physician services evaluated at the respective fixed-value MAR; for CPT codes that are not subject to a fixed-value MAR, actual prices substitute for the MAR
  - When used in charts, price departure is defined as the ratio minus 1
  - When used in the statistical model, price departure is defined as the (natural) logarithm of the ratio

(1) Technically, this ratio is a Lowe index

Appendix

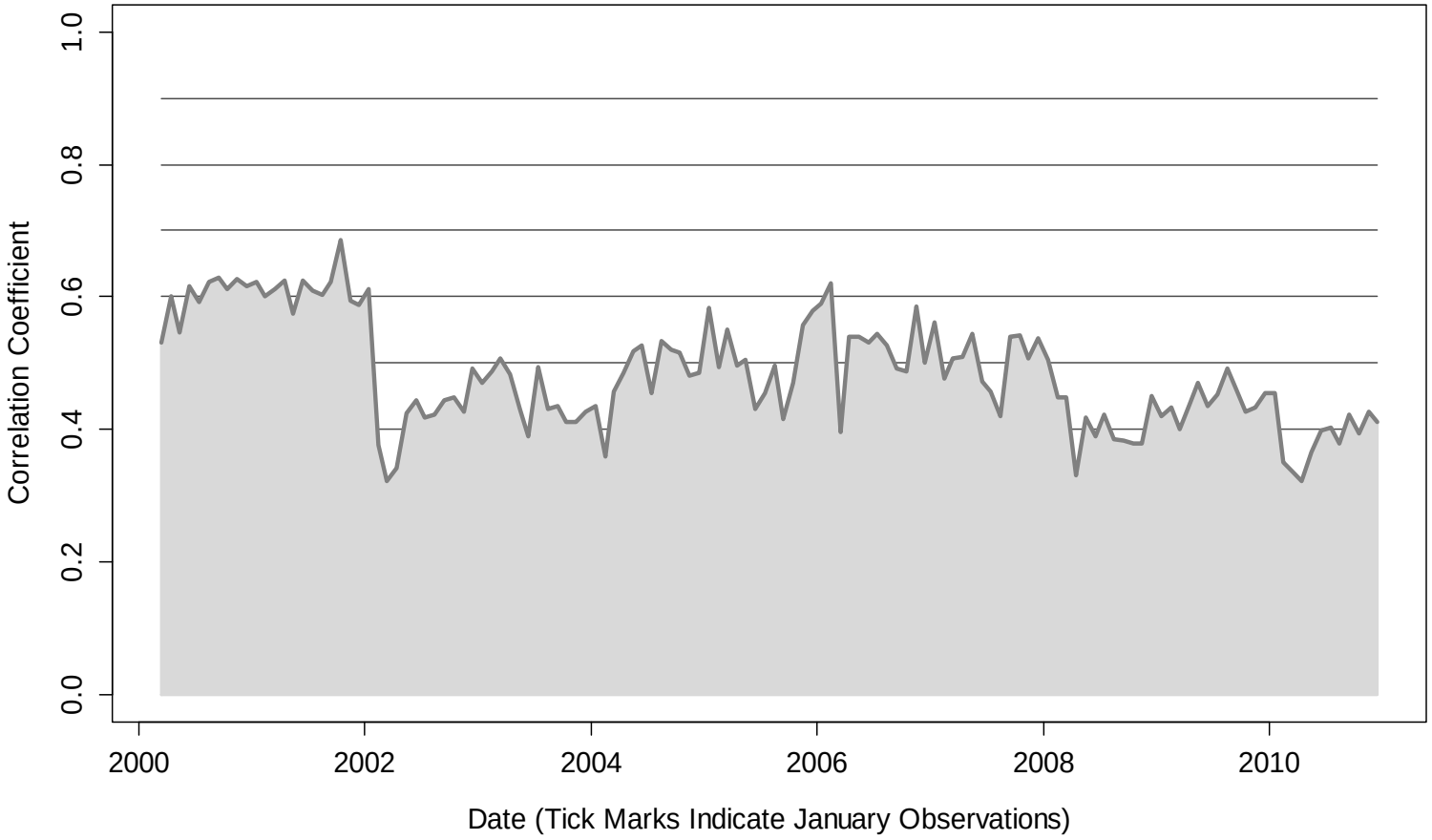
Definition: Fee Schedule Relative to Neighbor

- The variable Fee Schedule Relative to Neighbor equals the logarithm of the ratio of the fee schedule price level of a given state to the equally-weighted mean of the fee schedule price levels of its neighbors(1)
  - The neighbors are defined based on Census regions and divisions
  - The fee schedule price level of a given state is calculated as a Lowe index using the star method(2)
    - The numerator of this Lowe index of a given state in a given month is the weighted sum of the quantities of all states, where the weights are the prices of that state
    - The denominator of the Lowe index is the weighted sum of the quantities of all states, where the weights are the prices paid in the respective states

(1) See the appendix for a list of the states' neighbors
(2) See Peter Hill, "Lowe Indices," presented at the 2008 World Congress on National Accounts and Economic Performance Measures for Nations, Washington DC, May 13-17, 2008, www.indexmeasures.com/dc2008/papers/Lowe%20indices%20revised.doc

Appendix

Price Departure and Fee Schedule Relative to Neighboring States



The first observation is for March 2000. The final observation is for December 2010
Price departure is measured as the log ratio of the Fisher price index at fee schedule prices to the Fisher price index at actual prices. The two indexes include only CPT codes with a fixed-value MAR
The variable Fee Schedule Relative to Neighboring States is measured as the log ratio of the Lowe index of the state to the mean of the Lowe indexes of its neighbors; see the appendix for the individual states' neighbors

Appendix

Hypothetical Numerical Example for a Fee Schedule Increase

- Impulse
  - The ratio of new MAR to old MAR, where numerator and denominator are calculated as weighted averages based on the quantities of physician services consumed in the month prior to the fee schedule increase, equals 1.1 (thus indicating a 10 percent increase in the fee schedule)
  - In the month prior to the fee schedule change, 90 percent of the volume was subject to a MAR, thus leading to an impulse of $0.1 \times 0.9 = 0.09$, or 9 percent
- Percentage response to impulse ("multiplier")
  - The ratio of actual prices to MAR,[1] where numerator and denominator are calculated as weighted averages based on the quantities of physician services consumed in the month prior to the fee schedule increase, equals 0.95 (thus indicating a 5 percent price departure)
  - The impulse is to be multiplied by the following factor:[2,4] $0.806 \times (1.043 + 1.172 \times \log(0.95)) \approx 0.79$
  - The ratio of the Lowe index of the state to the equally-weighted average of the Lowe indexes of its neighbors equals 0.9[3,4]
    - The impulse is to be multiplied by the following factor: $0.806 \times (0.800 - 1.183 \times \log(0.9)) \approx 0.75$

(1) Actual price substitutes for MAR where no fixed-value MAR applies; see the definition of the variable Price Departure
(2) The log operator represents the natural logarithm
(3) See the definition of the variable Fee Schedule Relative to Neighbor; as mentioned, for most states, this ratio is less than unity
(4) Because the model was estimated on the (natural) logarithmic scale, the effect of the fee schedule increase reads: exp(log(1 + 0.1) x 0.9 x 0.79) – 1

Appendix

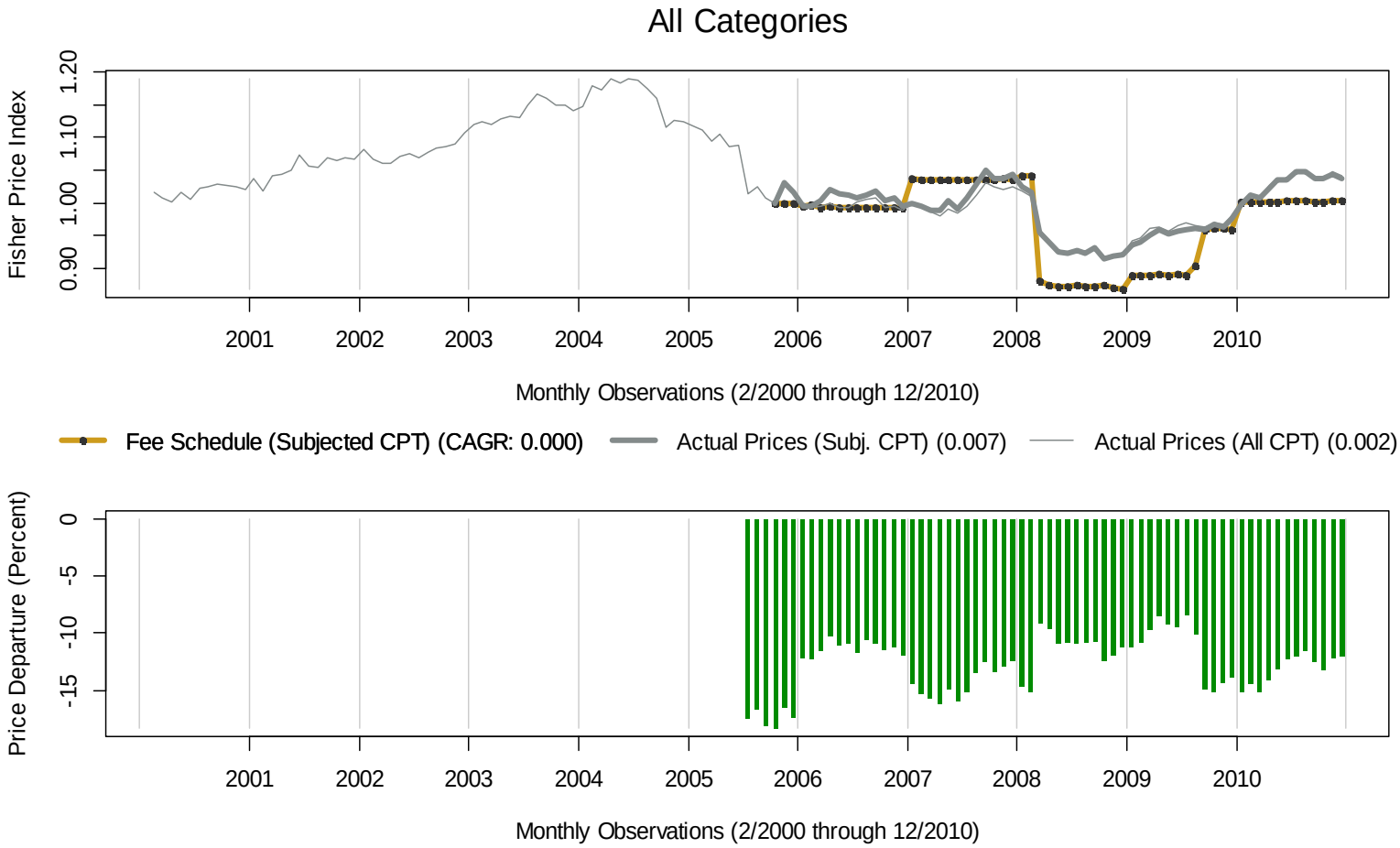
Zero-Price-Departure Constraint Puts Bounds on Price Level Changes

- Assuming that price departure cannot be positive (that is, quantity-weighted, actual prices cannot exceed fee schedule prices), there are bounds to the price level responses to fee schedule changes
  - In the event of a fee schedule increase, the response in the price level cannot exceed the initial impulse by an amount so large as to engender a positive price departure—this constraint was never found to be binding in the analyzed data set
  - In the event of a fee schedule decrease, the price level must follow the fee schedule down at least to the extent necessary for maintaining a non-positive price departure
    - The only observation in the data set where the fee schedule decrease was close to having the potential of completely eliminating the existing price departure is Tennessee
    - In March 2008, the fee schedule reduction amounted to a 13.1 percent price decrease (CPT codes subject to a fixed-value MAR only),(1) while the price departure (comprising all CPT codes) in the prior month equaled 14.0 percent;(2) more than half of the original price departure withstood the fee schedule decrease

(1) This is prior to weighting the fee schedule change with the volume of fixed-value MAR services to arrive at the impulse
(2) The fee schedule took effect on March 4, 2008, which was a Tuesday

Appendix

Tennessee: Fee Schedule, Price Level, and Price Departure



Price indexes are shown at actual and at fee schedule prices. Two types of price indexes at actual prices are shown: (1) comprising only CPT codes subject to a MAR stipulated in dollar terms (fixed-value MAR, for short) and (2) comprising all CPT codes. Price departure is the relative difference between actual and fee schedule prices. The price departure computation is based on all CPT codes, implicitly assuming no price departure for CPT codes that are not subject to a fixed-value MAR

Price indexes change only if prices change. Price departure, on the other hand, may change without prices changing

Appendix

First Fee Schedule Considered in the Analysis

- For the following 17 (of the total 31) states, the start date of the study(1) pre-dates the first fee schedule considered in the analysis
  - The states enter the analysis in the third month following the first fee schedule considered

NC	3/ 1/2000
AL	3/15/2000
OR	4/ 1/2000
CT	5/ 1/2000
NV	5/ 1/2000
AR	5/15/2000
NE	6/15/2000
RI	7/ 1/2000
SD	7/19/2000
UT	1/ 1/2001
VT	1/ 1/2001
GA	9/ 1/2001
FL	9/30/2001
TX	9/ 1/2002
TN	7/ 1/2005
IL	2/ 1/2006
ID	4/ 1/2006

(1) Utilization, price level, and severity rates of growth range from March 2000 through December 2010

Appendix

States' Neighbors

- When calculating the Lowe index for the covariate Fee Schedule Relative to Neighbors, a state's neighbors were defined based on Census divisions and, where applicable, regions(1)
  - New England: CT, MA, ME, NH, RI, VT
  - North Central: IA, IL, IN, KS, MI, MN, MO, ND, NE, OH, SD, WI
  - South Atlantic: DC, DE, FL, GA, MD, NC, SC, VA, WV
  - South Central: AL, AR, KY, LA, MS, OK, TN, TX
  - Mountain: AZ, CO, ID, MT, NM, NV, UT, WY
  - Pacific: AK, CA, HI, OR, WA

(1) See www.census.gov/econ/census07/www/geography/regions_and_divisions.html

Appendix

Outlier Detection

- We apply box plots to the observed transaction prices on the logarithmic scale,(1) using the following algorithm (where percentiles on the raw scale are indicated by capital letters and percentiles on the logarithmic scale are indicated by lowercase letters):
  - If $P_{75} \neq P_{25}$, then we define the service-level price fences as $p_{75} + .6$ and $p_{25} - .6$
    - Records with a paid value greater than $p_{25} - .7$ and, simultaneously, a paid-to-submit ratio greater than .5, are also retained
  - If $P_{75} = P_{25}$,(2) then we define the service-level price fences as $p_{85} + .2$ and $p_{15} - .2$
  - Records within the service-level price fences are used to calculate category-level price fences, which are defined as $p_{90} + .5$ and $p_{10} - .5$, subject to constraints
- All records that fall between both the service-level and category-level price fences are retained unedited and are used to calculate the average price and median units

(1) The natural logarithm is applied
(2) The distributions of prices by CPT code may be multi-modal; such multimodality may originate in variation in reimbursement transaction rates across the reimbursing institutions. Because the frequency distribution of reimbursing institutions may be highly skewed in a given CPT code, setting the service-level fences dependent on the 25th and 75th percentiles poses the risk of discarding entire institutions as outliers

Appendix

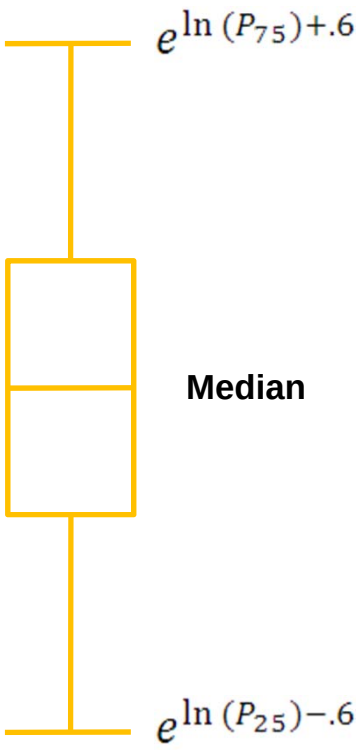
Outlier Management

- Records within service-level and category-level fences are retained unedited, subject to constraints
- Records with prices above any applicable price fence have these prices reset to the mean price for that service; the quantity information remains unaltered
- Records with prices below any applicable price fence have the unit values reset
  - The price is recalculated with the number of units reset to the median number of units of this service(1)
  - If this recalculated price falls below any of the lower price fences, then the price is recalculated once more, with the number of units set to unity
  - If the so recalculated price still falls below any of the lower price fences, then the record is discarded as a nuisance transaction(2)
- Services with less than 12 records in a given state in a given year are excluded from the price index computation

(1) The median is usually equal to unity
(2) If the price exceeds any upper fence, then the price is set to the mean of the applicable service level

Appendix

Tukey's Schematic Plot ("Box Plot")



- Shown is Tukey's schematic plot, the objective of which is to report major location parameters (median, 25th, and 75th percentiles) of a data set and to identify outliers
- The hinges identify the inter-quartile range (IQR), which comprises 50 percent of the data
- The fences signify (1) the sum of the 75th percentile and .6 on the logarithmic scale (approximately the 75th percentile, multiplied by 1.8) and (2) the difference between the 25th percentile and .6 on the logarithmic scale (approximately the 25th percentile, divided by 1.8)
- Values beyond the fences are considered outliers

Source: John W. Tukey (1977) Exploratory Data Analysis, Reading (MA): Addison-Wesley

Appendix

Laspeyres and Paasche Price Indexes Arithmetic

- The Laspeyres price index (P_L) and the Paasche price index (P_P) are calculated as follows:(1)

$$P_L \equiv \frac{\sum_{i=1}^{n} p_i^1 q_i^0}{\sum_{i=1}^{n} p_i^0 q_i^0} \qquad P_P \equiv \frac{\sum_{i=1}^{n} p_i^1 q_i^1}{\sum_{i=1}^{n} p_i^0 q_i^1}$$

where p and q indicate prices and quantities, respectively; 0 and 1 indicate the base period and the current period, respectively; and n is the number of items

  - In order for the Fisher index to be a chained index, the base periods of the P_L and P_P indexes must be the time period immediately preceding the current period (as opposed to a more distant past time period)(2)

(1) International Labor Office (2004) *Consumer Price Index Manual: Theory and Practice*, Geneva, p. 265
(2) Ibid., p. 280