

# Veterans and Chronic Pain Cost: Time, Site Variation, and Veteran Traits

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# Chronic Pain in the US

- Chronic Pain and Prescription Opioid abuse are one of the largest current public health crises' in the USA
- Over 100 million Americans suffer from Chronic Pain
- This is especially important to the Veterans' Healthcare Administration, the largest integrated healthcare system in the US
- 50% of Veterans Suffer from One or More Chronic Pain Conditions
- Chronic pain costs exceed \$500 Billion per year in the US



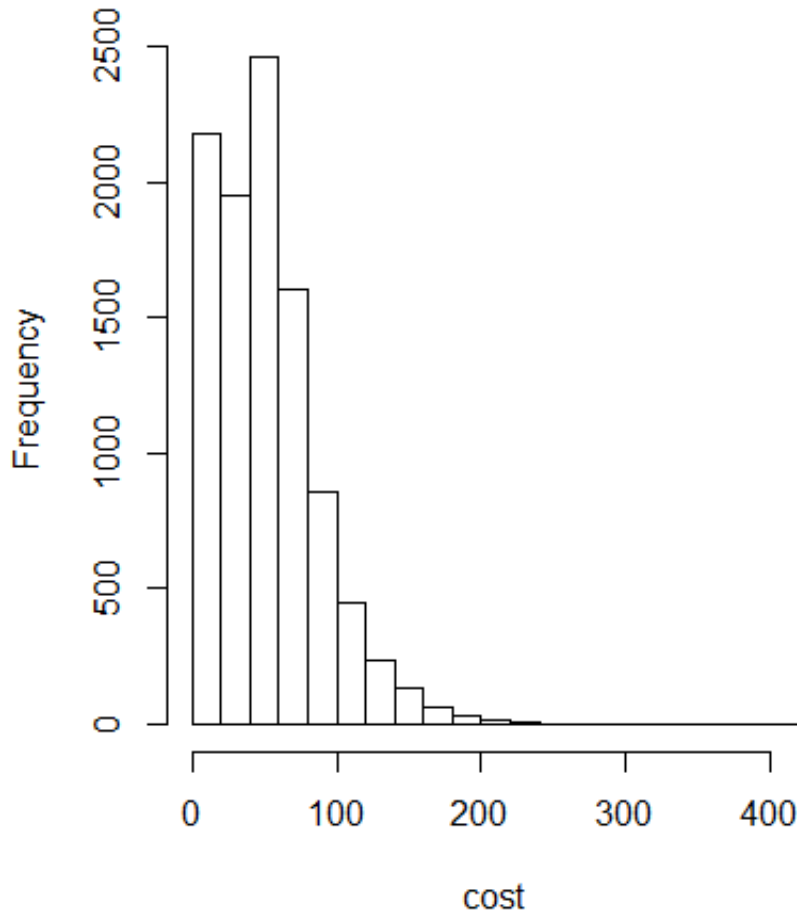
# The Cost of Pain Care



- Prior work has estimated the total costs of chronic pain in the United States to be over \$500 billion dollars
- However, understanding variation in pain care costs requires more specific modeling of patient costs
- Are increasing costs associated with care for Veterans suffering from Chronic Pain good or bad?
- Not all costs are created equal:
  - Inpatient
  - Outpatient
  - Emergency Department
  - Primary Care

Cost = .... ?

**Histogram of cost**



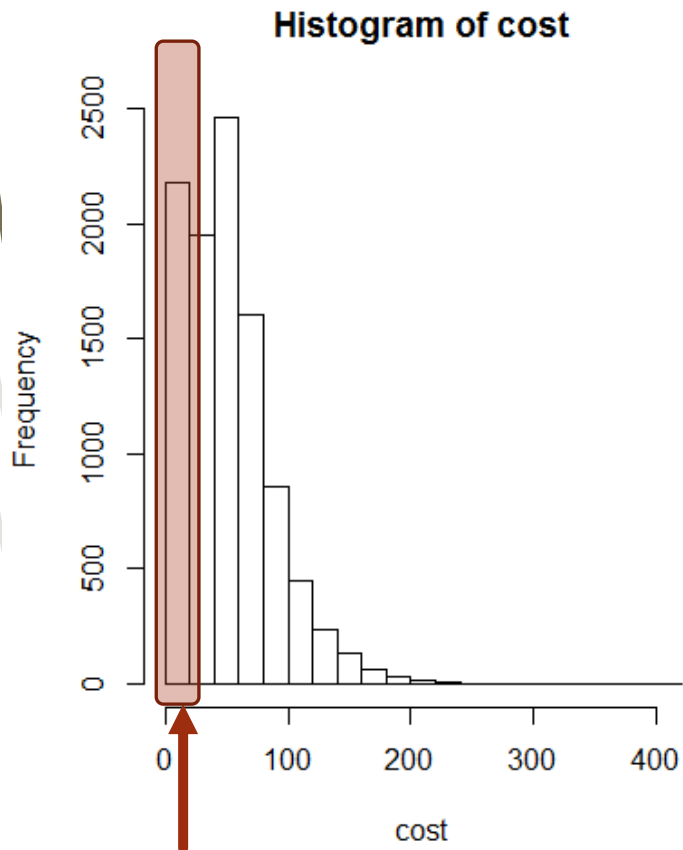
- What is the appropriate target of Inference when studying cost?
- What about different types of costs?
- Over what time period were these costs accumulated, adjustment?



# Cost = .... ?

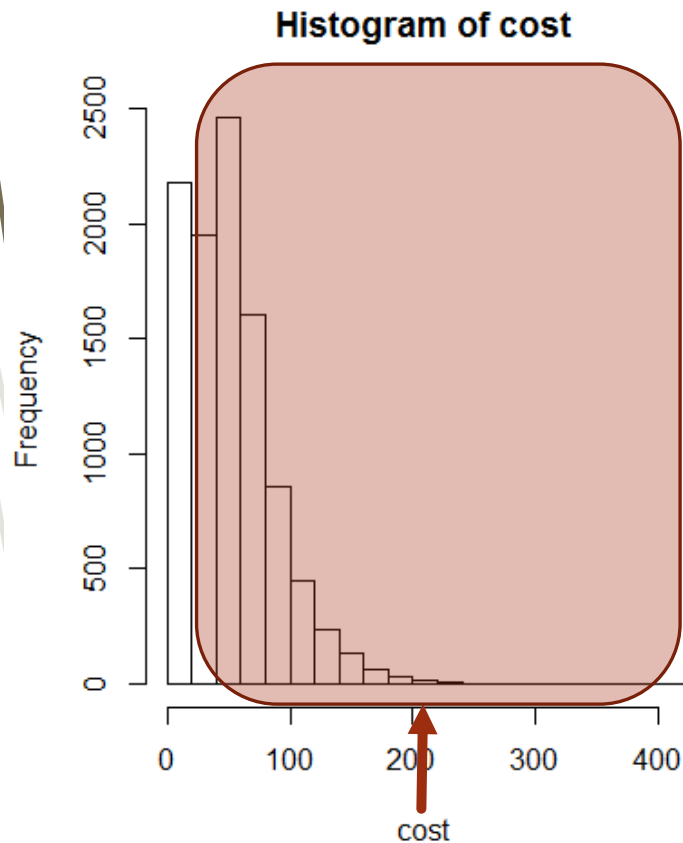
- What is the appropriate target of Inference when studying cost?
- Total Cost
  - Reflects both the probability of utilization and the intensity of utilization
  - Goes up when the probability of utilization goes up
  - Goes up when the prices or severity of utilization goes up
- Probability of Use:
  - How likely is a Veteran to be hospitalized?
  - How likely is a Veteran to utilize the emergency department?
- Intensity of Use:
  - How much does the hospital stay or emergency department visit cost?
  - How much was spent on mental health care ?

# Two Part Cost Modeling: Probability of Incurring Cost



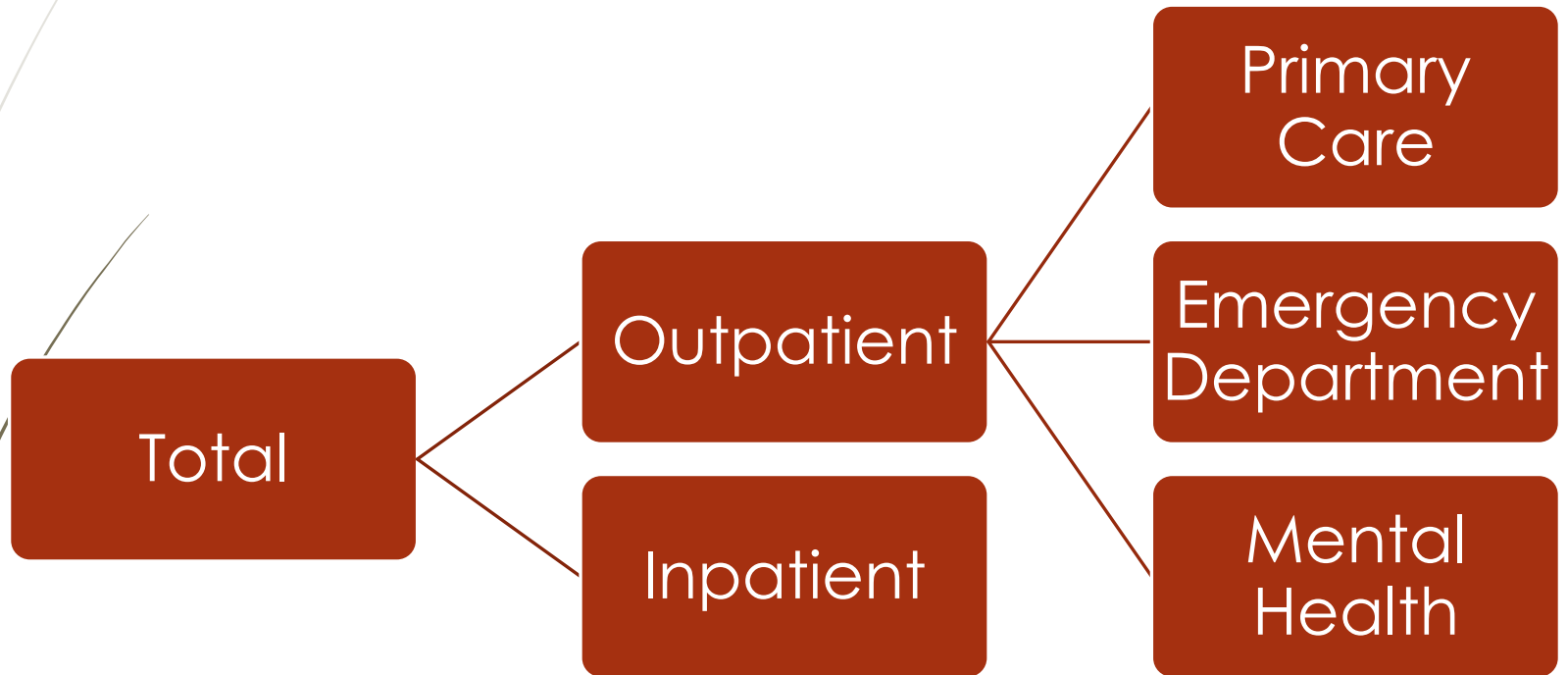
- Aggregate Costs to Total Monthly Patient level costs
- Random Effects Logistic Regression:  
 $\text{Cost} > 0 \sim x_1 + x_2 \dots$
- Interpretation:
  - Estimate the probability of monthly cost occurrence at the Veteran level

# Two Part Cost Modeling: Intensity of Non-zero Cost



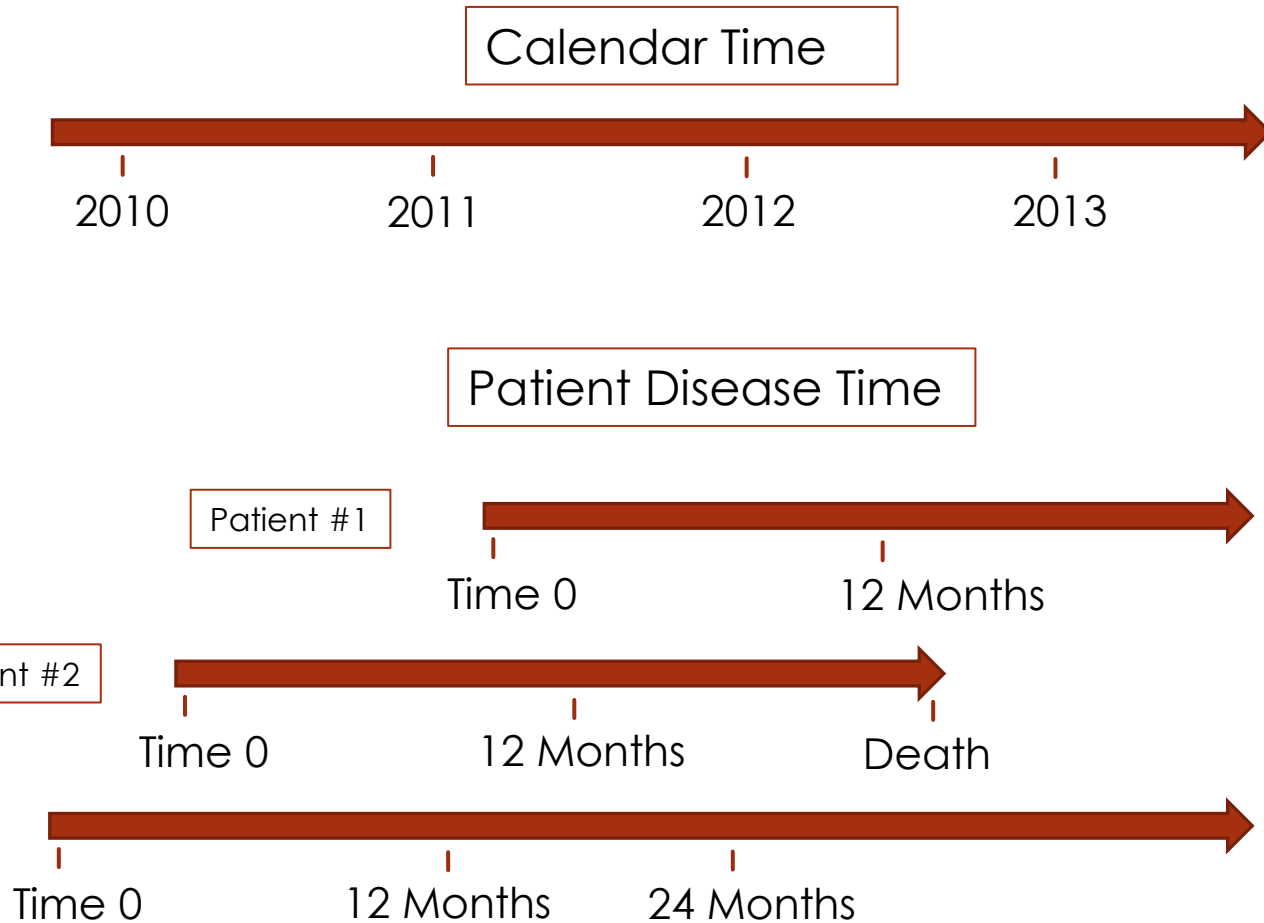
- Aggregate Costs to Total Monthly Patient level costs
- Random Effects Log-Gamma Regression:  
 $\text{Cost} \mid \text{Cost} > 0 \sim x_1 + x_2 \dots$
- Interpretation:
  - Estimate the expected value of non-zero monthly costs

# Cost Buckets





# Studying Cost and Time






# Overall Goals of this Work



- Construct a nationally representative cohort of Veterans in Chronic Pain
- Examine demographic and clinical traits of this cohort
- Model Variation in cost:
  - Inpatient, Outpatient, Emergency Department, Primary Care, Mental Health
  - Both the probability of cost events and the intensity of non-zero cost events
- Examine trends in these constructs over calendar time and patient disease time
- Describe site level heterogeneity in these costs
- Describe the association of Veteran level traits with these cost models



# Specific Aims:

- ▶ Are <total, inpatient, outpatient, primary care, emergency department, mental health> costs increasing over time?
    - ▶ How does this change when considering frequency versus severity?
  - ▶ What is the magnitude of site variation in costs among Veterans reporting chronic pain, and how does it change across categories?
  - ▶ What Veteran traits are associated with increased or decreased costs?
- 



# Cohort under Study



- ▶ Veterans suffering from Chronic Pain
  - ▶ Definition: 3 pain scores  $\geq 4$  in 3 distinct months in a 12 month period
- ▶ 329,287 Number of Veterans
  - ▶ In Regular Primary Care
  - ▶ 7 VISNs
  - ▶ 2010-06-01 to 2013-12-31
  - ▶ No Palliative Care
  - ▶ No Cancer (other than skin)
- ▶ Baseline Date
  - ▶ Defined as the first pain score date or primary care date (whichever comes last)



# Covariates



- ▶ Demographics
  - ▶ Age, race, gender, urban/large rural /small rural
- ▶ Clinical Traits
  - ▶ Type of Pain (Neuropathic, Musculoskeletal, IBD, Migraine, Fibromyalgia)
  - ▶ Alcohol Abuse, Other Drugs
  - ▶ Mental Health (Depression, Serious, Other)
  - ▶ Charlson Comorbidity Count > 3
- ▶ Health Care System Traits
  - ▶ PrimSTA3 (parent hospital ID)
- ▶ Time
  - ▶ Calendar Time (Spline)
  - ▶ Patient Disease Time (Spline)



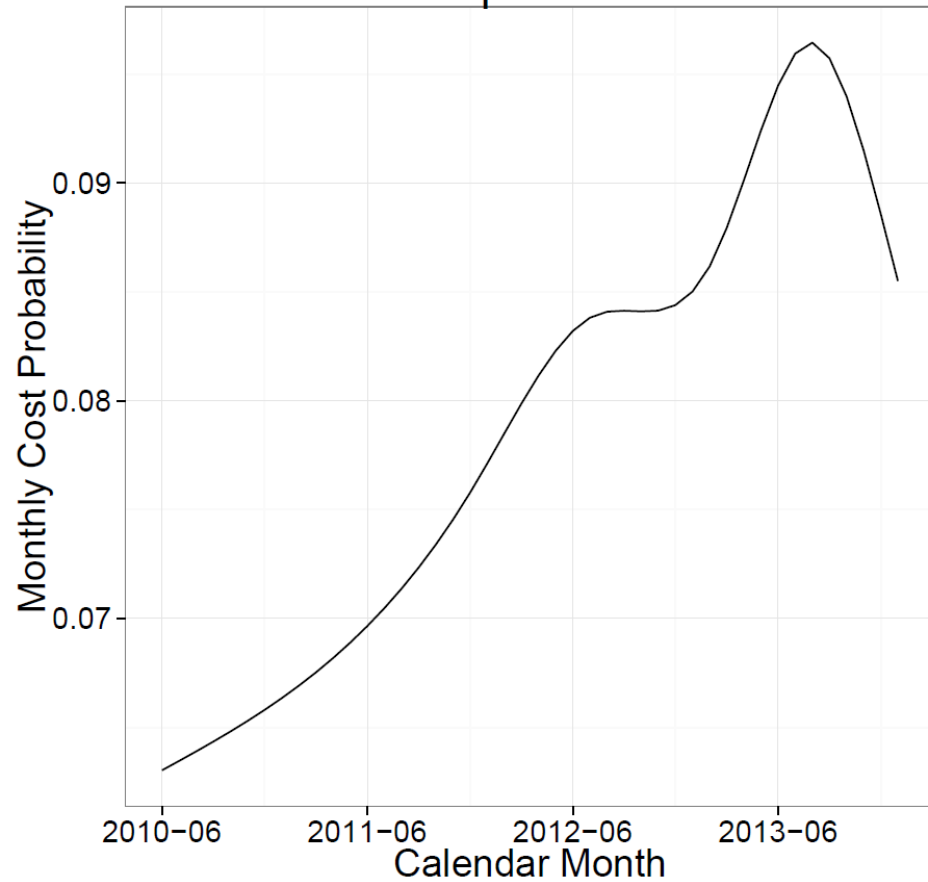
# Modeling Approaches



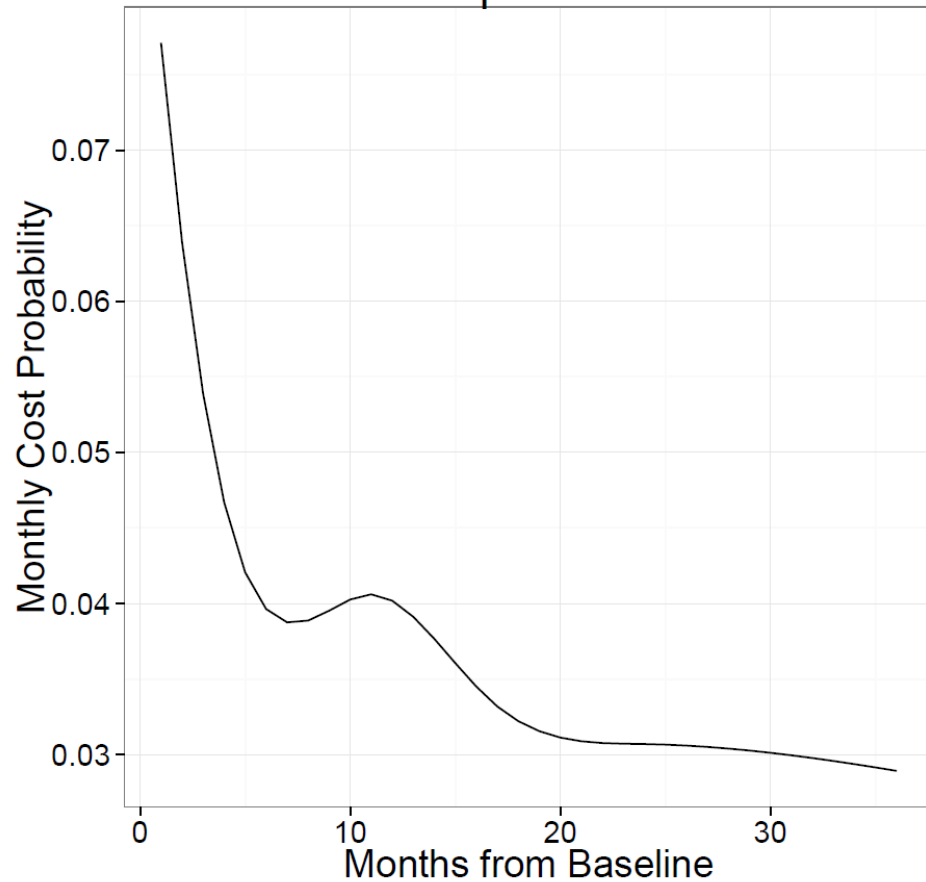
- ▶ Probability of event models:
  - ▶ Generalized linear model with logit link and binomial distribution
  - ▶ Random intercept for parent station
  - ▶ Natural cubic spline with 4 knots for time since baseline and calendar time
- ▶ Severity of outcome models:
  - ▶ Generalized linear model with log link and Gamma distribution
  - ▶ Random intercept effect for parent station
  - ▶ Natural cubic spline with 4 knots for time since baseline and calendar time

# Probability of Inpatient Cost > 0

Inpatient

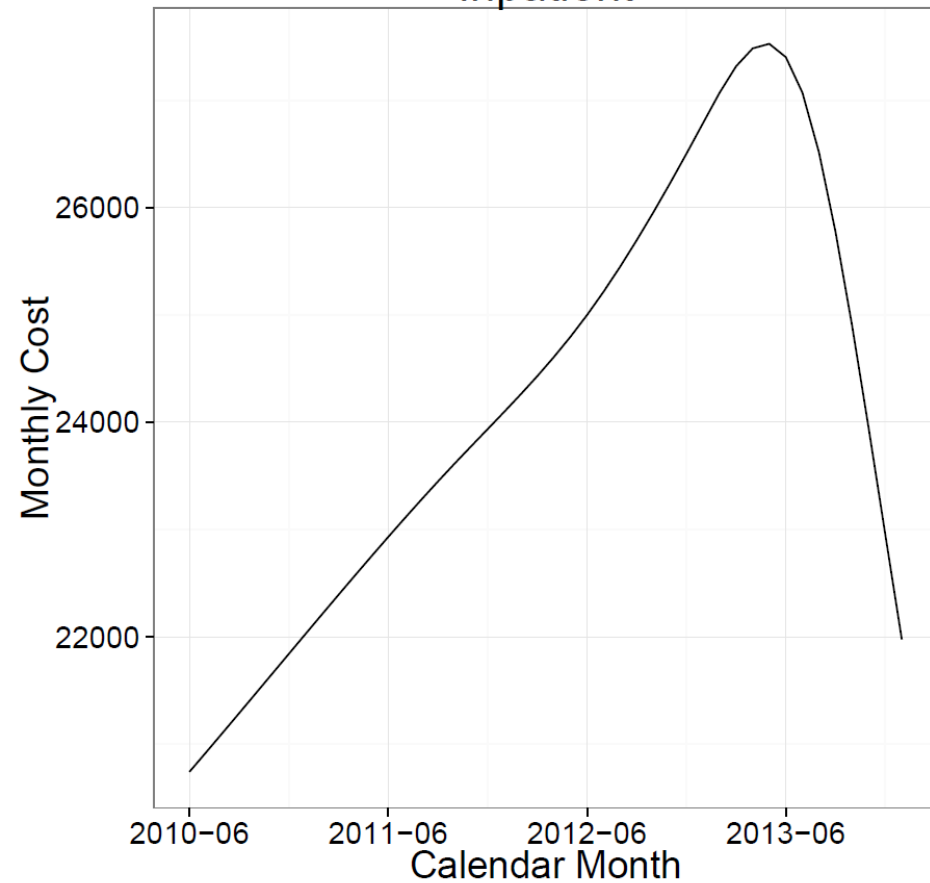


Inpatient

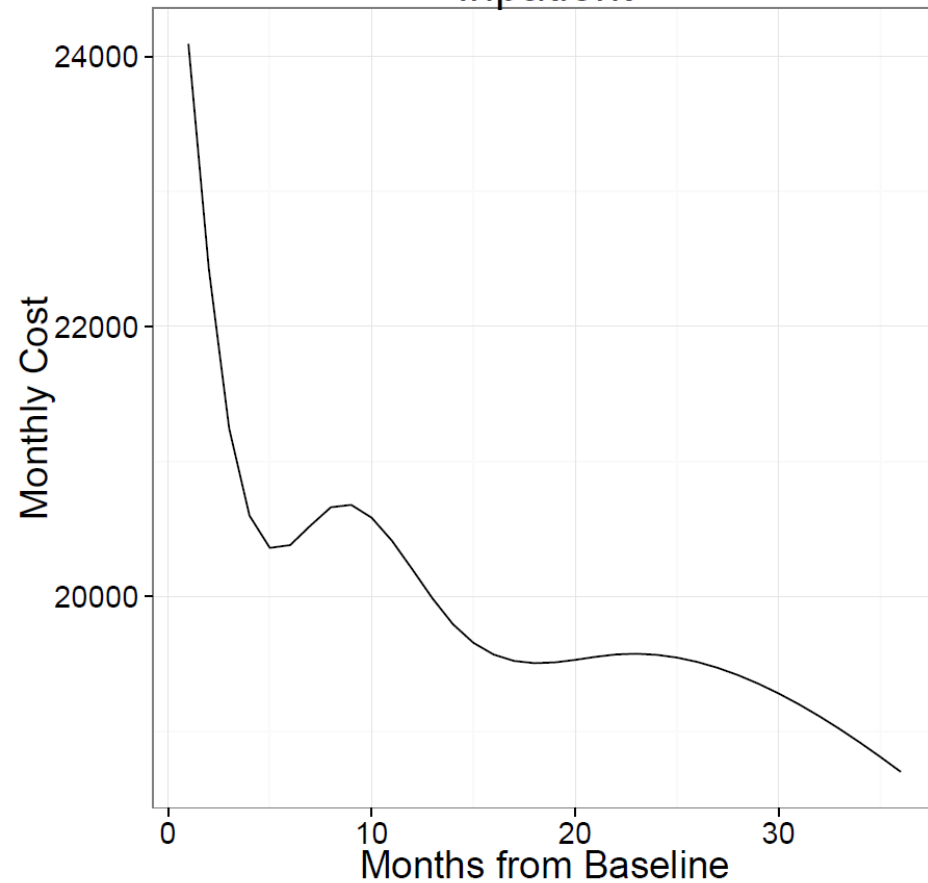


# Intensity of Non-zero Inpatient Cost

Inpatient



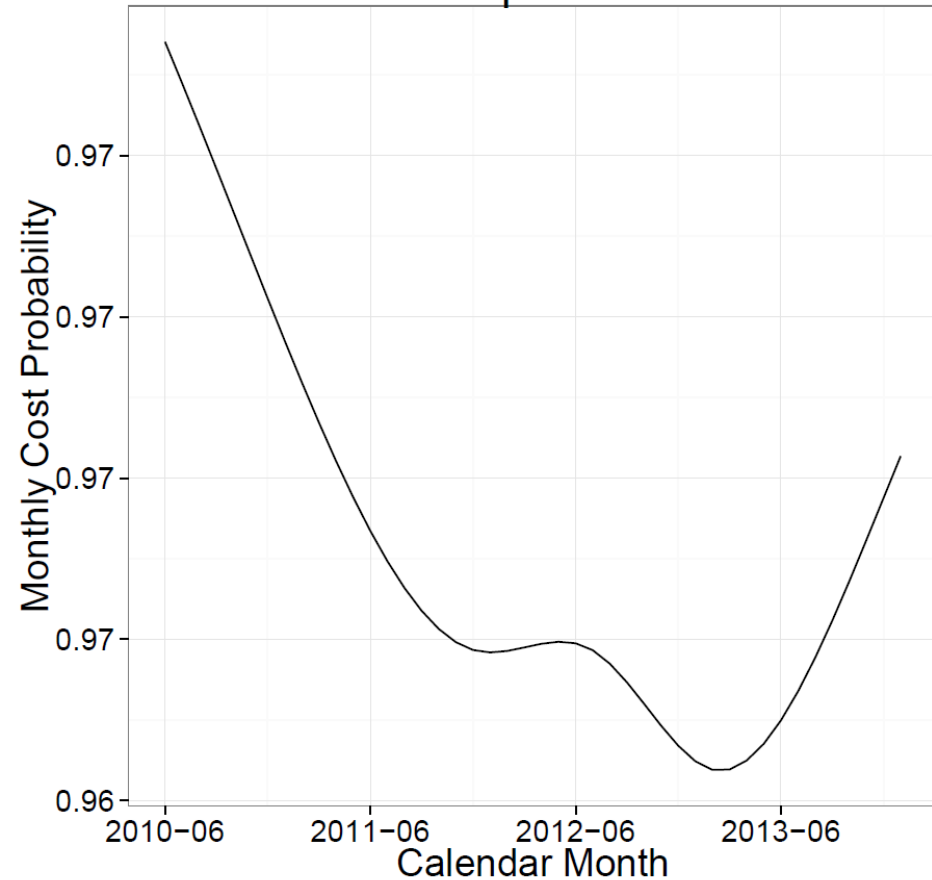
Inpatient



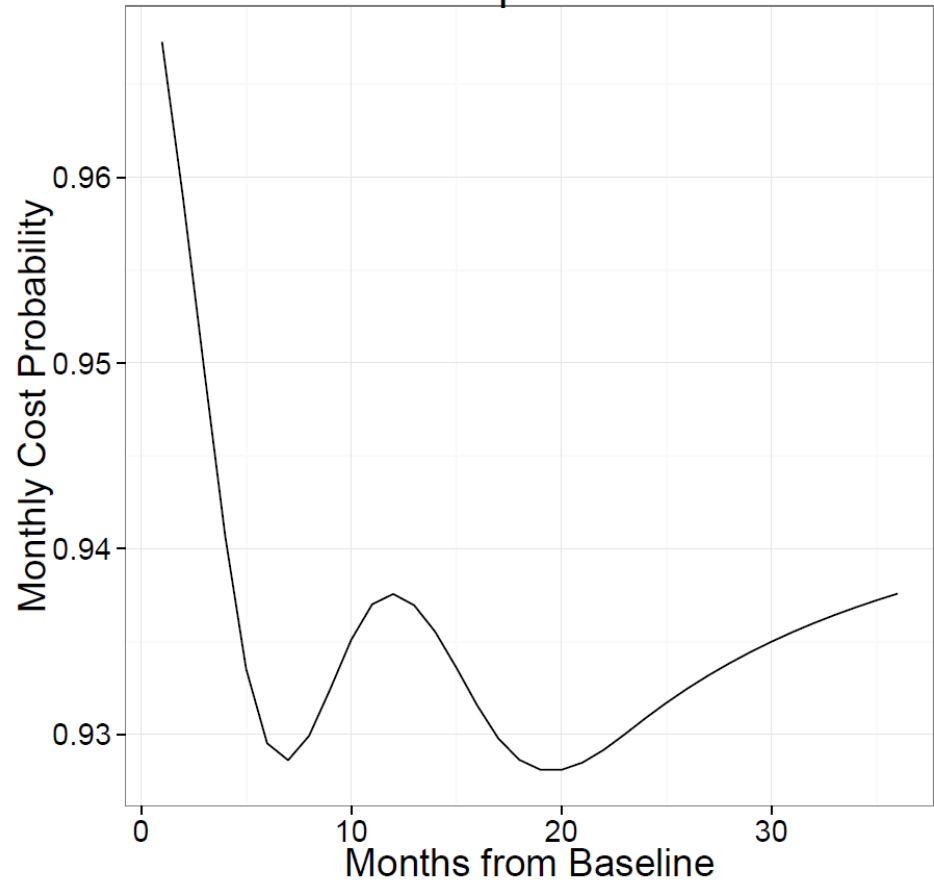


# Probability of Outpatient Cost $> 0$

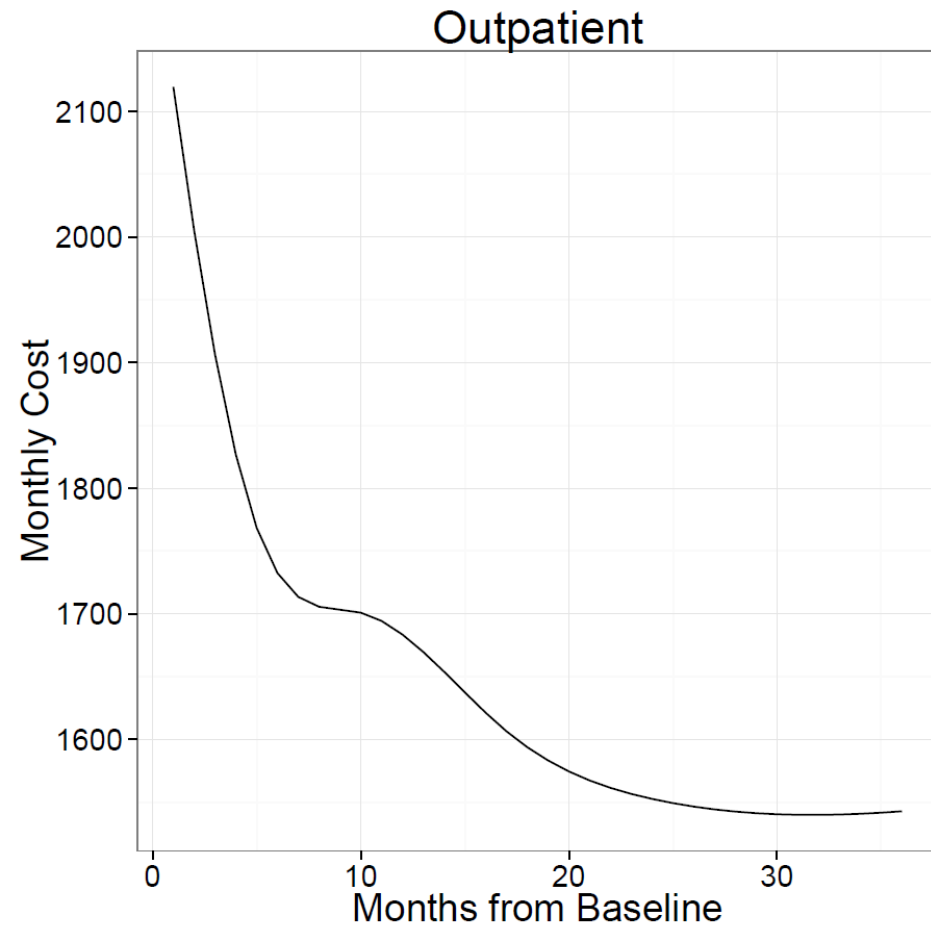
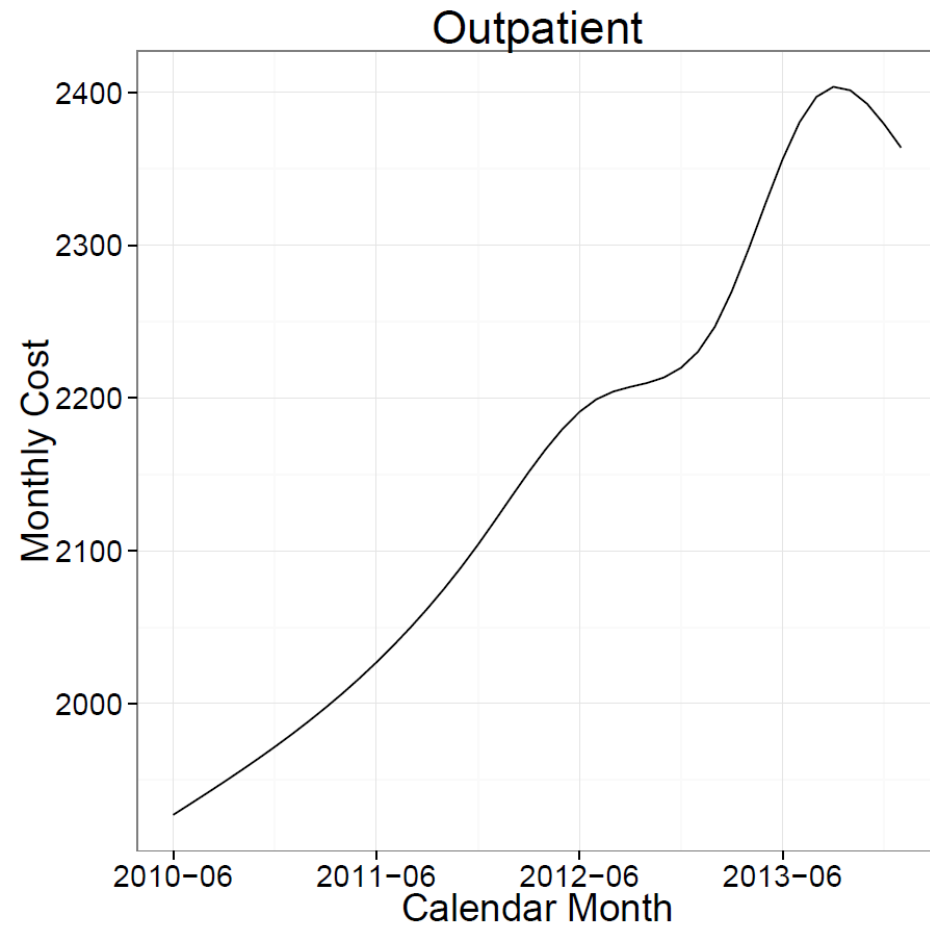
Outpatient



Outpatient

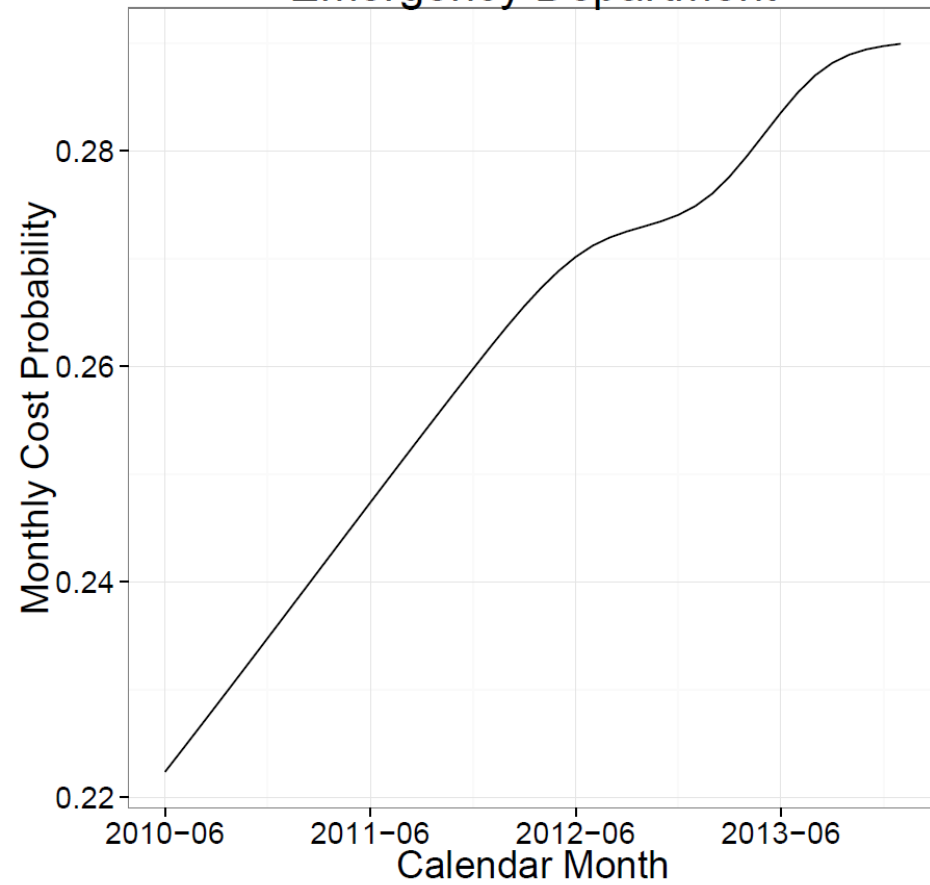


# Intensity of Non-zero Outpatient Cost

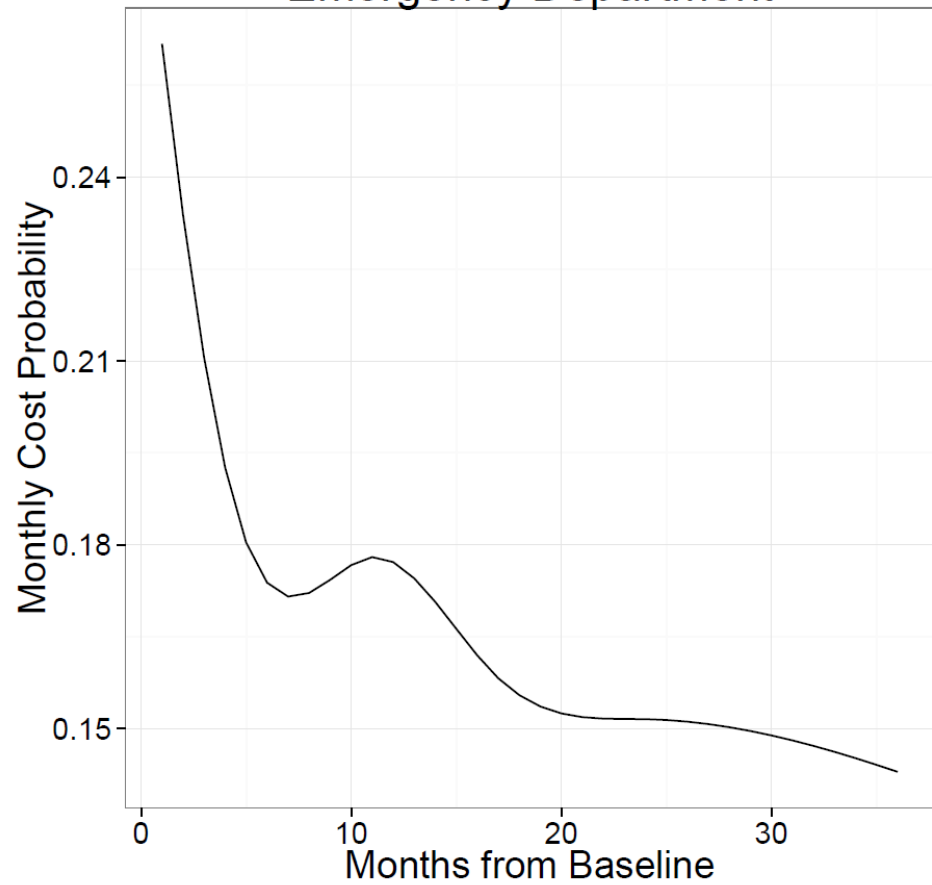


# Probability of Emergency Dept Cost > 0

Emergency Department

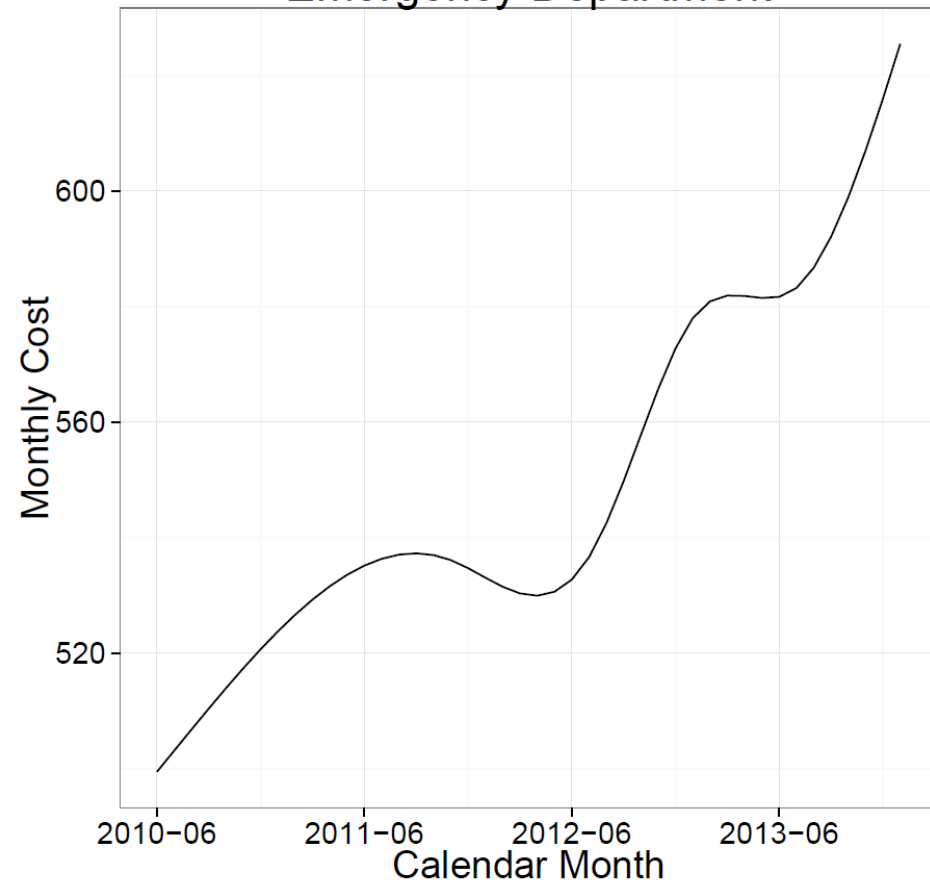


Emergency Department

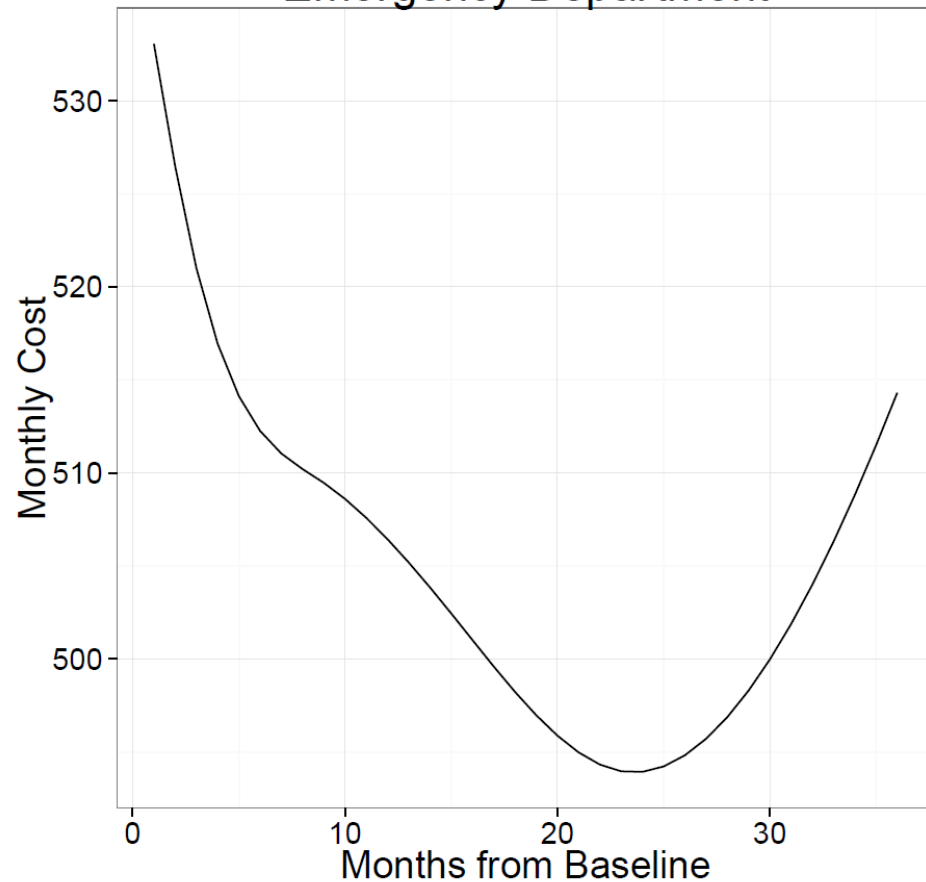


# Intensity of Non-zero Emergency Dept Cost

Emergency Department

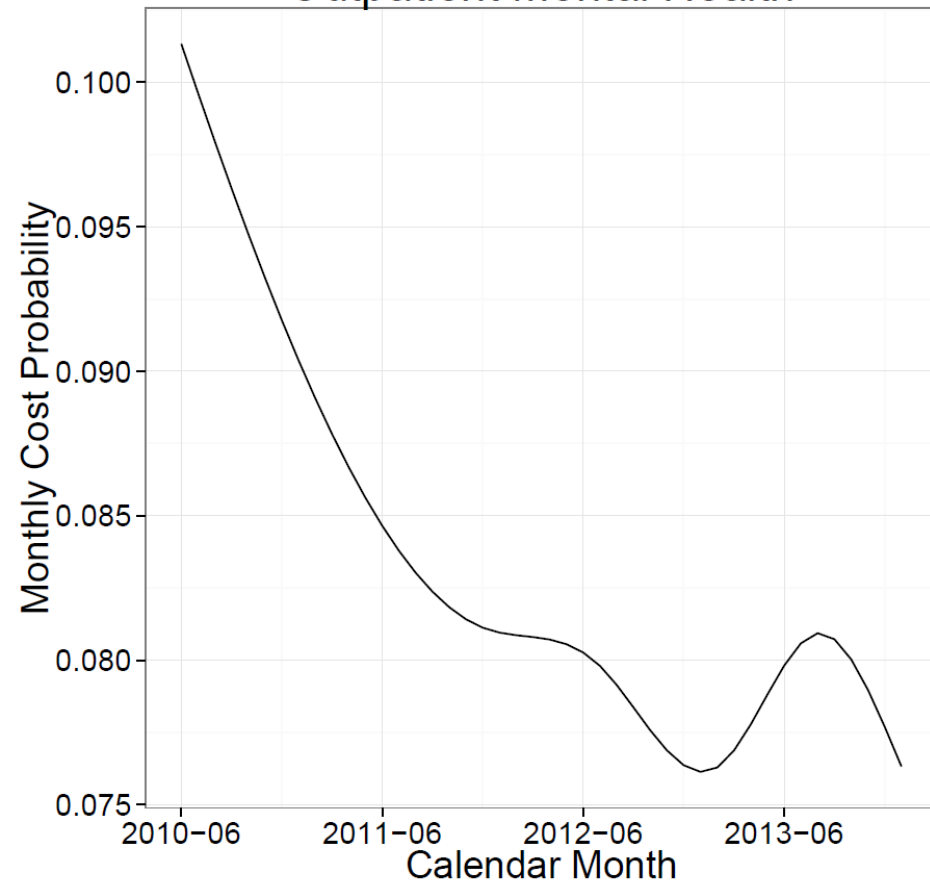


Emergency Department

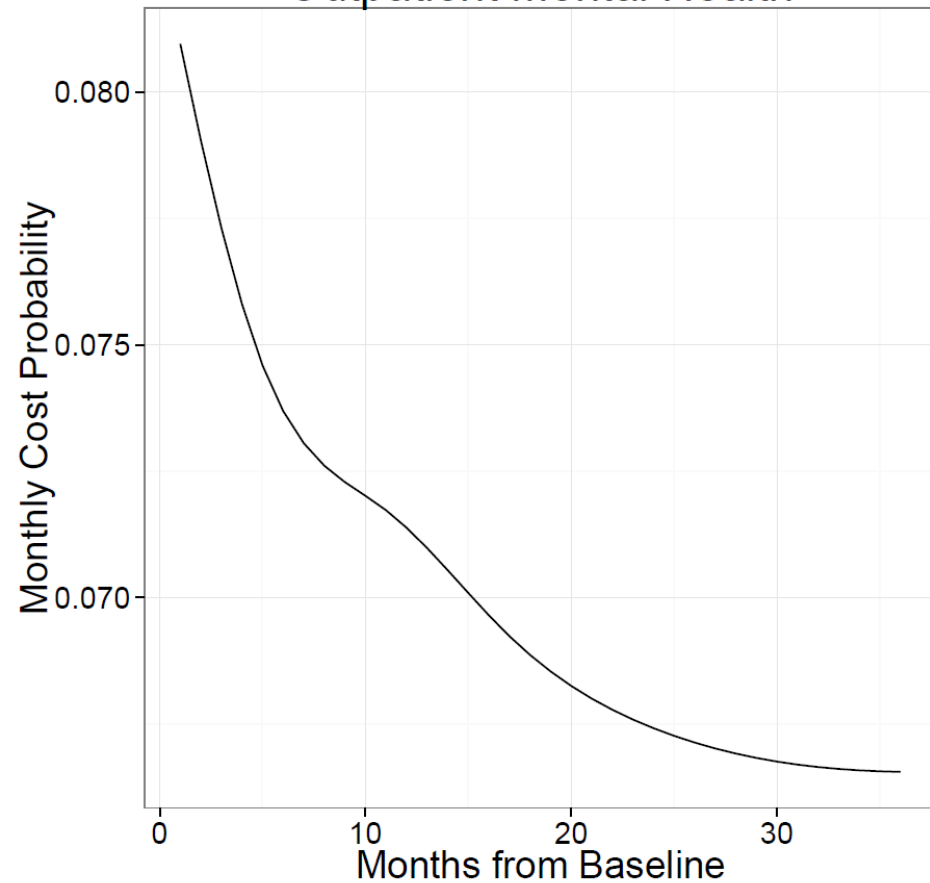


# Probability of Mental Health Cost > 0

Outpatient Mental Health

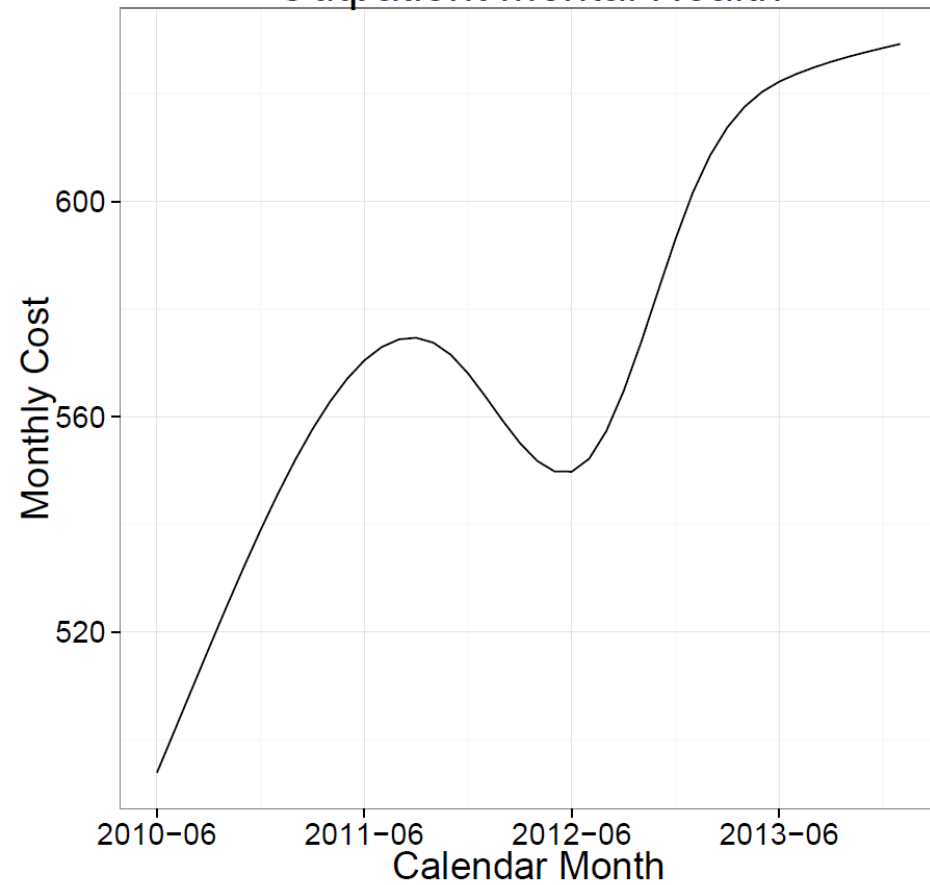


Outpatient Mental Health

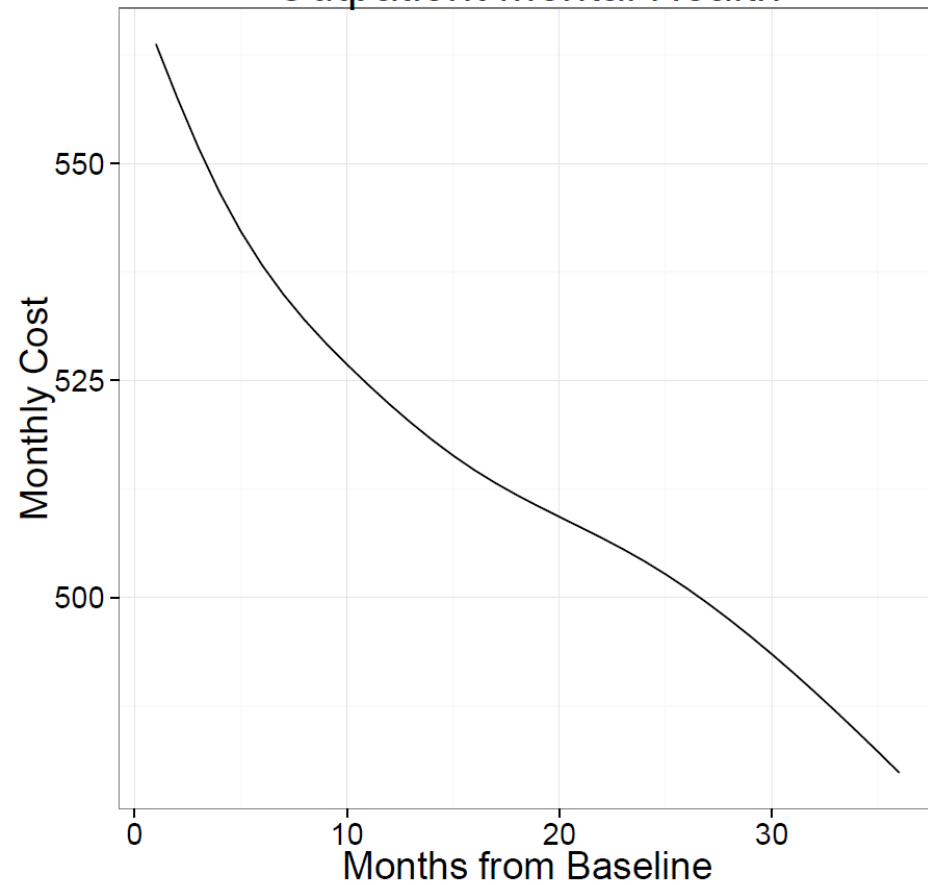


# Intensity of Non-zero Mental Health Cost

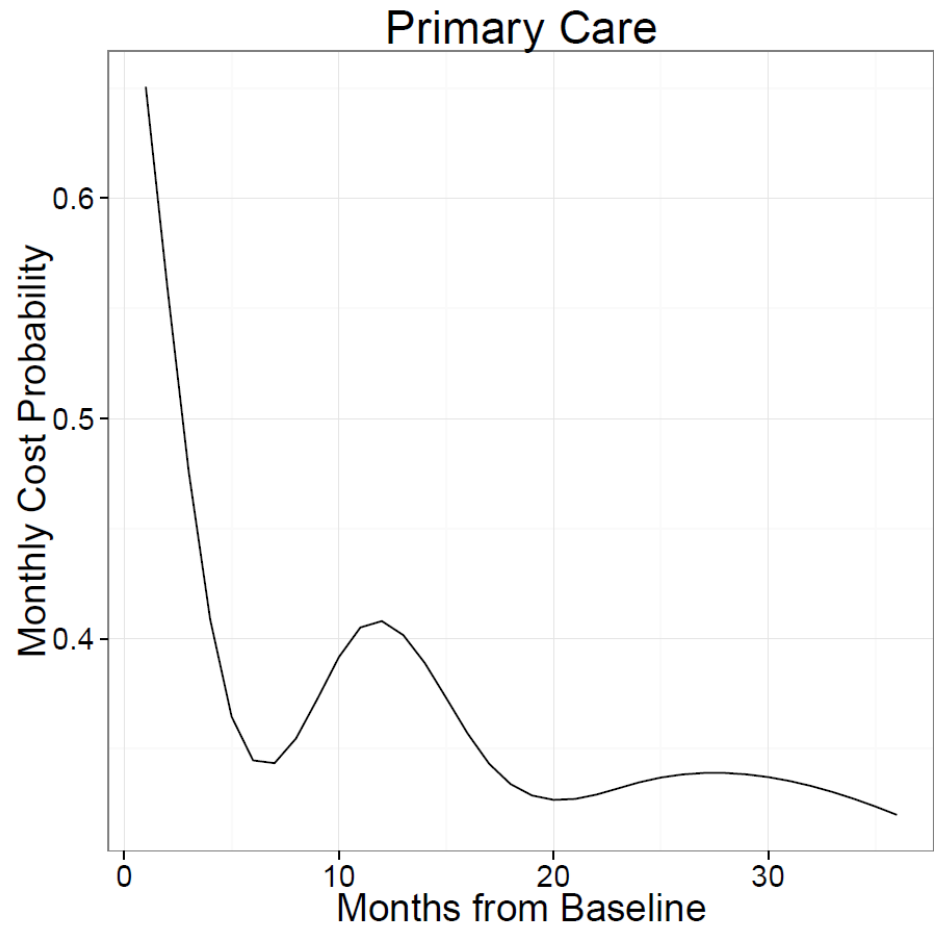
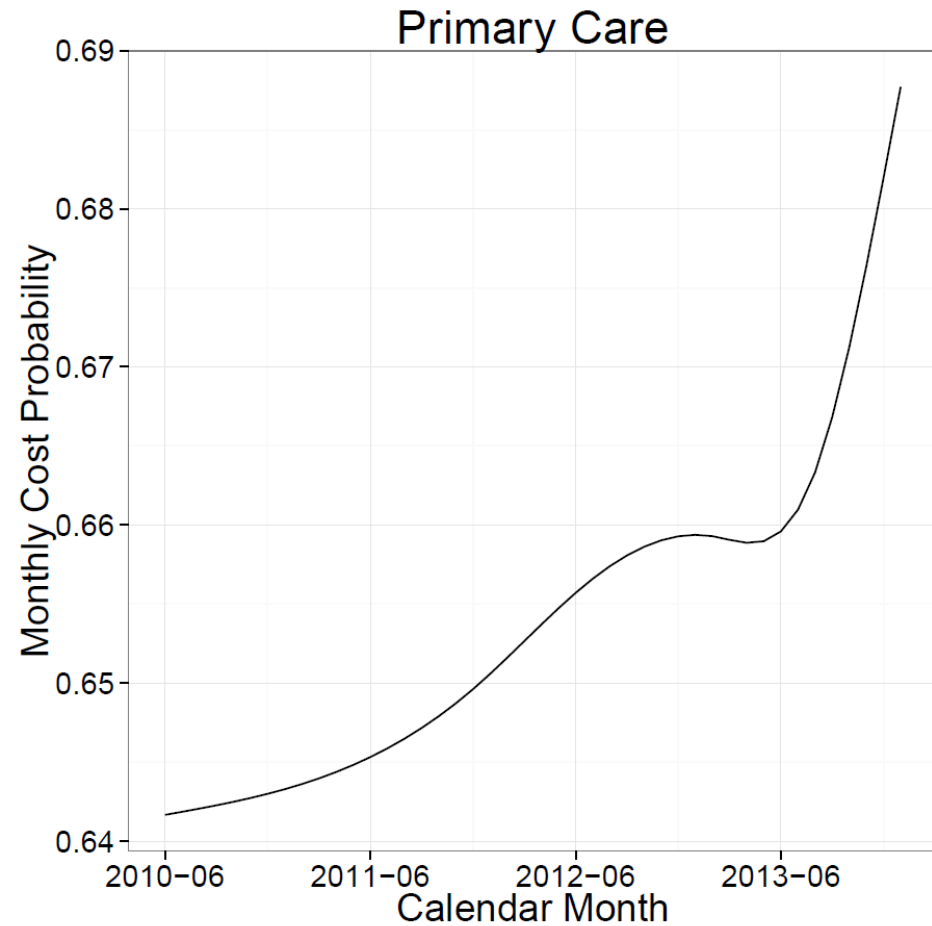
Outpatient Mental Health



Outpatient Mental Health

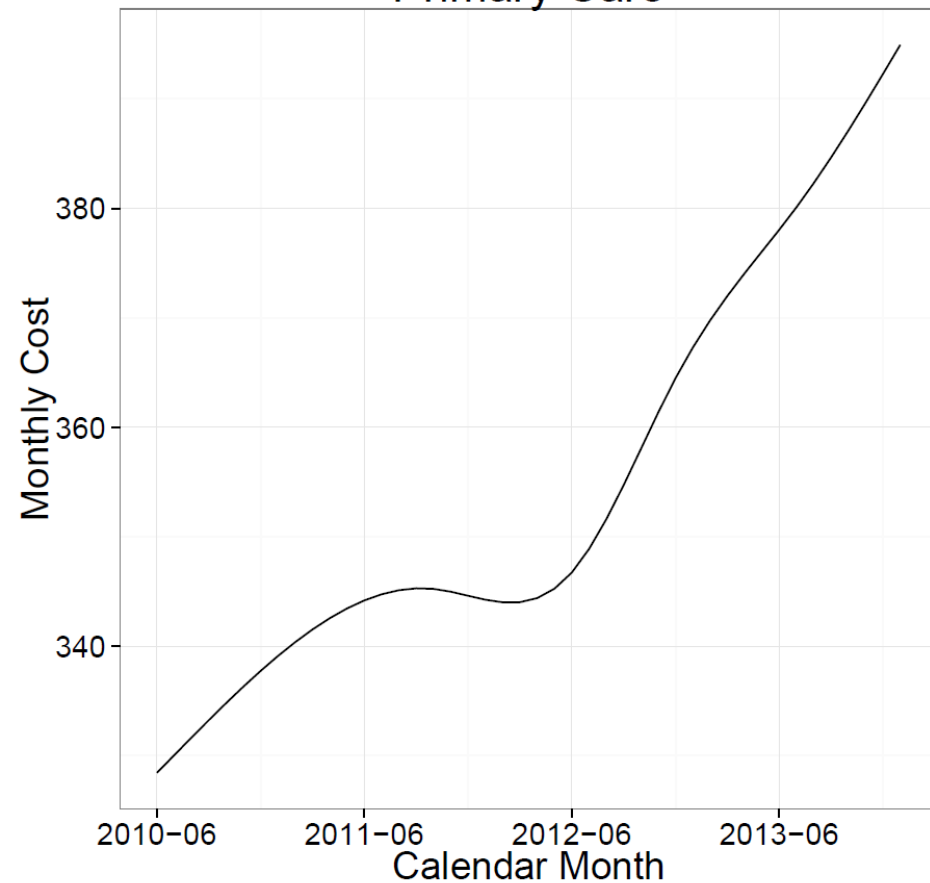


# Probability of Primary Care Cost $> 0$

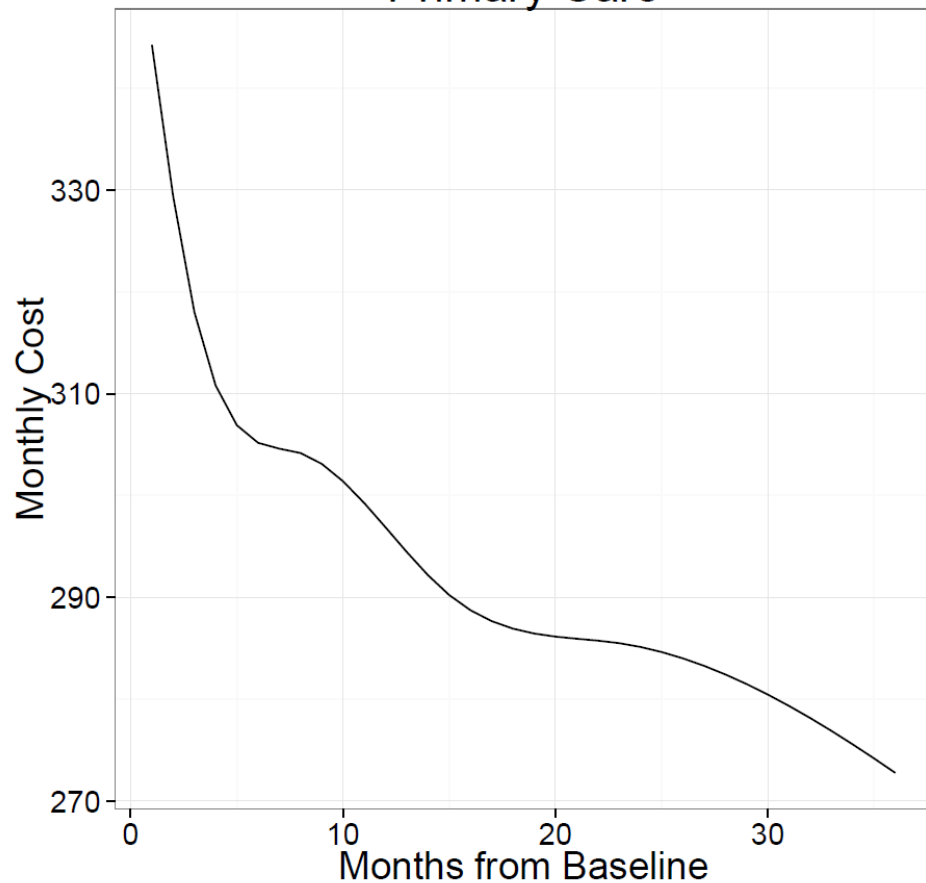


# Intensity of Non-zero Primary Care Cost

Primary Care




Primary Care





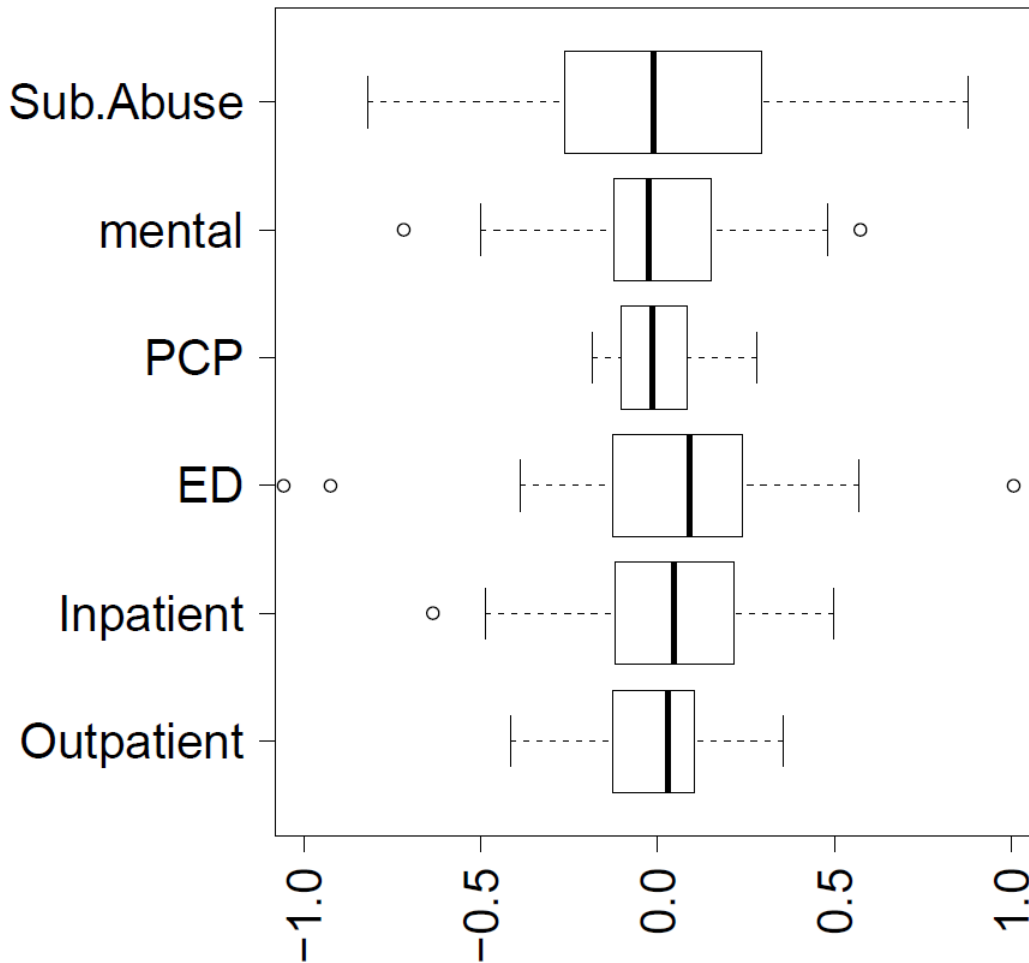


# Temporal Trends Summary

- 
- Prices/Severity generally increasing over calendar time
  - Probability of cost and severity decreasing over patient time
  - Increasing Probability of Cost: Inpatient, emergency department, primary care
  - Decreasing / Static Probability of Cost: Outpatient general, outpatient mental health

# Site Heterogeneity: Probability

**Cost Probability Site Random Effects**

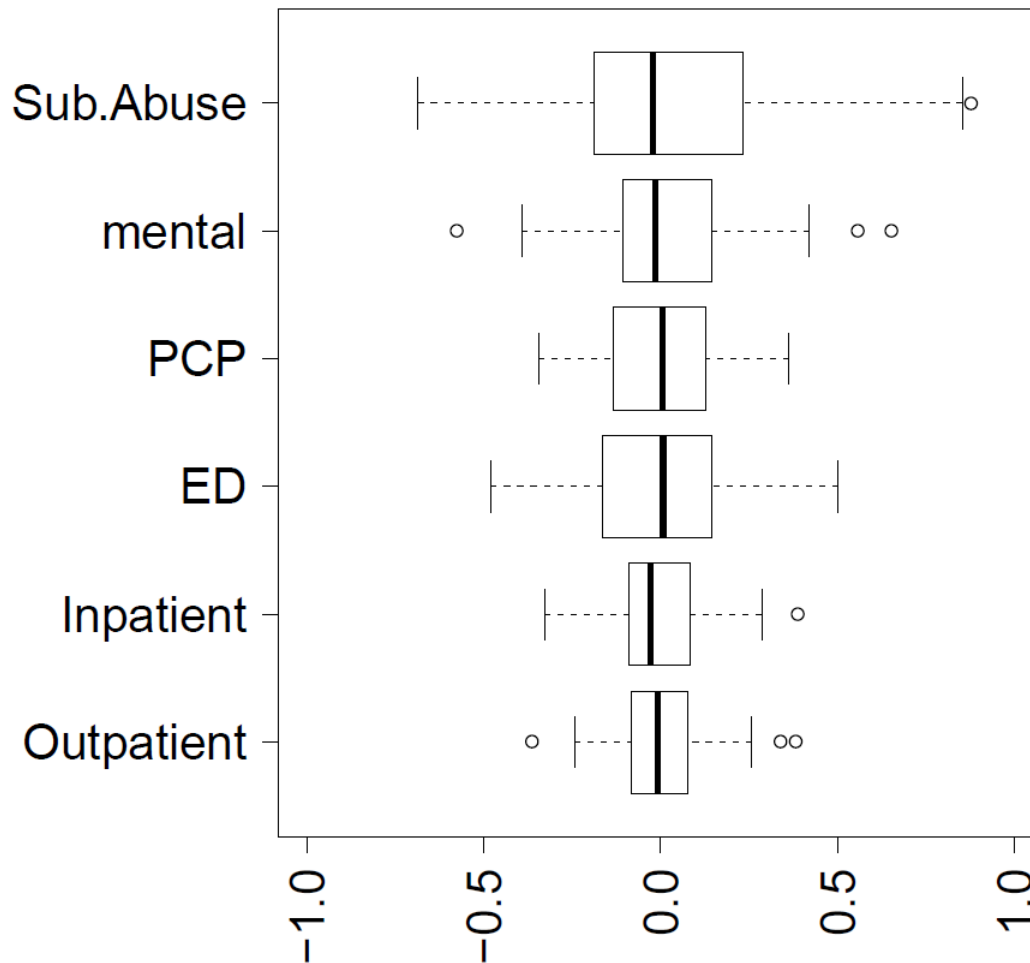


Untransformed  
Scale on Graph.

Beta	OR
1	2.72
0.5	0.65
-0.5	0.60
-1	0.36

# Site Heterogeneity: Severity

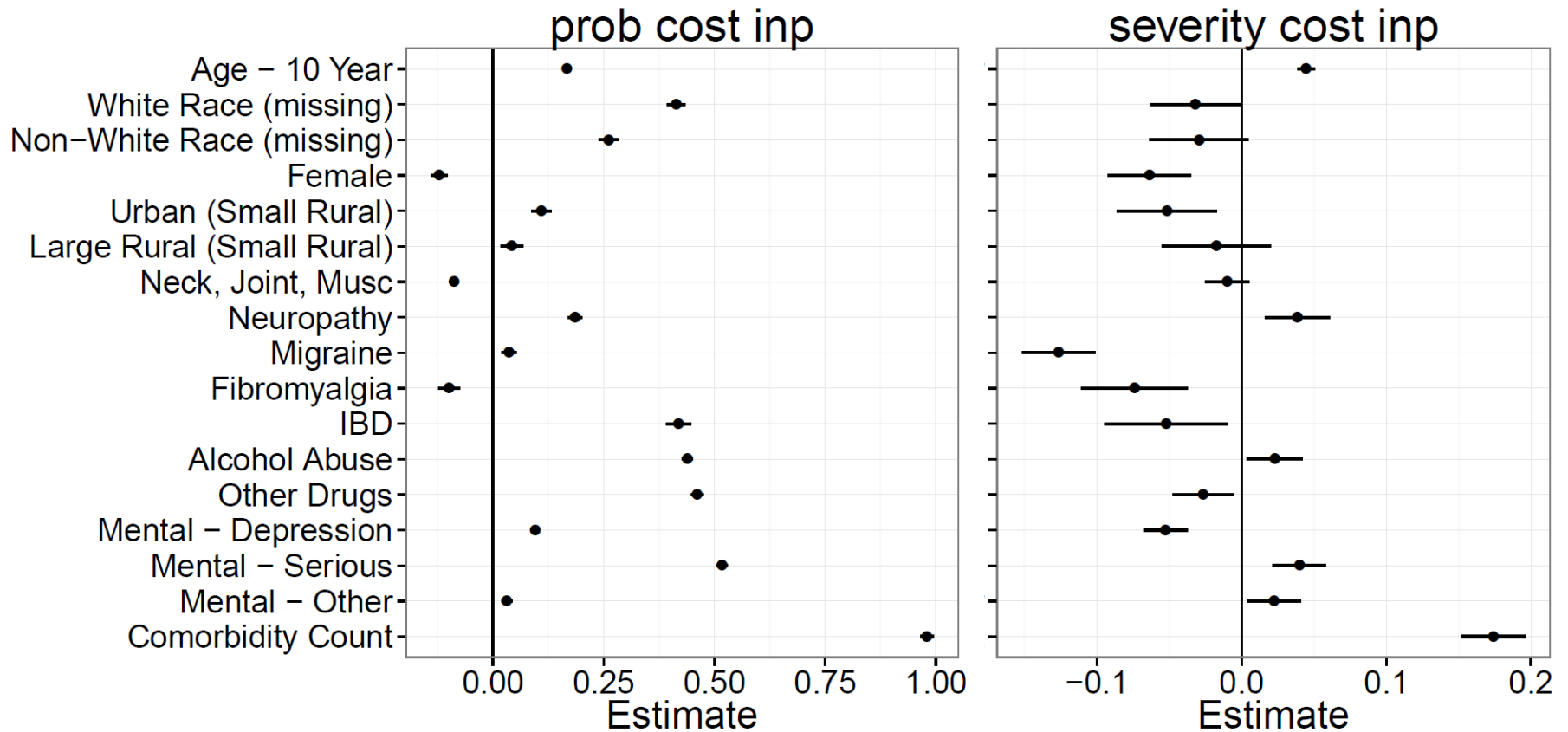
Cost Severity Site Random Effects



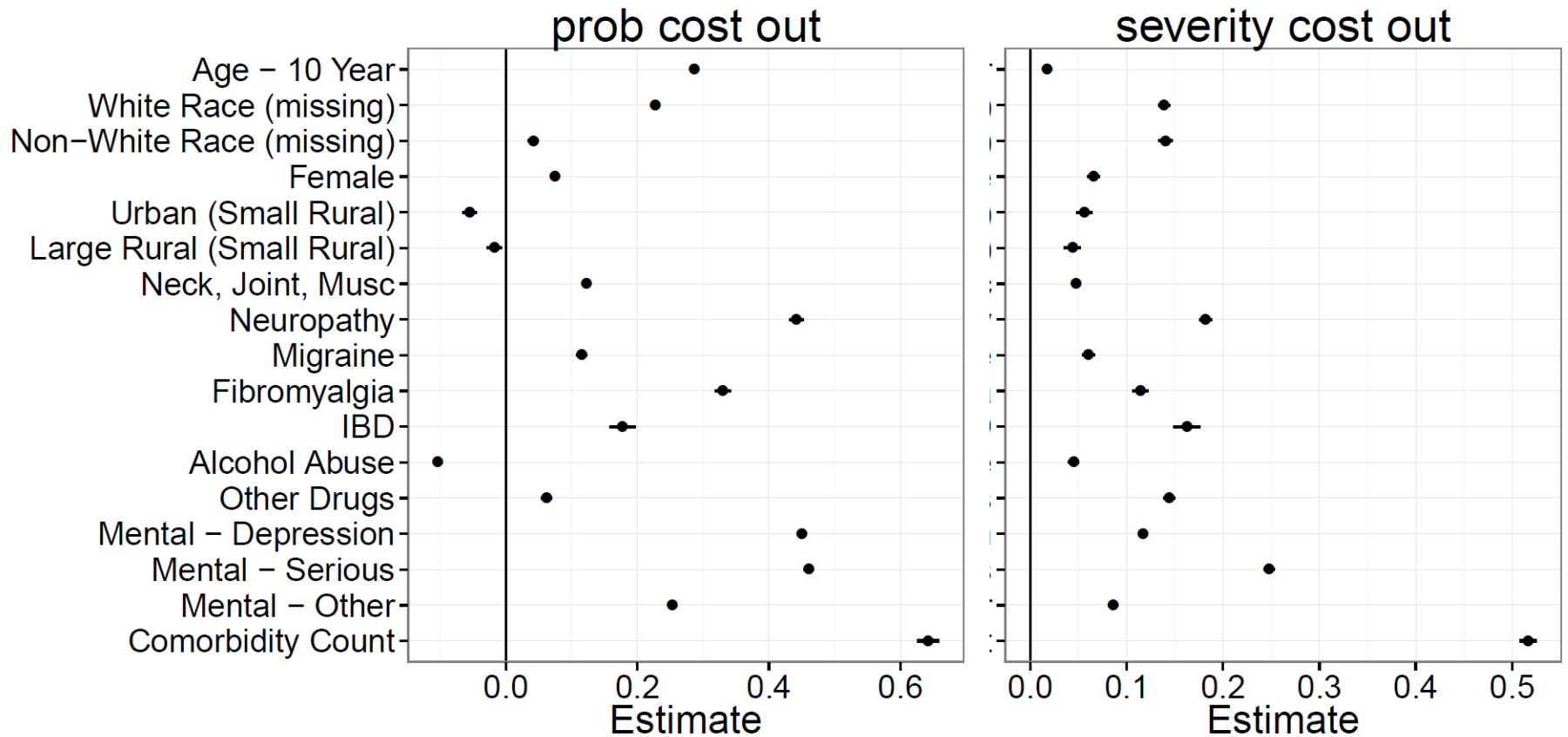
Untransformed  
Scale on Graph.

Beta	Percent Change
1	+172%
0.5	+65%
-0.5	-65%
-1	-172%

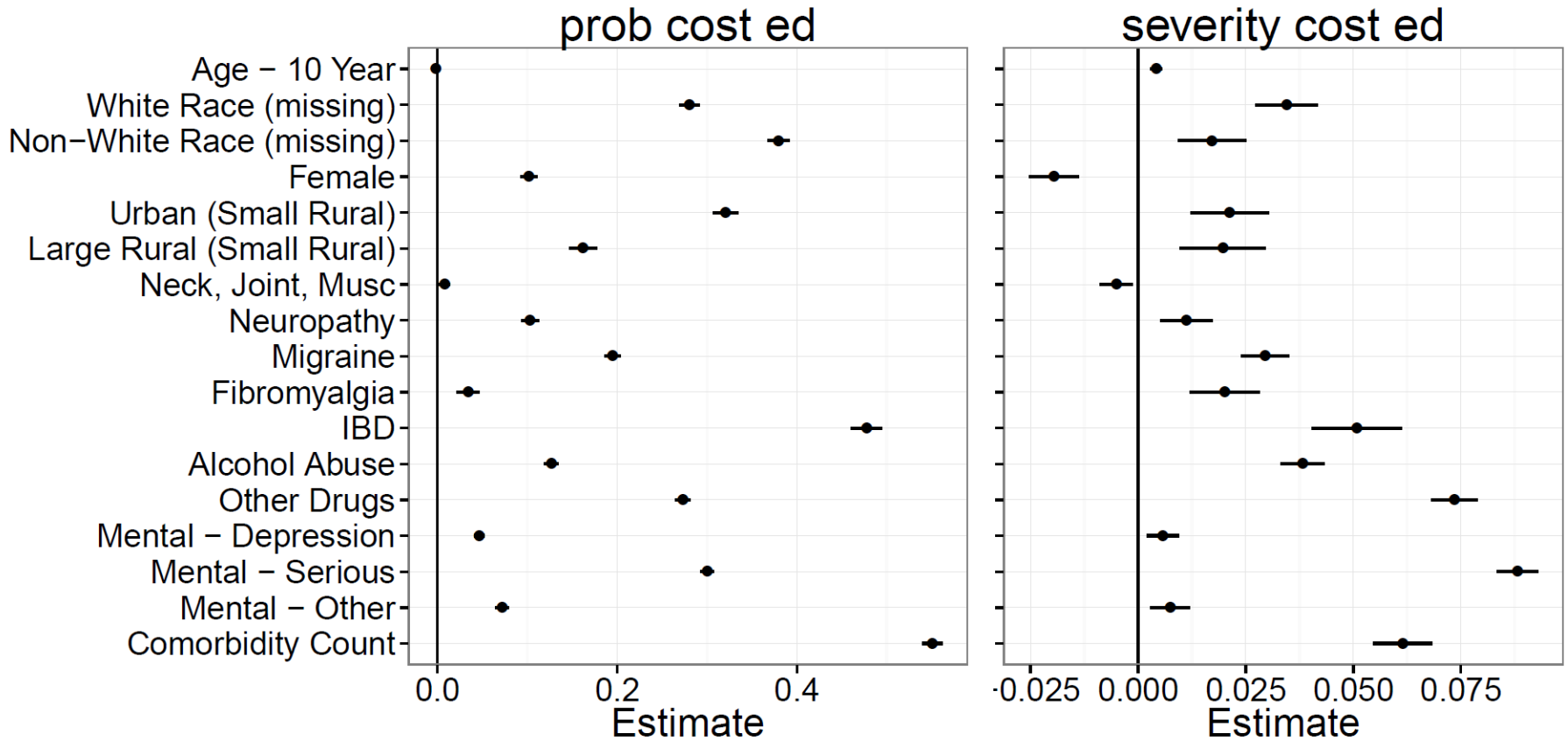
# Multivariate Results: Inpatient



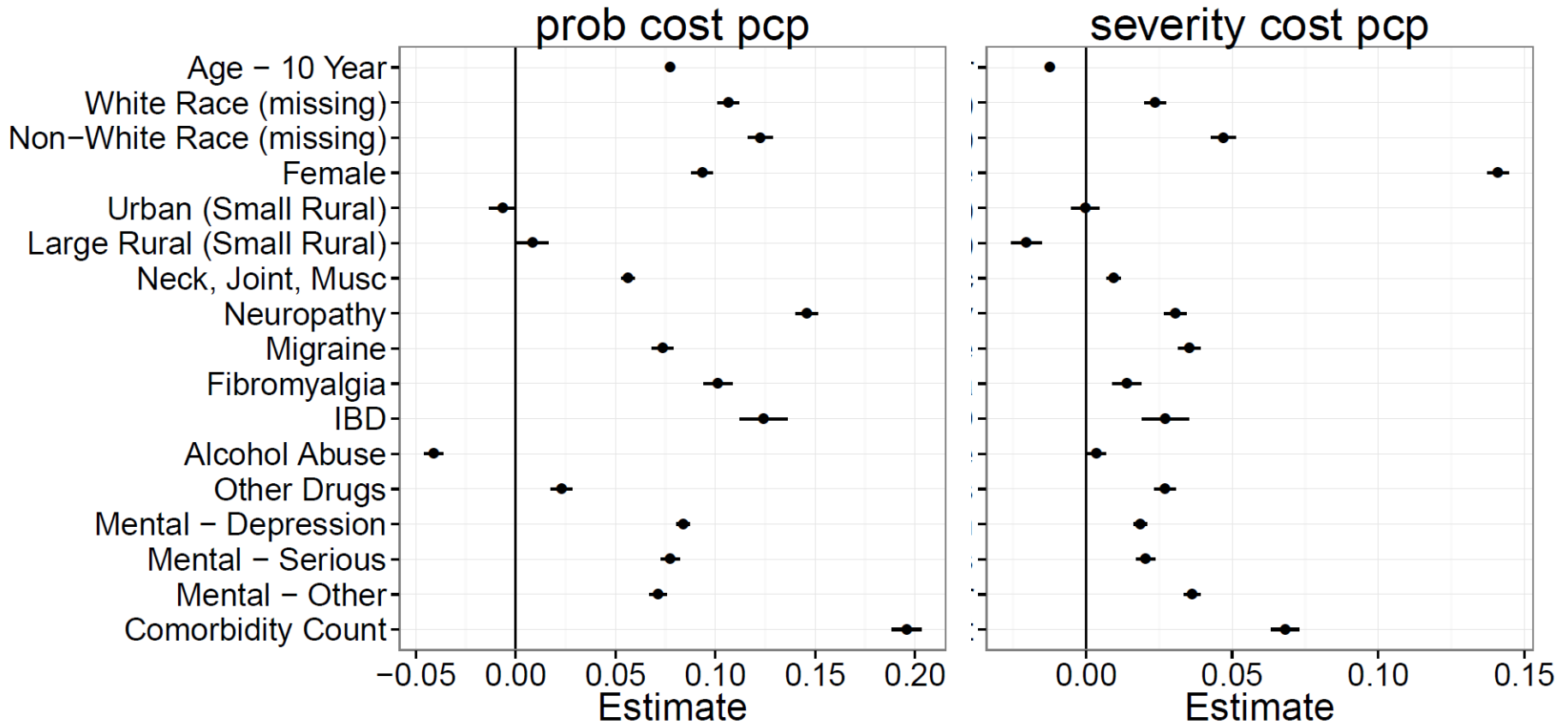
# Multivariate Results: Outpatient



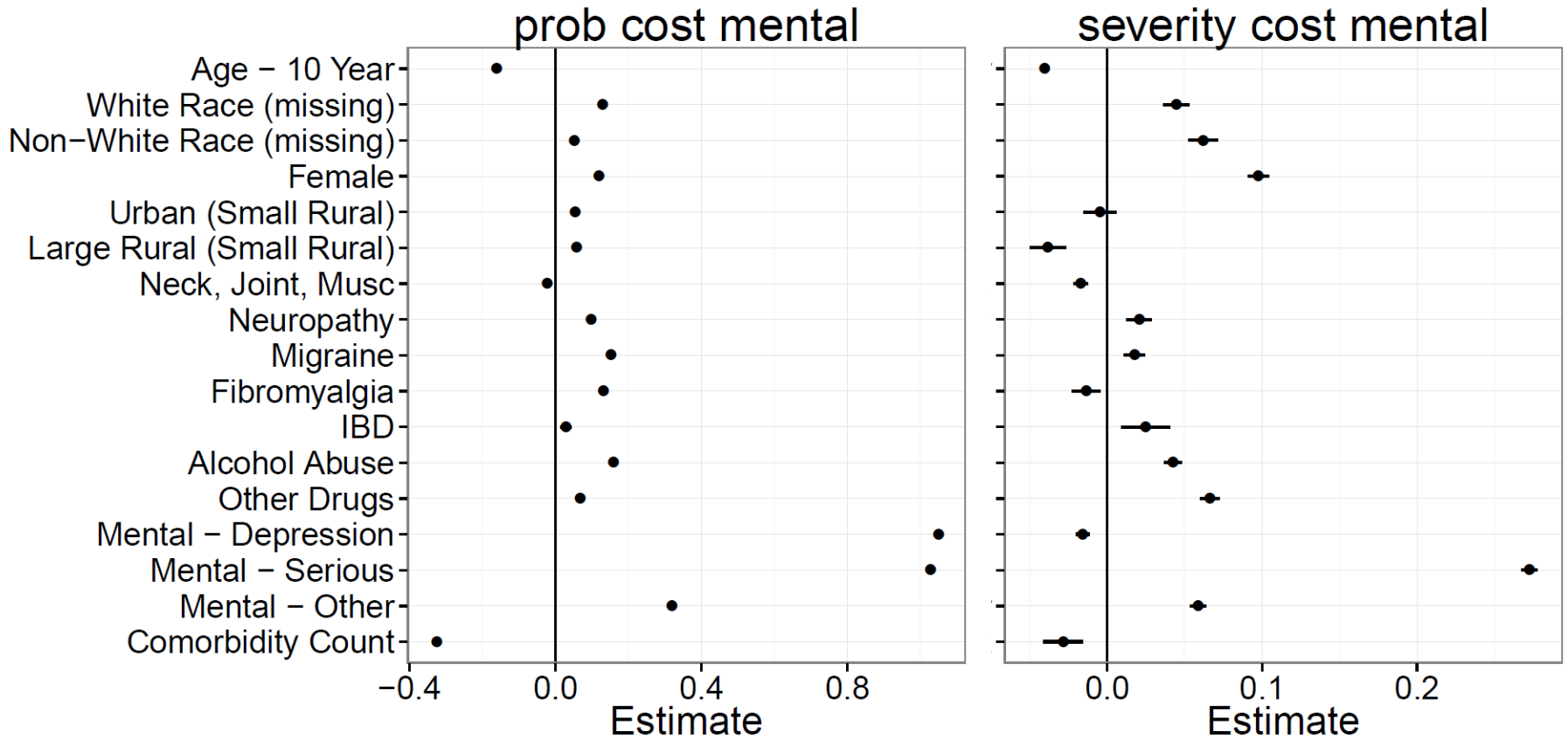
# Multivariate Results: ED



# Multivariate Results: Primary Care



# Multivariate Results: Mental Health







# Limitations



- No External Cost Data currently in these models
  - Define regular users?
  - Include Fee basis data, but not as specific buckets?
- No geographic Price Index adjustments
  - This should be isolated to the severity model by study design
- Confidence Intervals / combined covariate estimates on total cost?
- What other cost buckets of interest?
  - How much site heterogeneity is due to accounting?



# Acknowledgements



- Robert Kerns

- Michael Ho

- Denver statistical team:

- Gary Grunwald, Tom Glorioso, Colin O'Donnell, Wenhui Liu