

Before we begin...



# Do you still remember the story?



# Partner Project Presentation

Boston University  
Statistics Practicum  
December 13<sup>th</sup>, 2018



# What Factors Influenced Writing of Xiidra NRx Based on Historical Data?

- New patients insured by non-government plans typically received Xiidra prescriptions at higher proportions compared to new patients on government plans
  - Relationship holds up even when examined across different insurers, dates, or sales call volumes
- For prescriptions to new patients (NRx), the proportions of Xiidra versus Restasis differ significantly across Books of Business (BOB) and for each BOB, these proportions vary over time
- Increased sales call volume is associated with higher proportions of Xiidra NRx when examined on a health care practitioner (HCP) or decile level
- The higher an HCP's patient government payer mix, the lower the proportion Xiidra NRx for that HCP
  - Physicians with very high government payer mix still received significant sales call volume



# Agenda

## Market and Payer Effects

- Dry Eye Disease (DED)
- New Patient Prescriptions (NRx)
- Government and Non-Gov. Plans
- Book of Business (BOB)

## Sales Call Effects

- HCP Level Response
- Response by Payer Mix
- State and Decile Analysis
- Momentum Effect

## Model Summary

- Model Predictors
- Key Takeaways
- Model Performance
- Limitations and Opportunities



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# Market and Payer Effects

- Dry Eye Disease (DED)
- New Patient Prescriptions (NRx)
- Government and Non-Government Plans
- Book of Business (BOB)

# Dry Eye Disease (DED) is an Inflammatory Ocular Surface Condition

- Common eye disease affecting 30M people in US and 344M globally
  - Only 1M are on prescriptions for DED in the US
- Symptoms include eye dryness, discomfort, stinging, burning, and blurred vision
- Incidence growing worldwide due to aging population, increased digital screen use, and improved awareness and diagnosis
- Treatments:



Xiidra



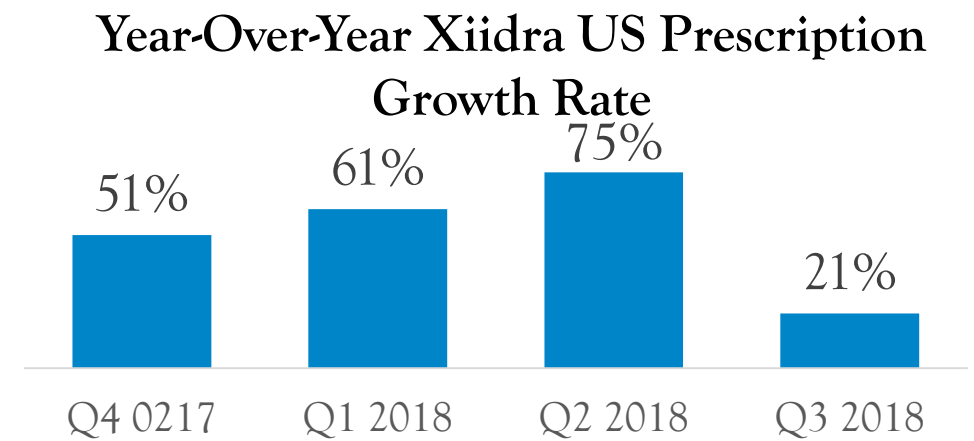
Restasis



Artificial  
Tears (OTC)

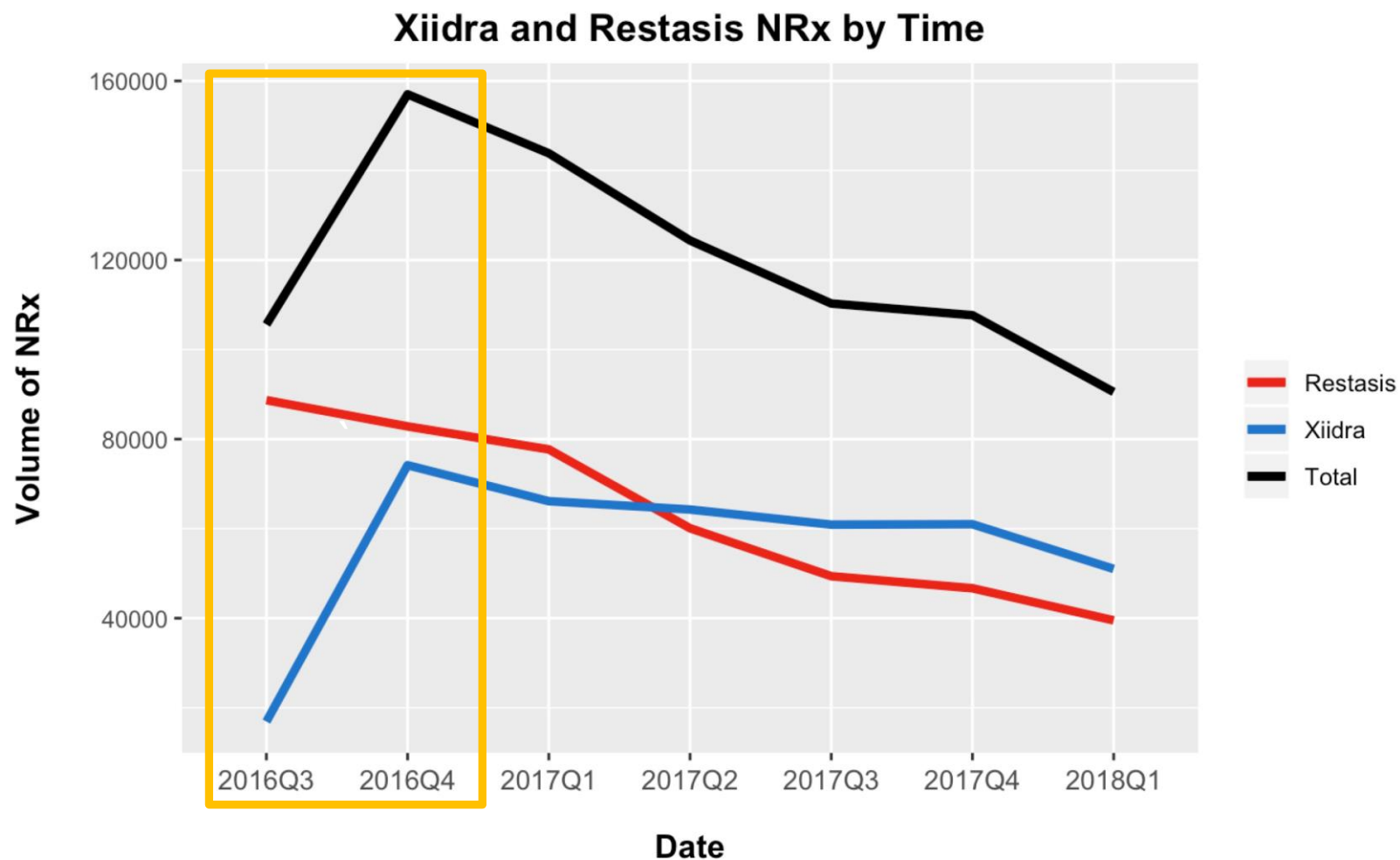
# Xiidra is Shire's FDA-approved Aqueous Solution For DED

- Main competitor is long-time incumbent, Allergan's Restasis
- Xiidra gaining market share with ~25% vs. 75% for Restasis by prescriptions (as of 10/18) <sup>(1)</sup>
- 200,000+ prescriptions written in the four months available in 2016



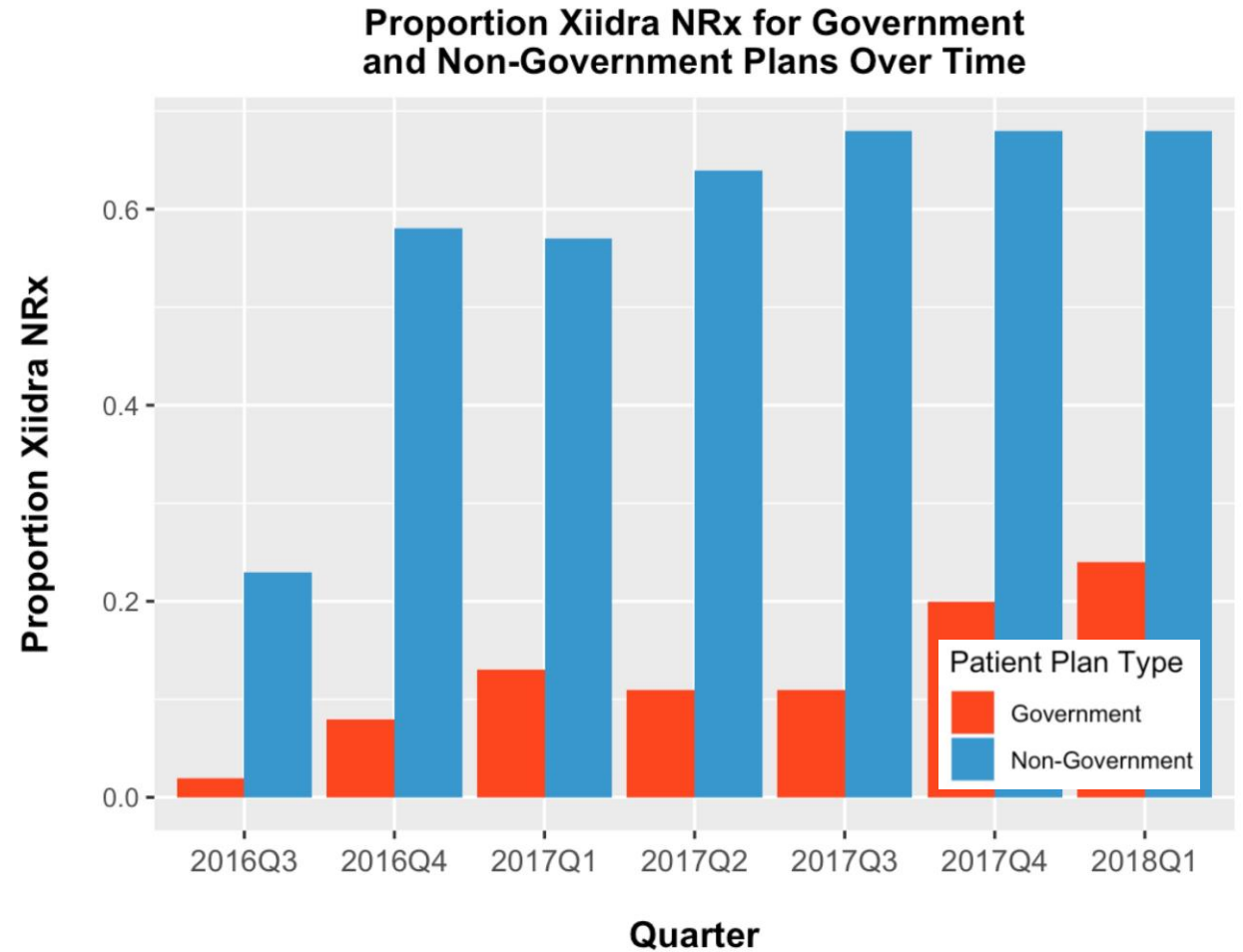


# Xiidra Launch was a Massive Success that Increased Size of DED Market



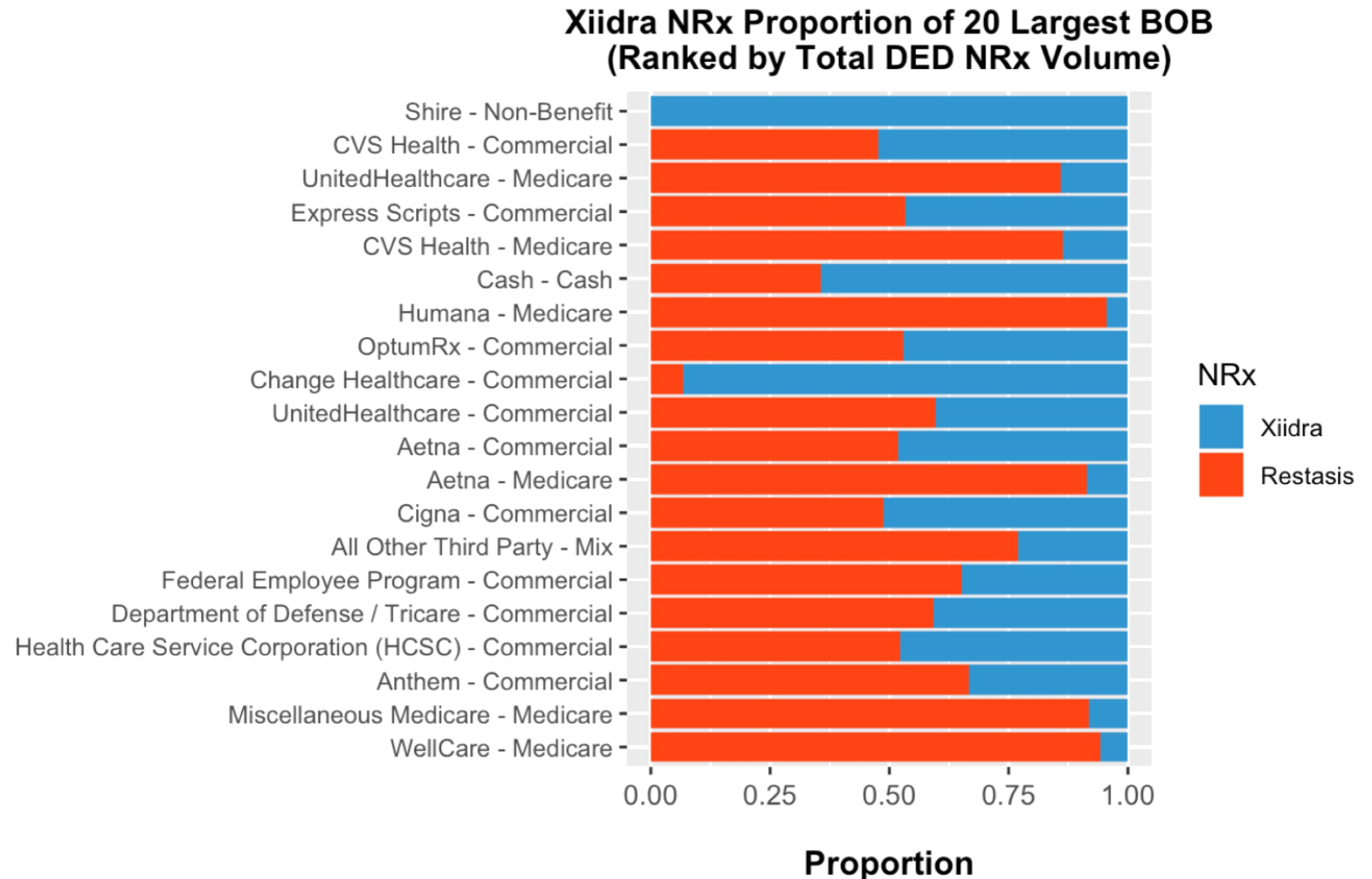
# Non-Government Plan Xiidra NRx Proportions Are Greater But Both Types Are Growing

- Proportions of Xiidra NRx for patients on non-government plans are significantly greater than those on government plans
- Disparity due in part to differences in Plan D coverage of Restasis versus Xiidra

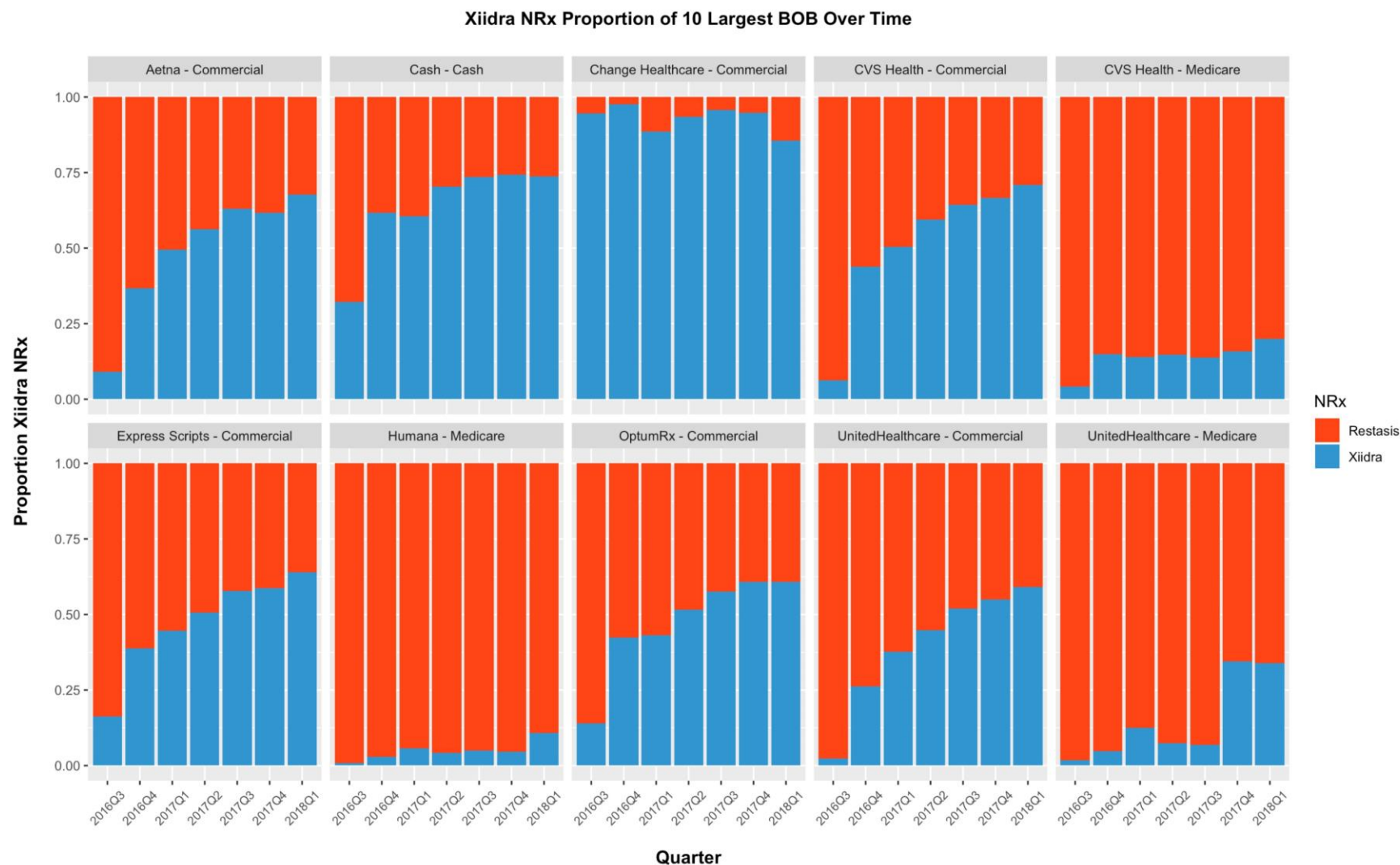


# BOBs have Significant Variation in Proportions of Xiidra NRx

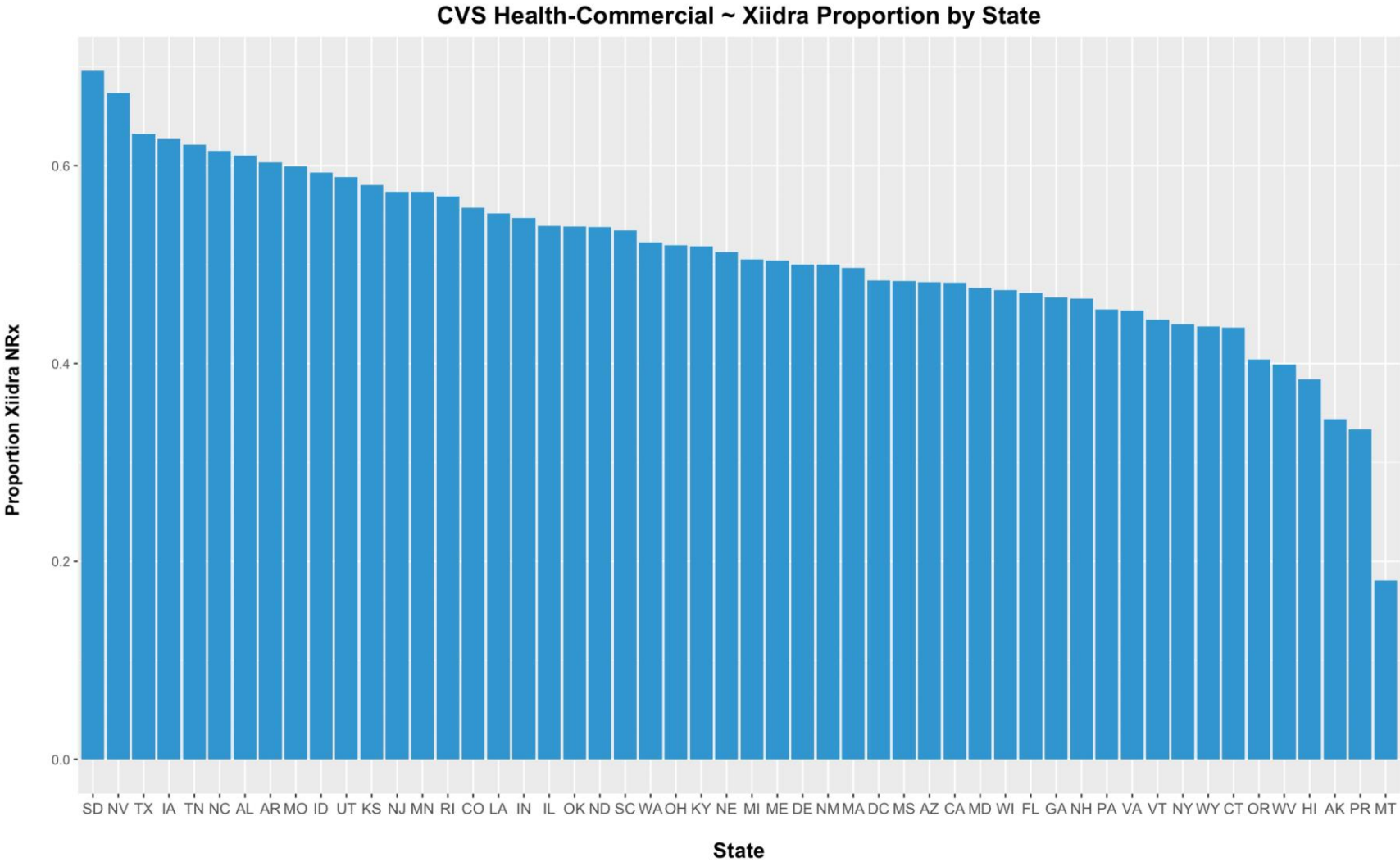
- Regardless of BOB, government plans (such as those with “Medicare” in name) all have very high Restasis proportions
- Shire Non-Benefit, the company’s eponymous program, has the highest total volume NRx and is all Xiidra



# Xiidra NRx Growth Varies Across BOBs But are Generally Positive

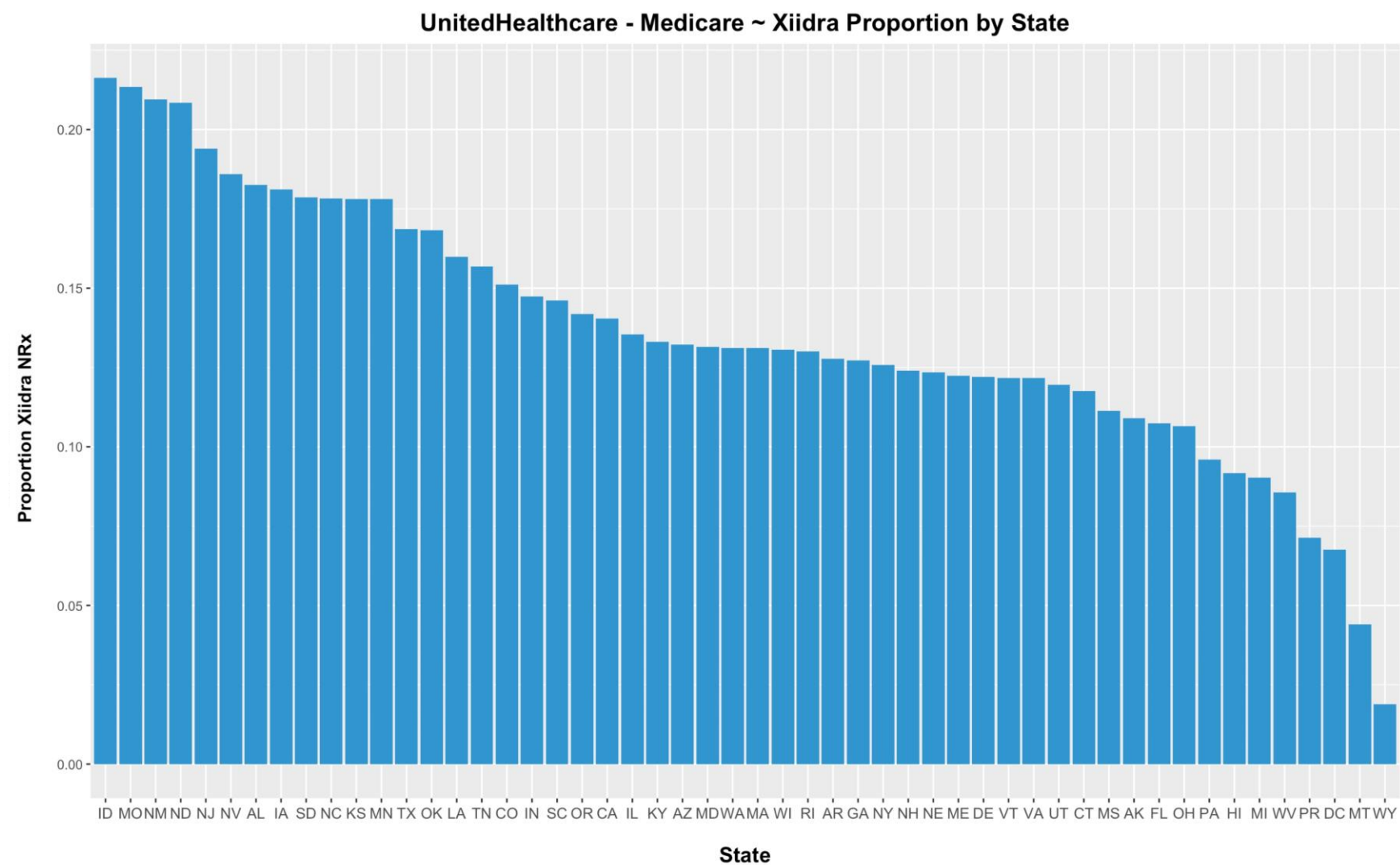


# Xiidra NRx Proportions Varies Across States: eg. CVS Health (Non-Government)





# Xiidra NRx Proportions Varies Across States: eg. UnitedHealthcare (Government)



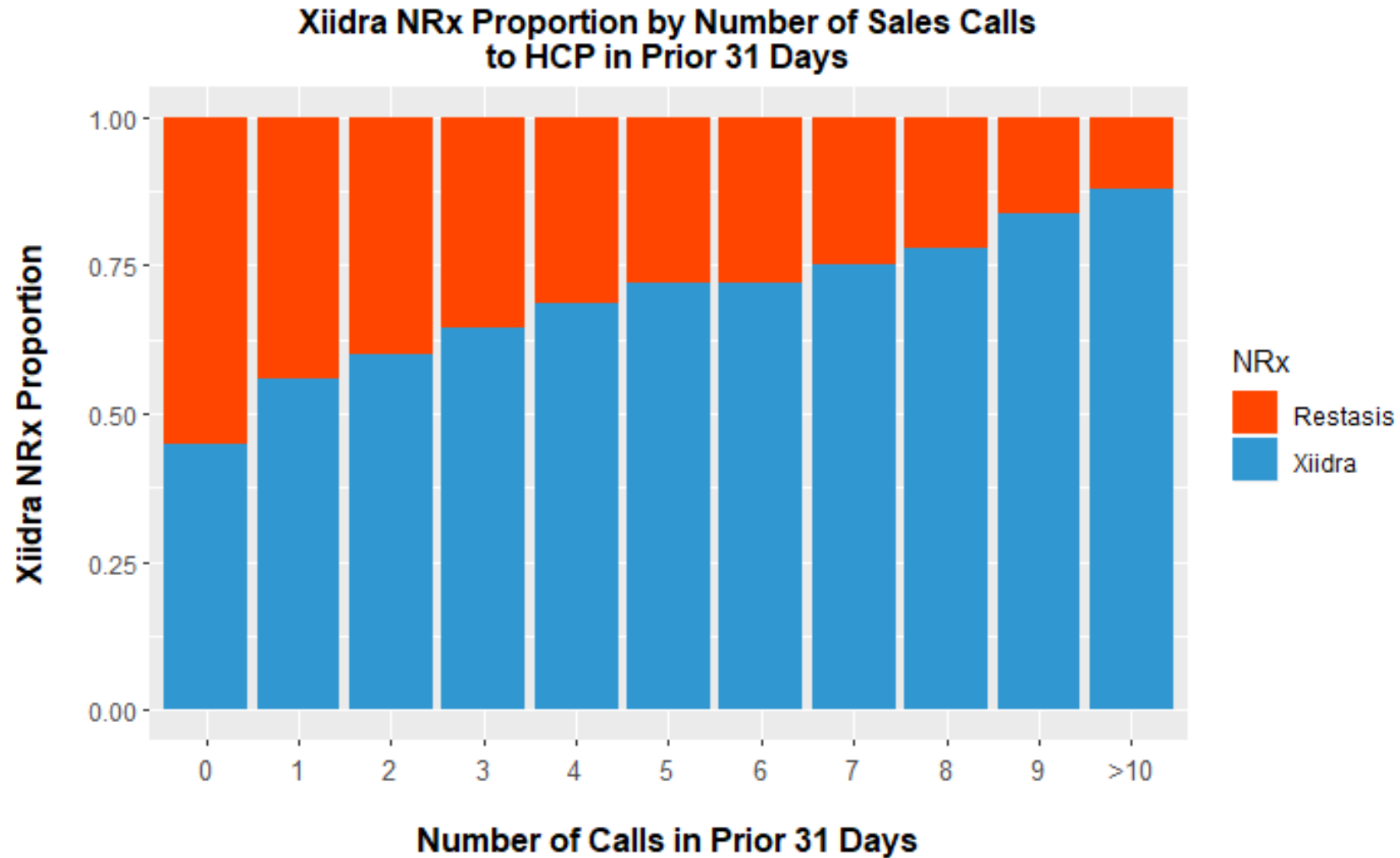
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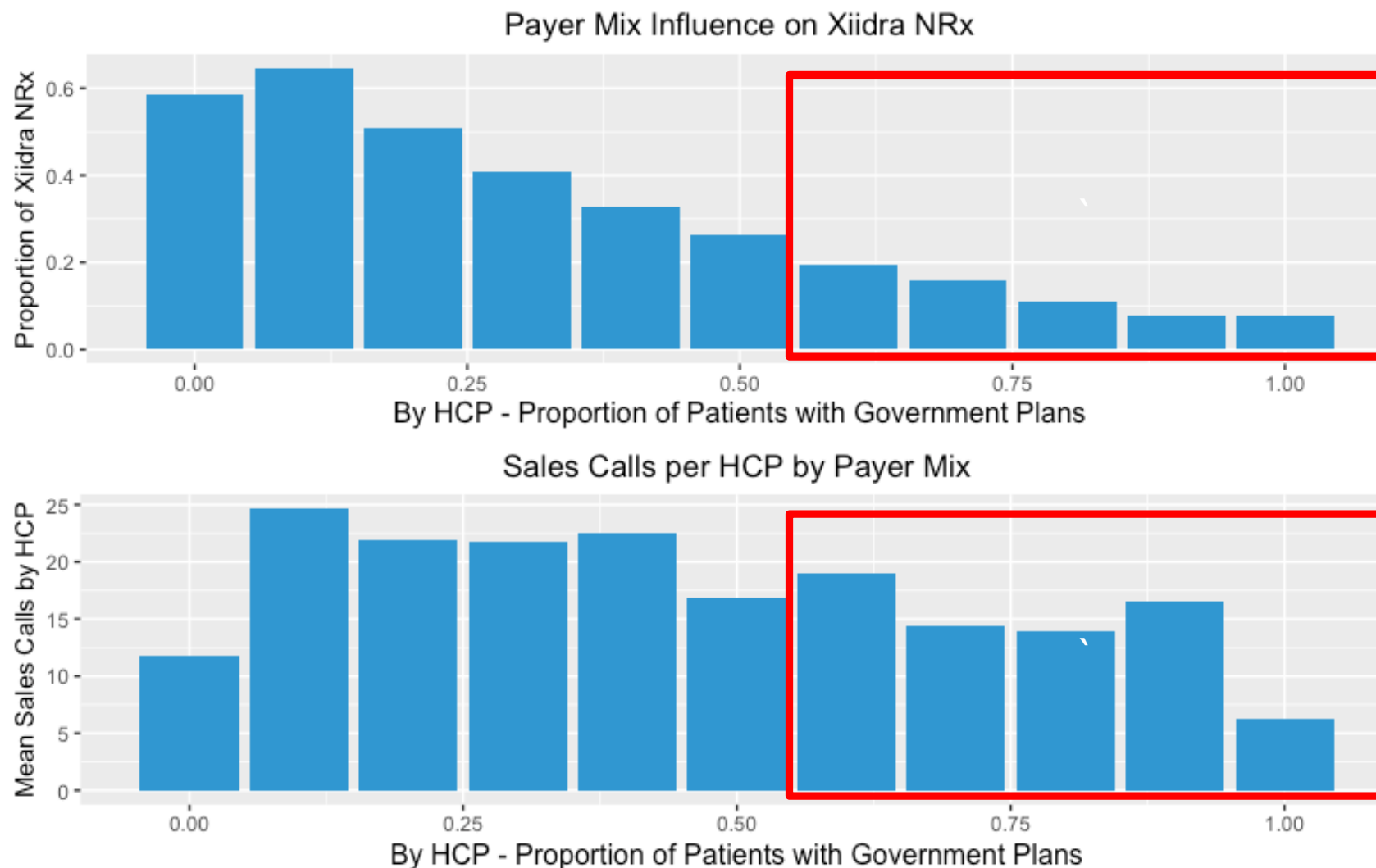
# Sales Call Effects

- HCP Level Response
- Response by Payer Mix
- State and Decile Analysis
- Momentum Effect

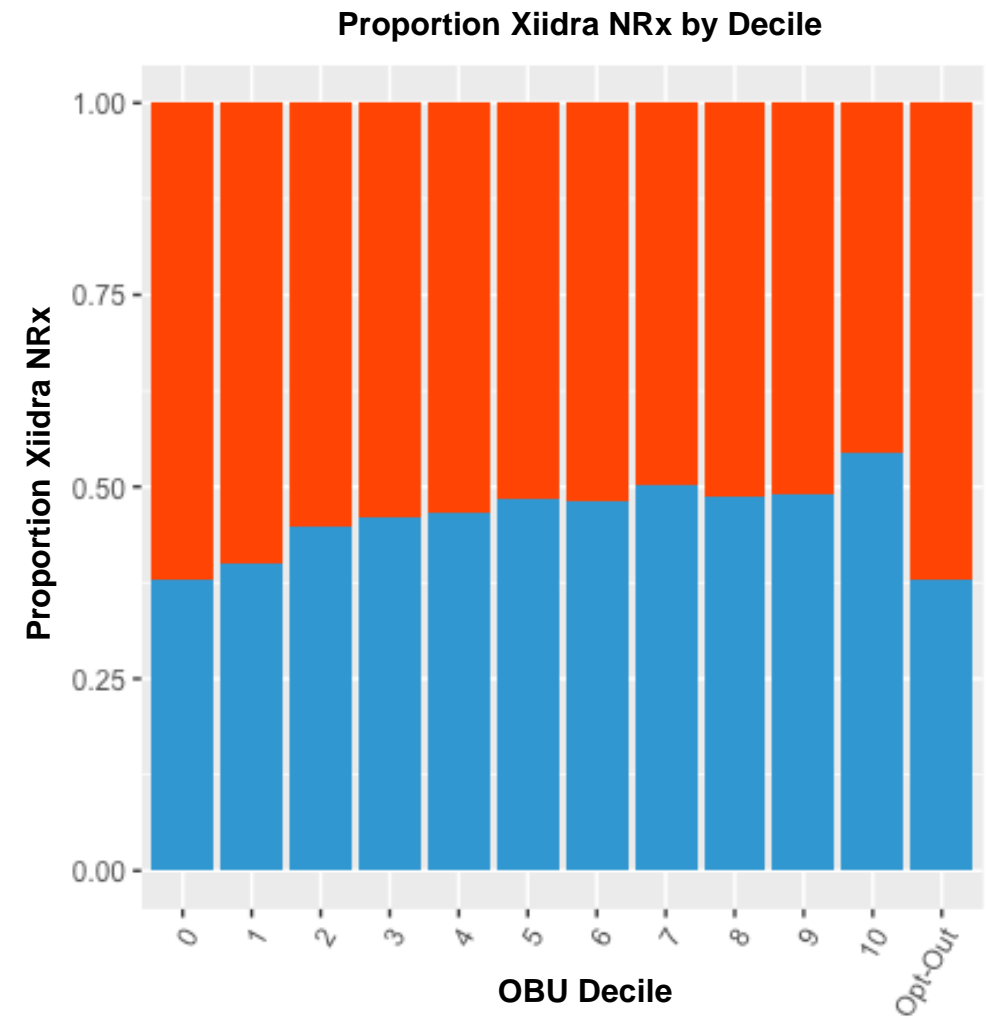
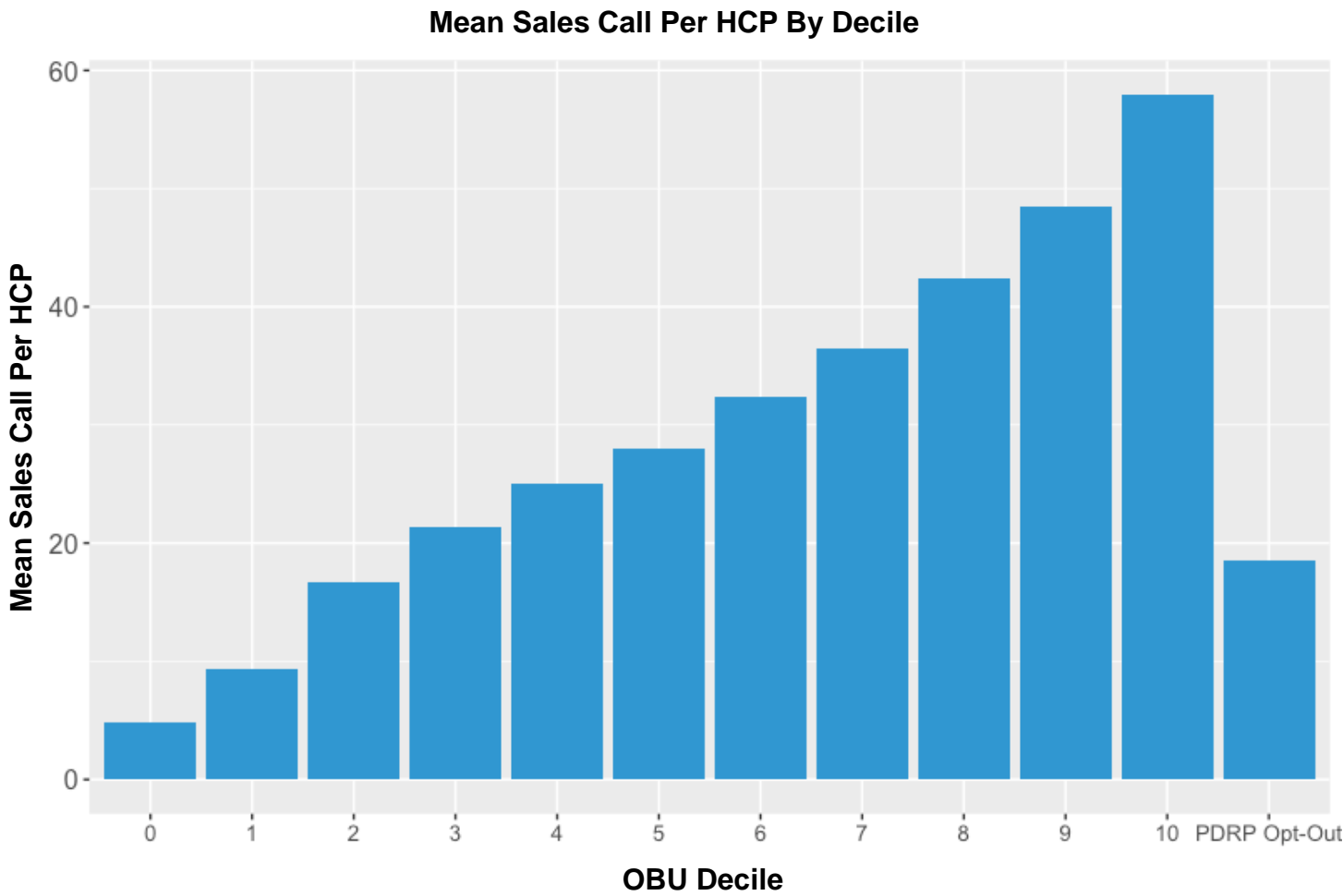
# Higher Call Volumes to HCPs Associated with Higher Xiidra NRx Proportions



# Calls to HCPs with Large Government Payer Mix May Be Less Effective

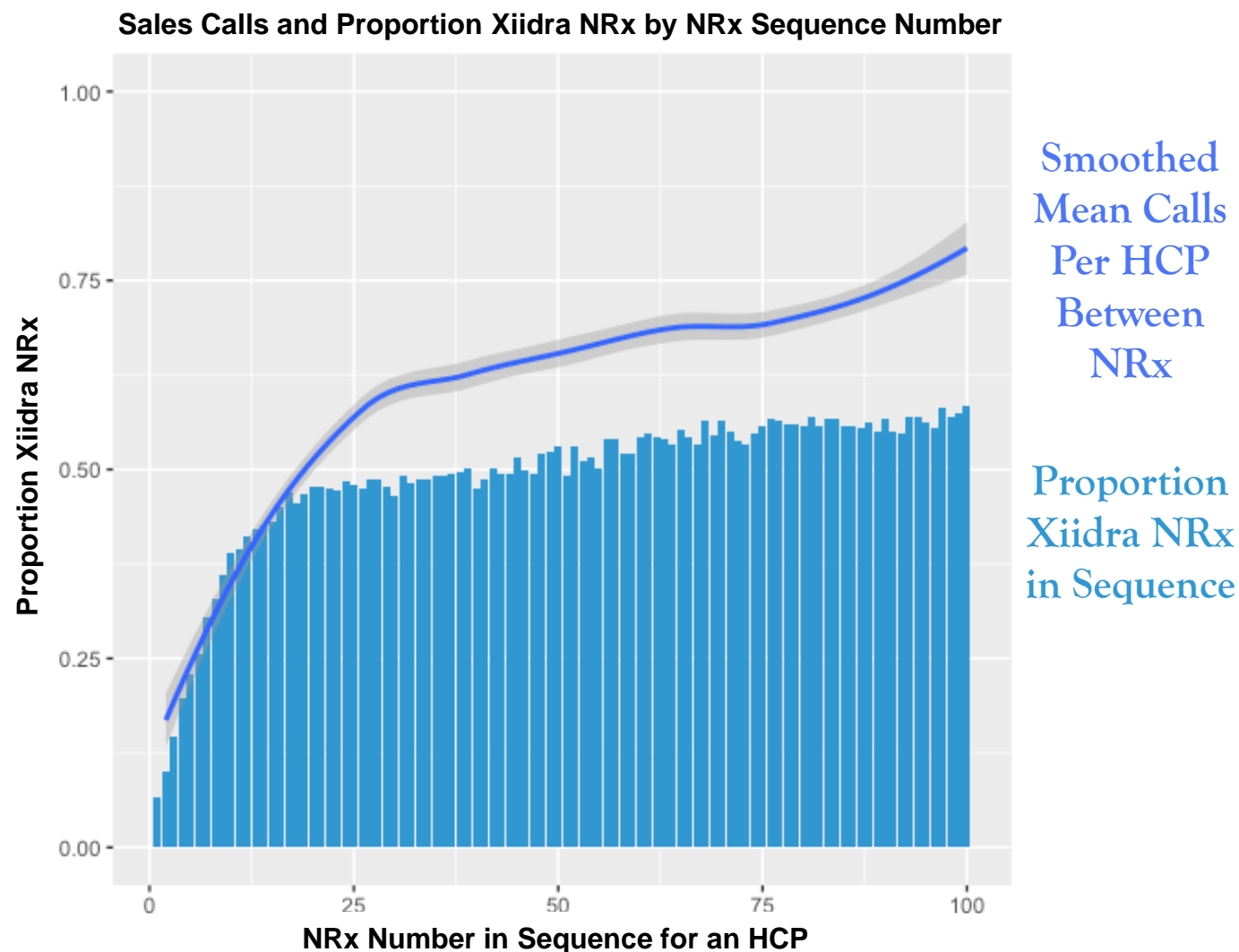


# Higher OBU Deciles Receive More Calls and Prescribe Higher Proportion Xiidra NRx





# Writing of Xiidra Prescriptions Builds Momentum Before Plateauing



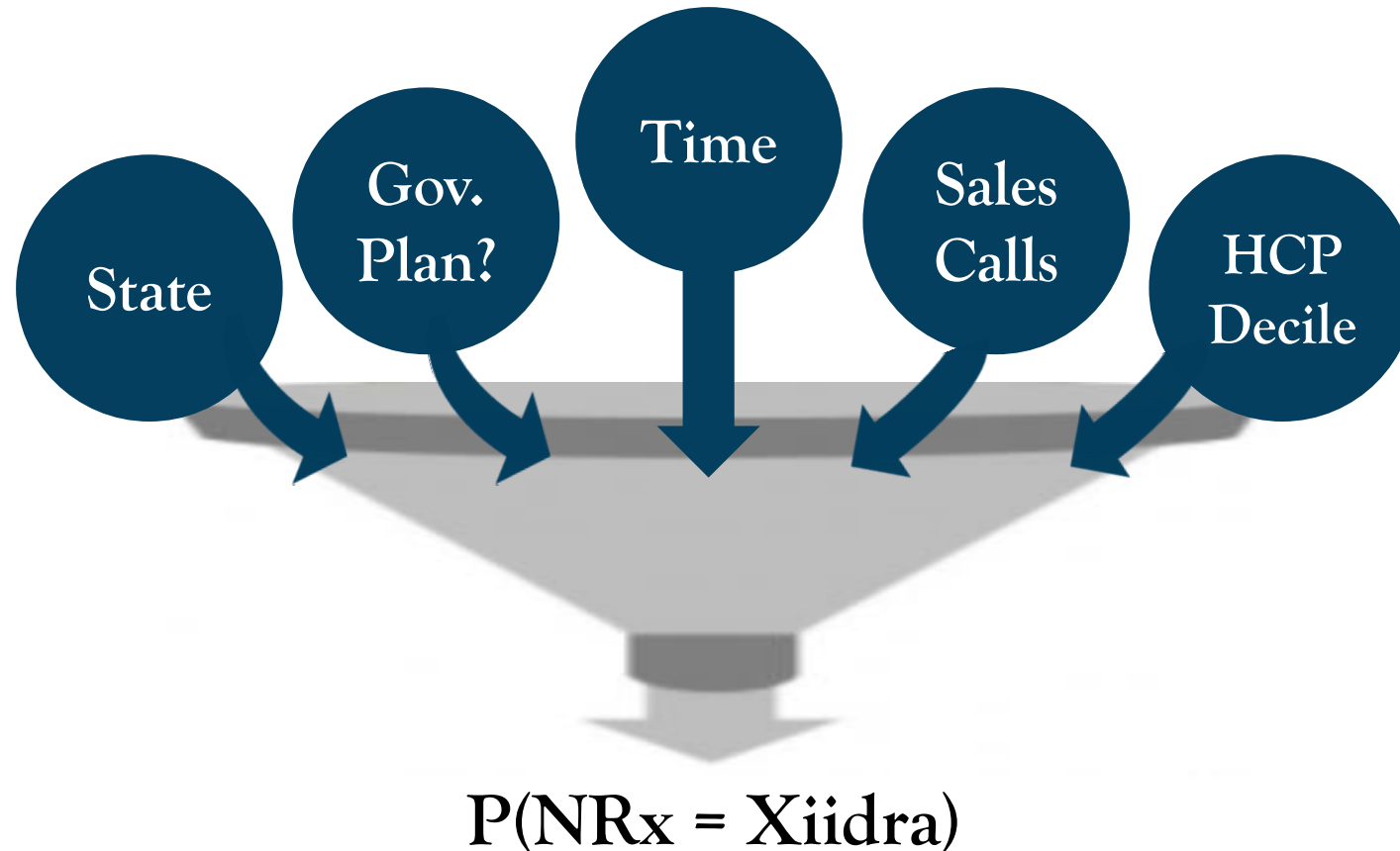
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# Model Summary

- Model Predictors
- Key Takeaways
- Model Performance
- Limitations and Future Opportunities

# Regression Model Uses Five Predictors To Estimate Probability of Xiidra NR<sub>x</sub>



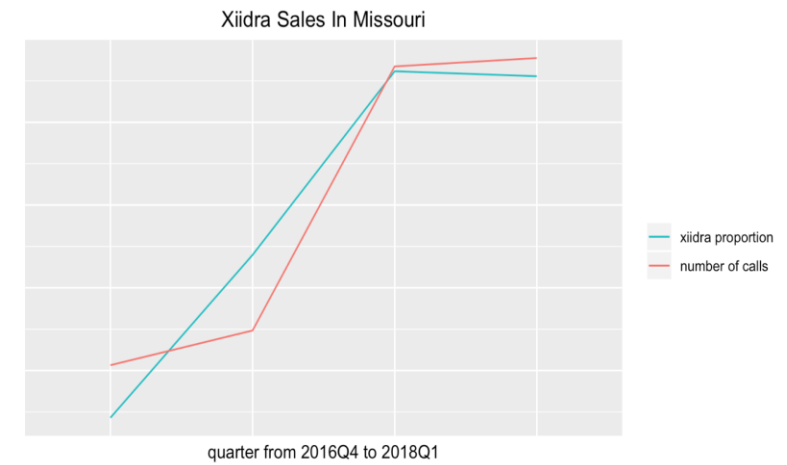
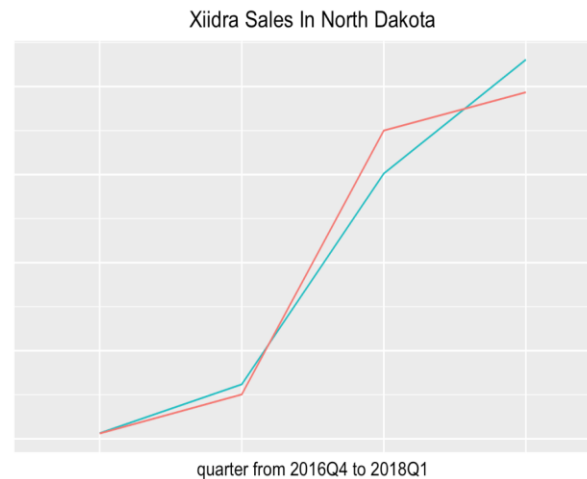
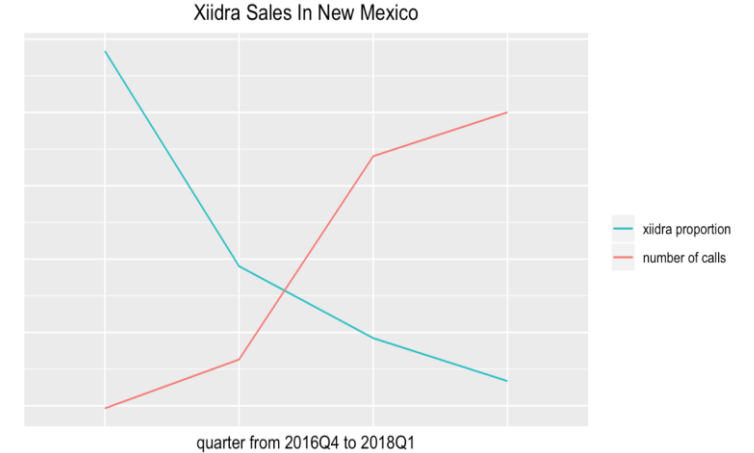
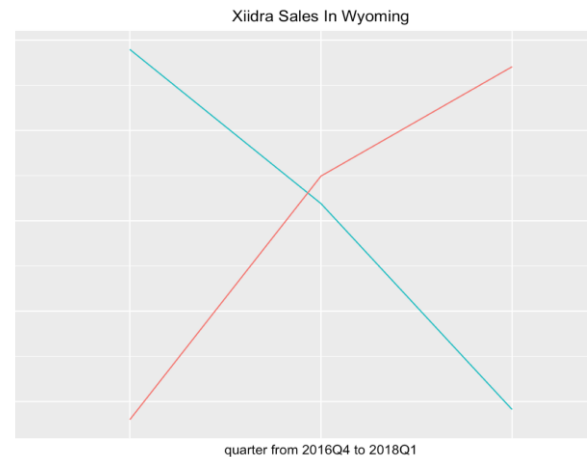
*Probability a New Patient Prescription is Xiidra*

# Model Computes Probabilities given Combination of Attributes

- Input values for five indicators and probabilities modeled based on comparison of means in historical data
- We can infer that every unit increase in Non-Government BOB will lead to the increase of probabilities for Xiidra NRx in all states.
  - But, every unit increase in call weight has different influences in different states
- This can not be extended to future dates because model is not calibrated with baseline values in that time period

# An Examples on State and Sales Call Effects From Model

- Two states that has negative association between number of calls and Xiidra proportion from the EDA plot
- Coefficients**
  - Interaction term WY and Call\_weight: - 0.35
  - Interaction term NM and Call\_weight: - 0.86
- Two states that has negative association between number of calls and Xiidra proportion from the EDA plot.
- Coefficients:**
  - Interaction term ND and Call weight: 0.10
  - Interaction term MO and Call\_weight: 0.60





# Significantly More Accurate Classification than Null Model

- Classification accuracy rate: 0.72
- Error rate: 0.28
- Null model accuracy rate: 0.53
- Rate of Improvement: 0.19

		Actual		
		Restasis	Xiidra	
Predicted	Restasis	272,970	67,535 <i>(17% True Negative)</i>	340,505
	Xiidra	171,958 <i>(39% False Positive)</i>	326,861	498,819
		444,928	394,396	

# Limitations of Analysis and Opportunities for Future Projects

## Limitations

- Model is not appropriate for future prediction in current form
- Responses to sales calls vary by HCP
- Observations of NRx are not independent
- Causal inference can't be achieved through regression
- Exploring high dimensional data using dataset with only a few attributes

## Opportunities

- Multilevel models to account for structure of clustering within HCP, state, and payer
- Randomized control experiments (A/B testing) to glean effects of varying sales call volume on different HCP groups
- Causal inference through large-scale observational studies of prescription data and electronic health records using propensity score matching

Q & A



 Shire