

# Predicting Economic Sentiment: When Are Citizens Satisfied with the State of the Economy?

## A Disciplined Approach to a Multidimensional Problem

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# Main areas of inquiry

- What drives beliefs about the economy? Many (too many?) possibilities?
  - Total production
  - How easy/hard it is to find a job?
  - How many jobs are created?
  - Wage growth? Other?
- Are consumers everywhere paying attention to the same attributes of the economy?
- Claim: approaches from machine learning can reliably identify the attributes of the economy that drive subjective economic sentiment.

# Data & Baseline specification

- Starting point: Predicting evaluations with linear models
- 5-fold OLS with 2 intuitive predictors: GDP growth & the unemployment rate.

$$Perceptions_{i,t} = \alpha + \beta_1 GDP_{i,t} + \beta_2 Unemp_{i,t} + \epsilon_{i,t}$$

# 5-fold cross validation

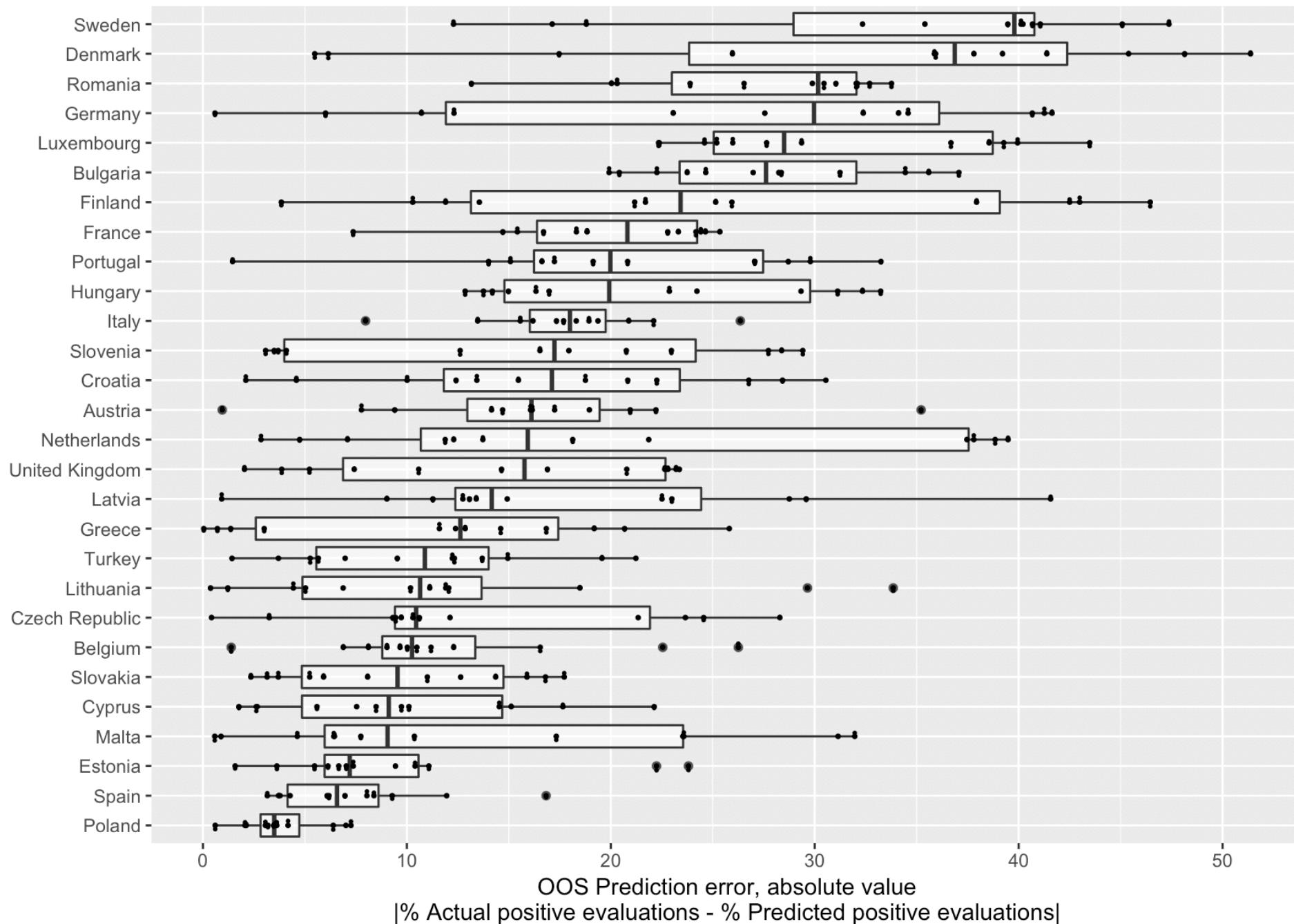
- Split the data into 5 subsets.
- Estimate the regression on 80% of the data.
- Calculate residuals on the 20% of the data the model “has not seen”.
- Repeat 5 times (and report average residuals or their distribution)
- Standard practice in ML, usually not viewed as necessary for simple linear specifications.

1 2 3

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Prediction errors from 5 OLS regressions trained on 80% of the data  
Errors from holdout observations (5x20%) displayed



# Under what conditions will people evaluate the state of the economy positively?

- Goal: Uncover which economic outcomes citizens value.
- Adding variable to OLS regressions is unprincipled.
- Is GDP a sufficient statistic? What else are voters paying attention to?
- Cross-nationally, realized economic conditions contain some signal about perceptions.

# A more general problem

- Increasingly encounter situations when 100s or 1000s of variables about an economic/political actor are available.
- Recent example:

# A more general problem

- Increasingly encounter situations when 100s or 1000s of variables about an economic/political actor are available.

By **Gregory Eady, Jan Zilinsky, Jonathan Nagler and Joshua Tucker**

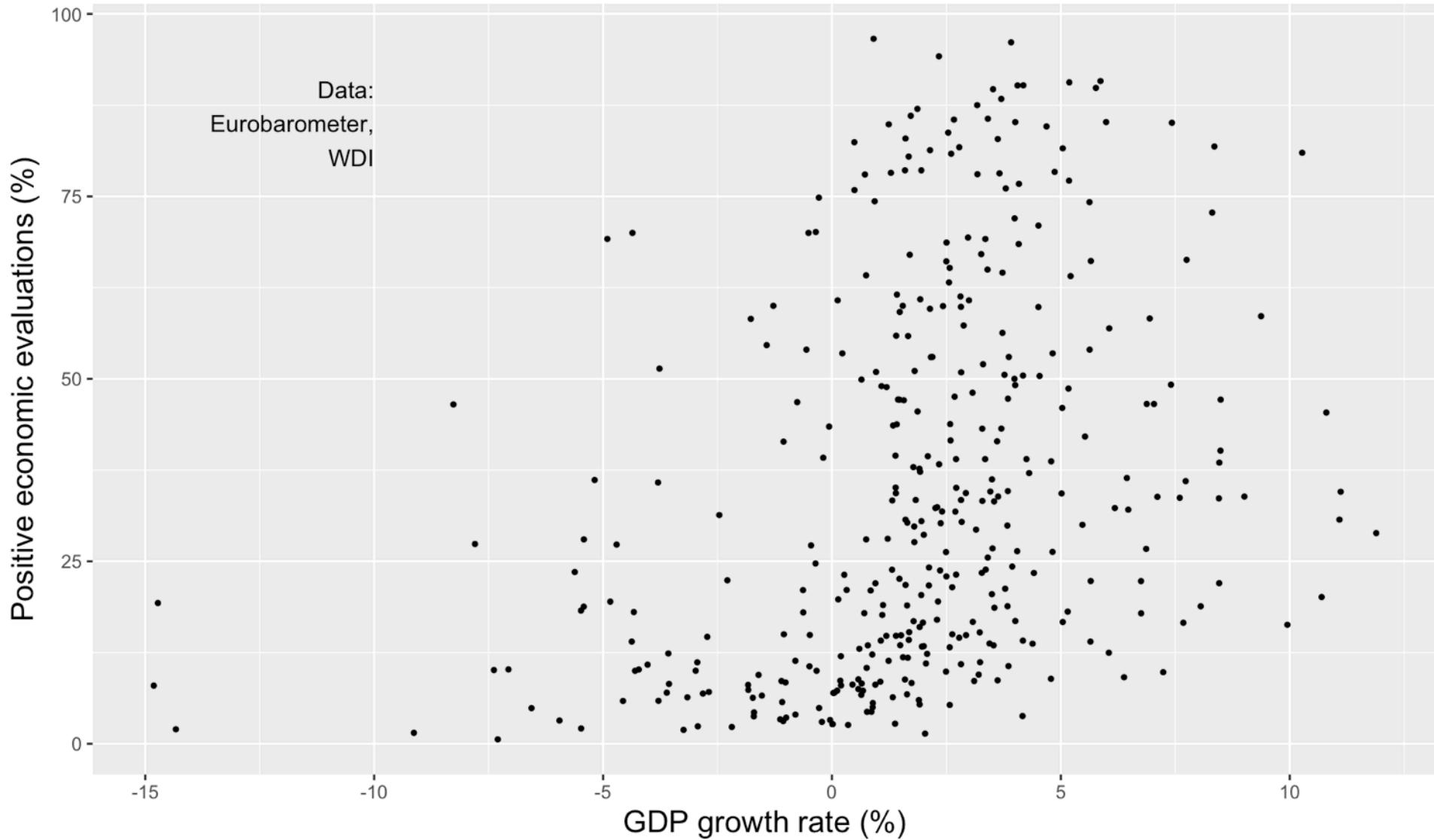
October 5

**Monkey Cage** • Analysis

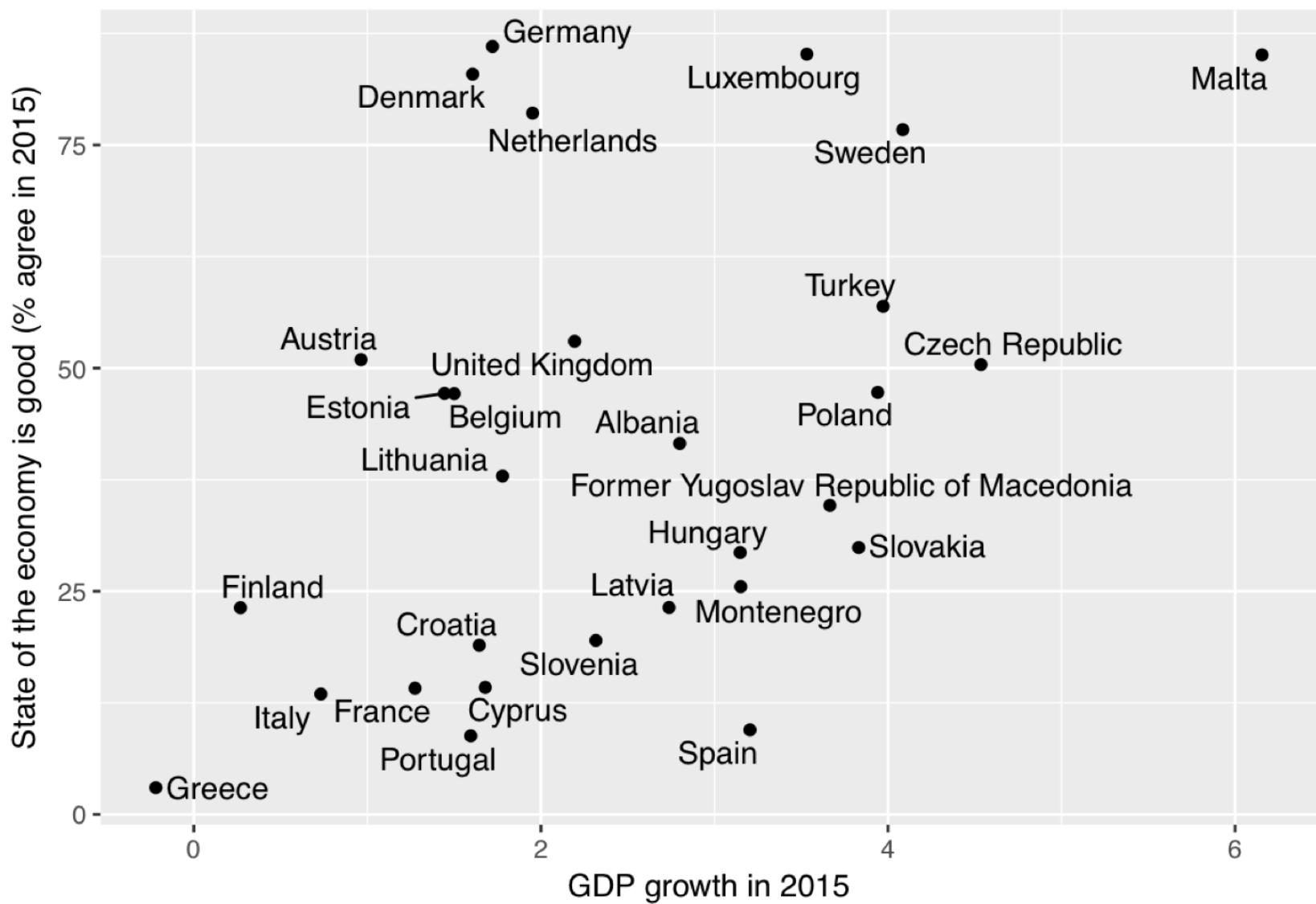


## Trying to understand how Jeff Flake is leaning? We analyzed his Twitter feed

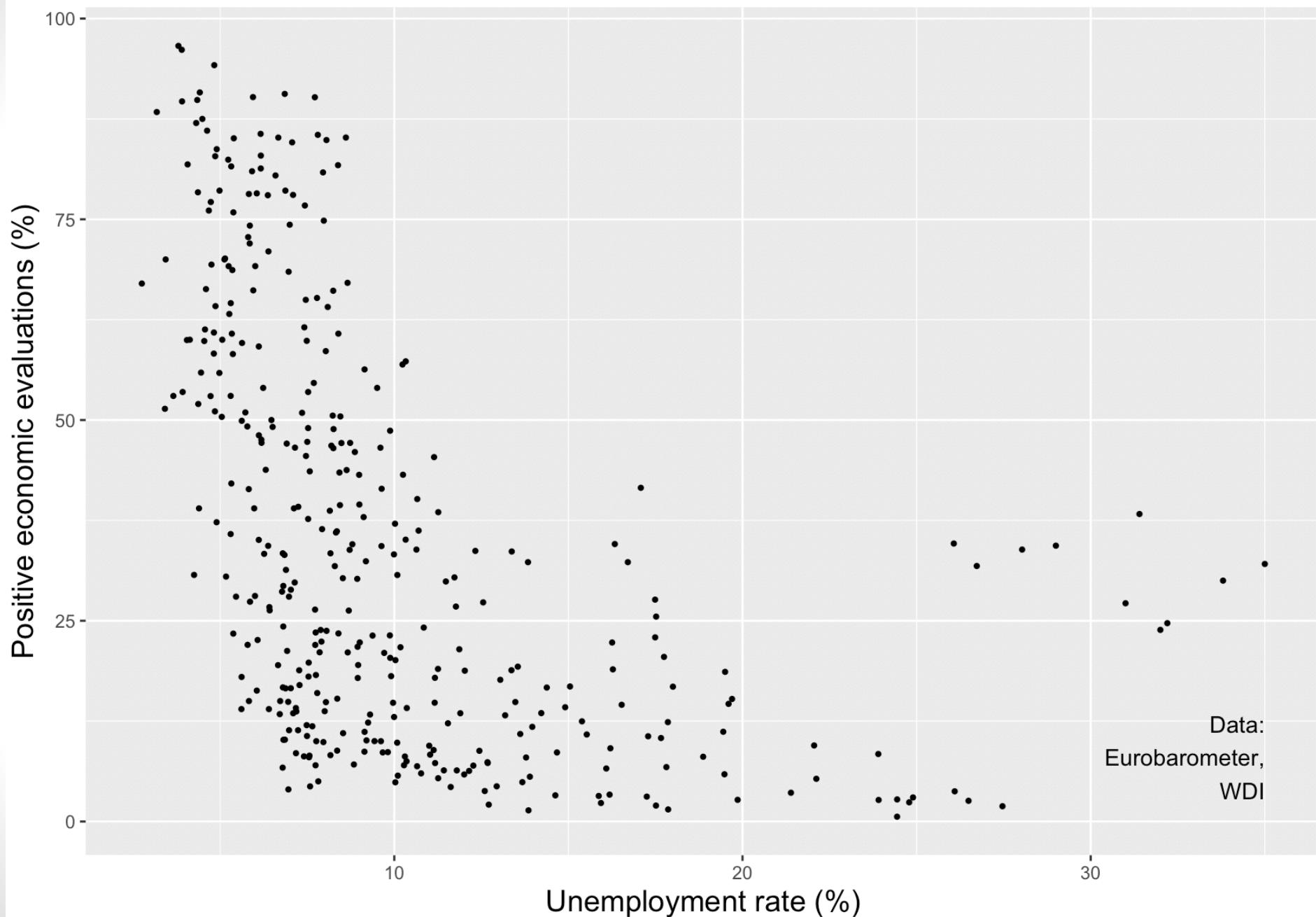
Economic evaluations and GDP growth  
34 countries, 2005-2016



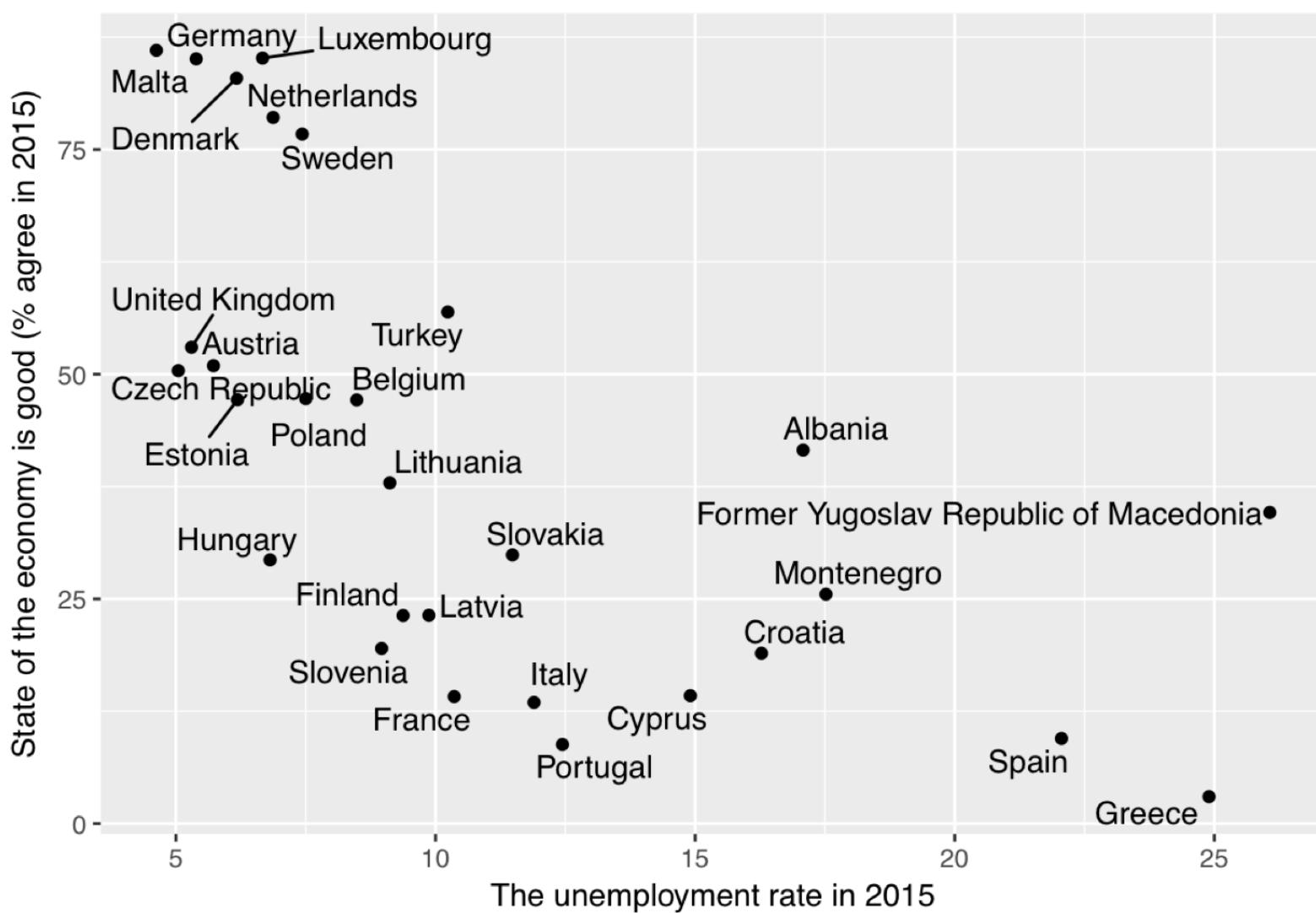
# When growth is high perceptions are positive



# Economic evaluations and the unemployment rate 34 countries, 2005-2016



# More unemployment, worse evaluations



# Next

1. Allow for inclusion of various socio-economic covariates
  - Goals: learn “what matters to people”, improve predictions
2. Use regression trees and random forests
3. Use LASSO (regularized regressions)
  - Purpose: Penalty for inclusion of each additional covariate
  - On the lookout for overfitting

# Correlates of positive evaluations

	Full sample	2005-2007	2008-2011	2012-2015
GDP growth	33%	7%	31%	36%
Real wage growth	26%	-6%	22%	29%
Unemployment	-63%	-57%	-61%	-67%
Inflation	23%	-15%	27%	23%
LFP	47%	58%	37%	56%
LFP (men)	36%	50%	25%	46%
Regional: CEE	-26%	-34%	-31%	-23%
Regional: PIGS	-47%	-43%	-40%	-53%
Manufacturing	-5%	5%	-7%	-4%
Trade	30%	32%	29%	29%

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Trade	30%	32%	29%	29%

- Common approach: add “plausible” covariates into a long regression
- Alternative approach: disciplined variable selection (ML)

# Covariate space

- GDP growth (annual %)
- GDP per capita, PPP (current international \$)
- Inflation
- Unemployment rate
- Personal remittances, received (% of GDP)
- Government expenditures (% of GDP)
- General government final consumption expenditure (% of GDP)
- Exports of goods and services (% of GDP)
- Gross fixed capital formation (annual % growth)
- Trade (% of GDP)
- Agriculture, forestry, and fishing, value added (% of GDP)
- Manufacturing, value added (% of GDP)
- Industry (including construction), value added (% of GDP)
- Industry (including construction), value added (annual % growth)
- **And 80+ other variables**

# Machine learning

Why use ML?

- Researcher will specify the set of **potential** covariates
- Letting the data speak (without ex-post data-mining)
- Cross-validation (prune the model if over-fitting)
- Athey (2016)
  - Model selection in social science is unprincipled
  - Questions in social science “entail a combination of prediction and causal inference”; econometrics and social science statistics “fail with many covariates”
- Kleinberg et al. (2015): “Machine learning techniques are in one sense not new: they are a natural offshoot of non-parametric statistics. But they provide a disciplined way to predict  $\hat{y}$  which (i) uses the data itself to decide how to make the bias-variance trade-off and (ii) allows for search over a very rich set of variables and functional forms.”
- **Tree and classification models**: partition the sample by those attributes & cutoff points that maximize
- **Lasso**: pay a penalty each time you add a new regressor

# Regression tree

- Sequentially partition the covariate space
- Pick an optimal split of the data to minimize deviance (squared residuals)
- Check all variables but only pick the most diagnostic one at each step
- Typically keep going until a large tree is built, then prune

## How high is the unemployment rate?

6.7% or above

Less than 6.7%

### GDP growth

Less than 0.91%

### Labor force participation rate

<59

$\geq 59$

*Prediction:*  
**14%** believe  
the state of the  
economy is good  
(N=75)

*Prediction:*  
**26%** believe  
the state of the  
economy is good  
(N=97)

*Prediction:*  
**44%** believe  
the state of the  
economy is good  
(N=49)

*Prediction:*  
**61%** believe  
the state of the  
economy is good  
(N=79)

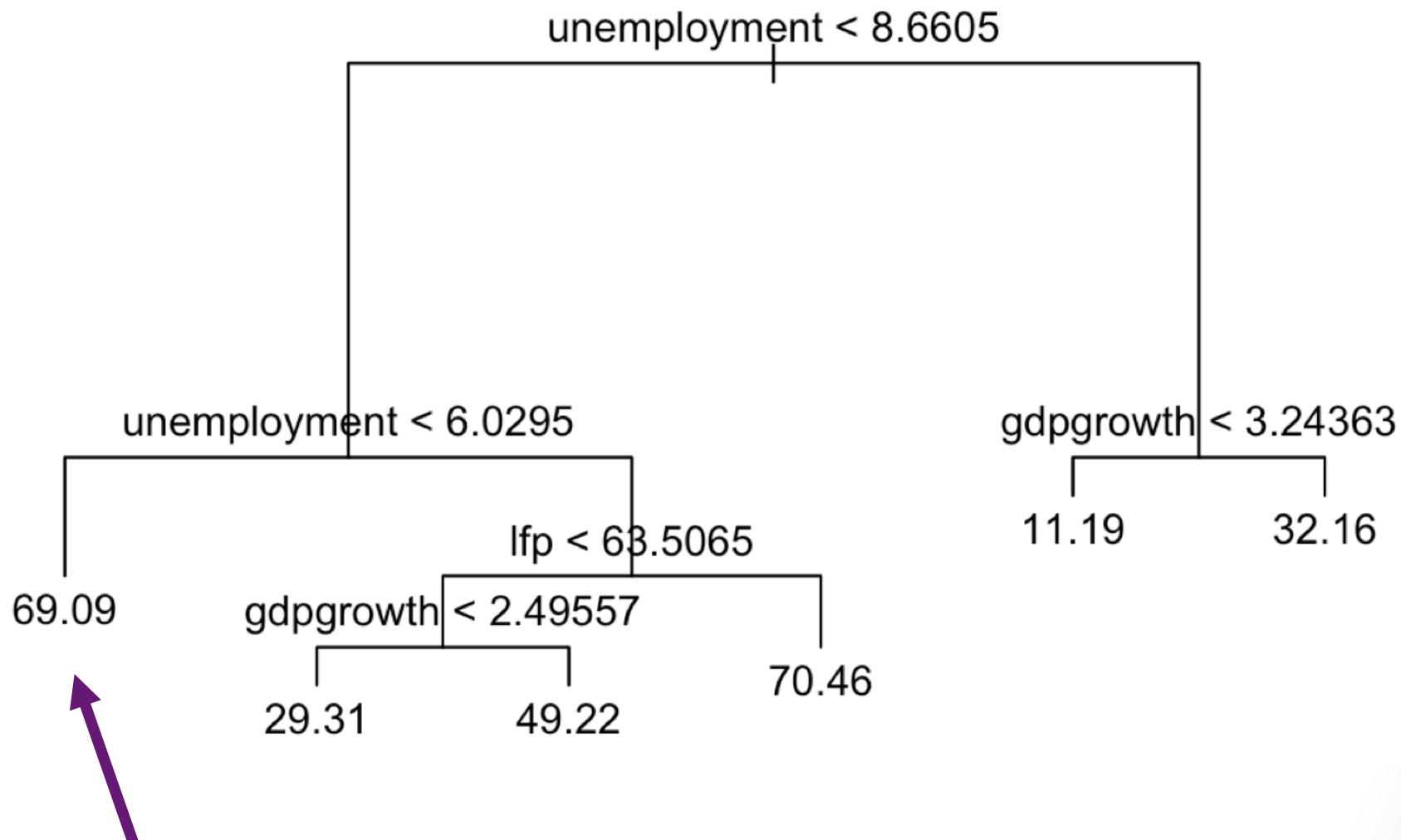
# Regression tree: properties

- Athey and Imbens (2016): “The regression tree uses the data to determine the appropriate “buckets” for discretization, thus potentially capturing the underlying nonlinearities with a more parsimonious form.”
- Note: a deep tree is not appropriate for OOS prediction
- Solutions: manual constraints; random forests (model averaging).

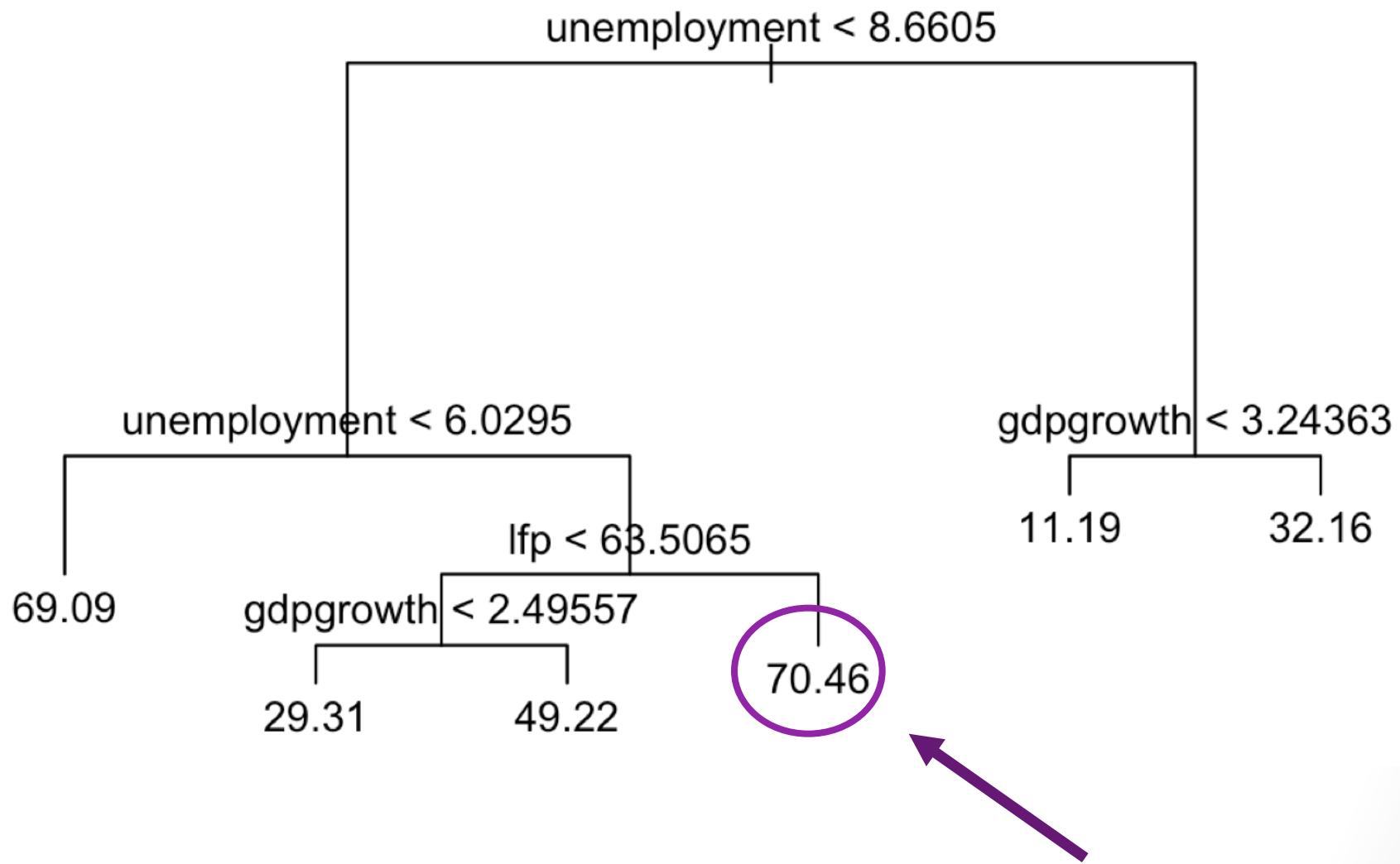
# Regression trees reveal the best predictors

- People' responses indicate they attend to three attributes of the economy: **GDP growth, unemployment rate, LFP.**
- Beyond the unemployment rate, other labor market statistics contain useful signals.
- There are circumstances when knowing the **GDP growth rate is not informative** (*it is unnecessary for accurate predictions of economic sentiment*).

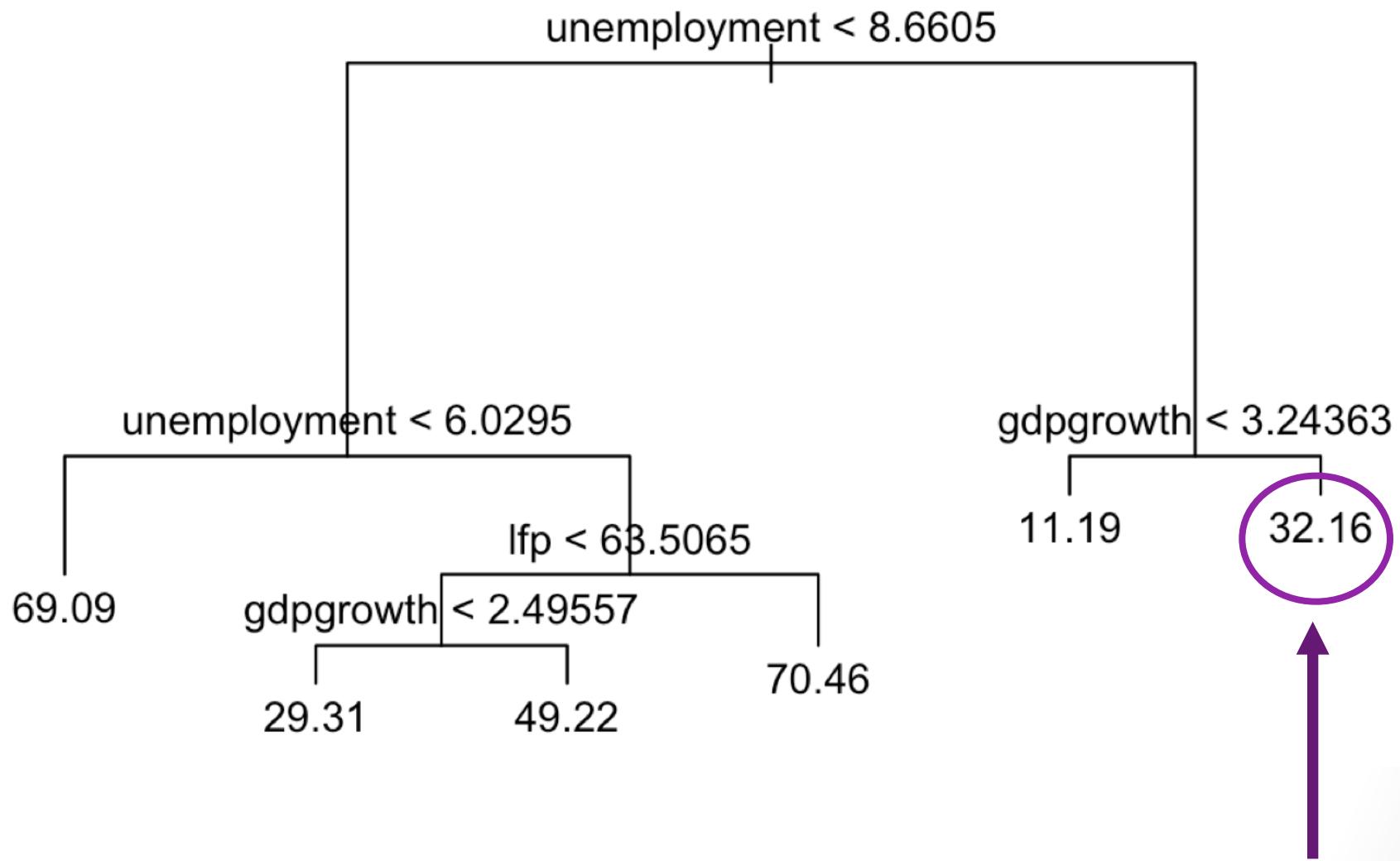
# Grow another tree...



When the unemployment rate is sufficiently low,  
that is all you need to know: 69% positive evaluations



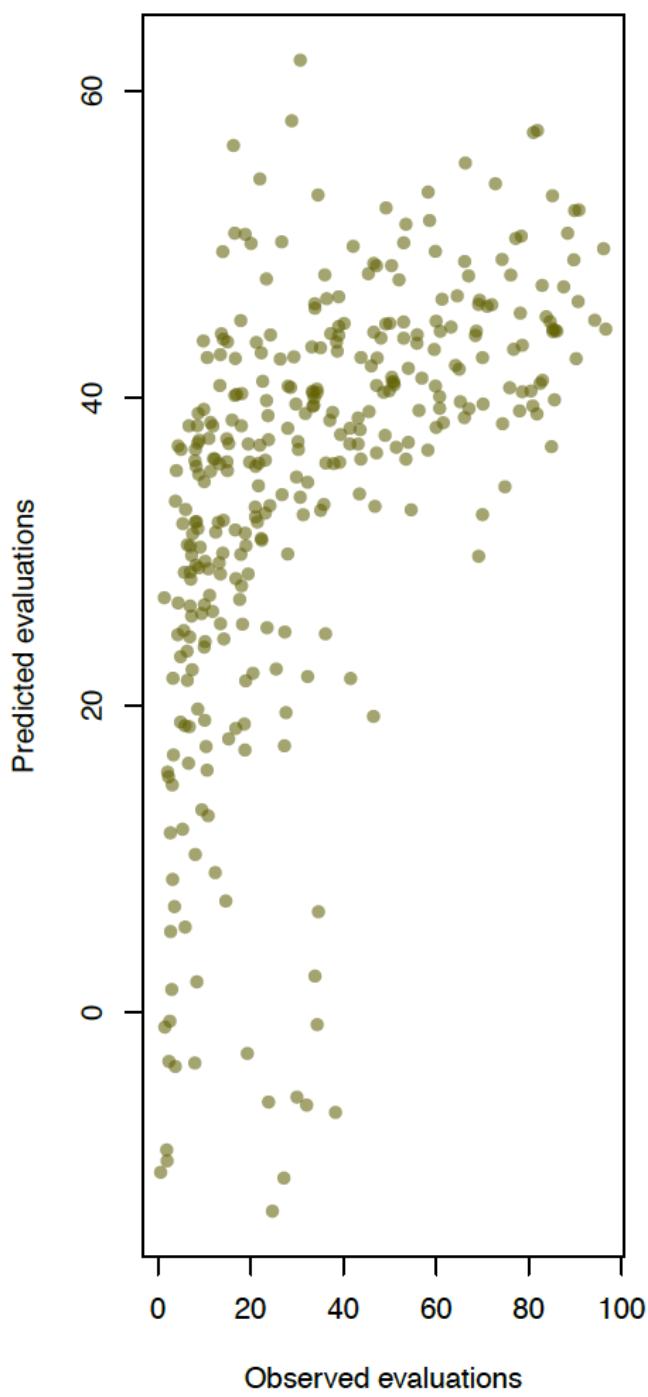
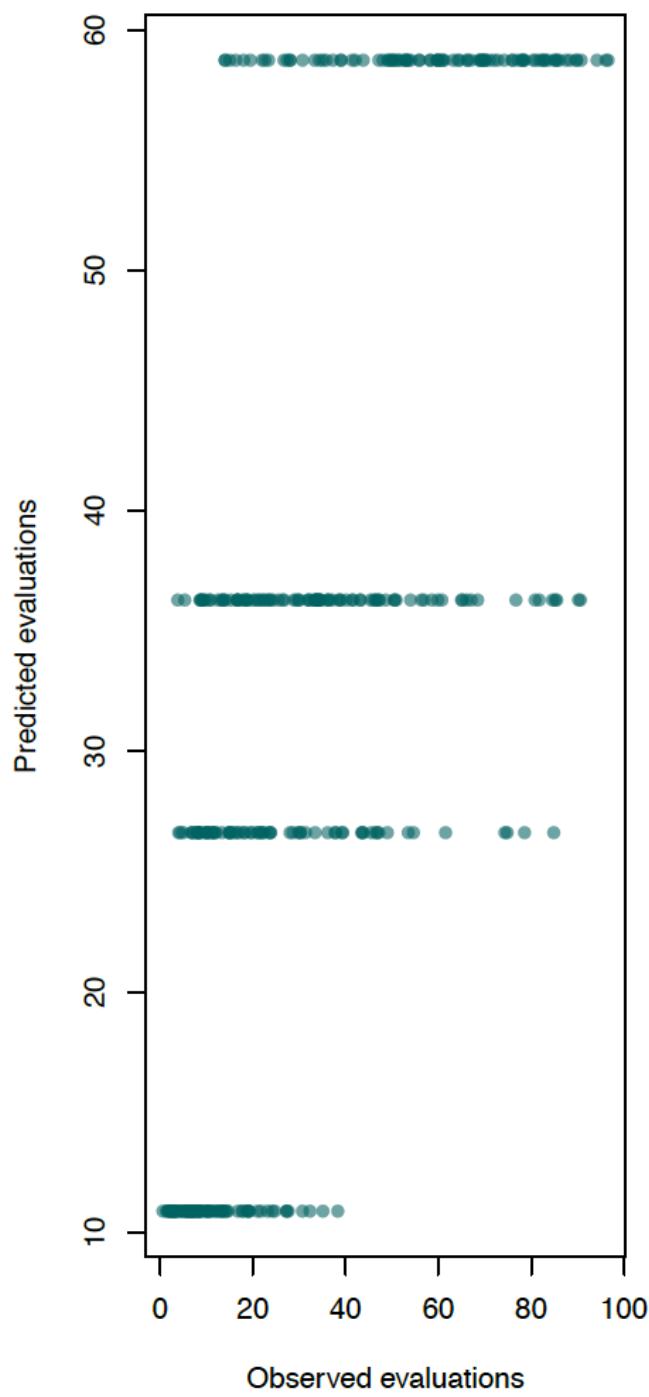
Some unemployment 6-8.7% is OK, as long as LFP is high



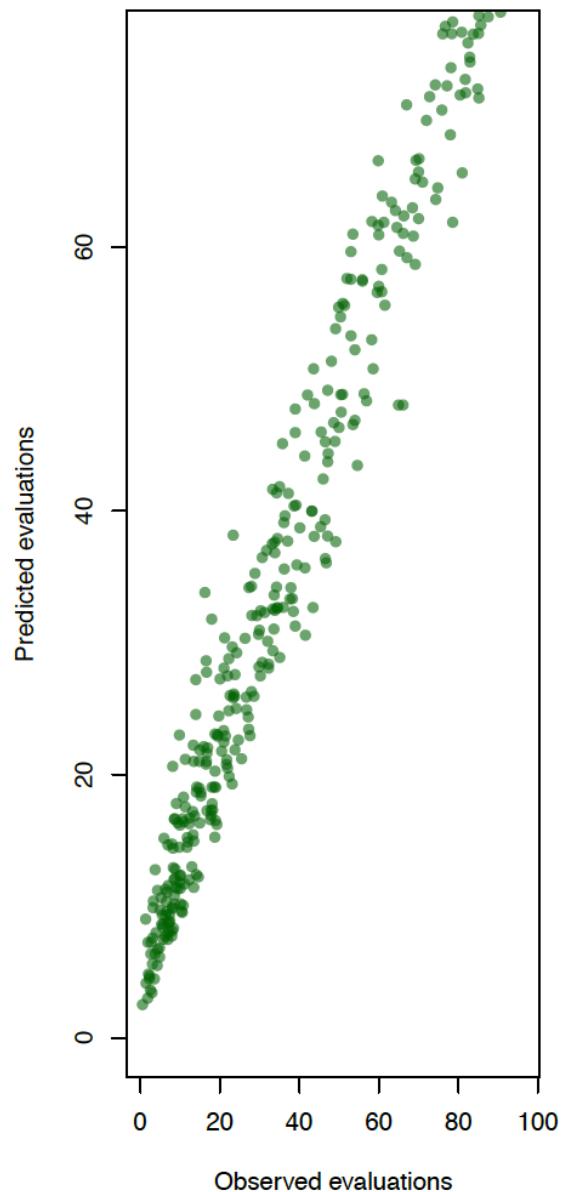
High unemployment (above 8.7%) predicts very low evaluations, but they are rescued to some degree **when GDP growth is high enough**

# Random forest

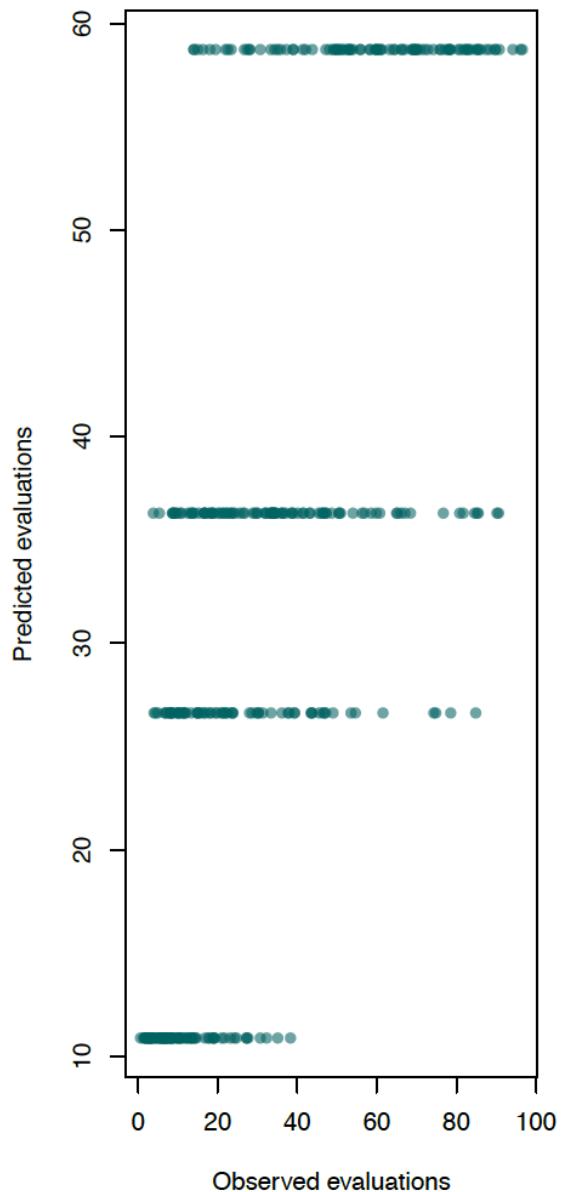
- Grow 1000 trees
- Randomly vary which predictors are available at each split
- Make the trees “vote”



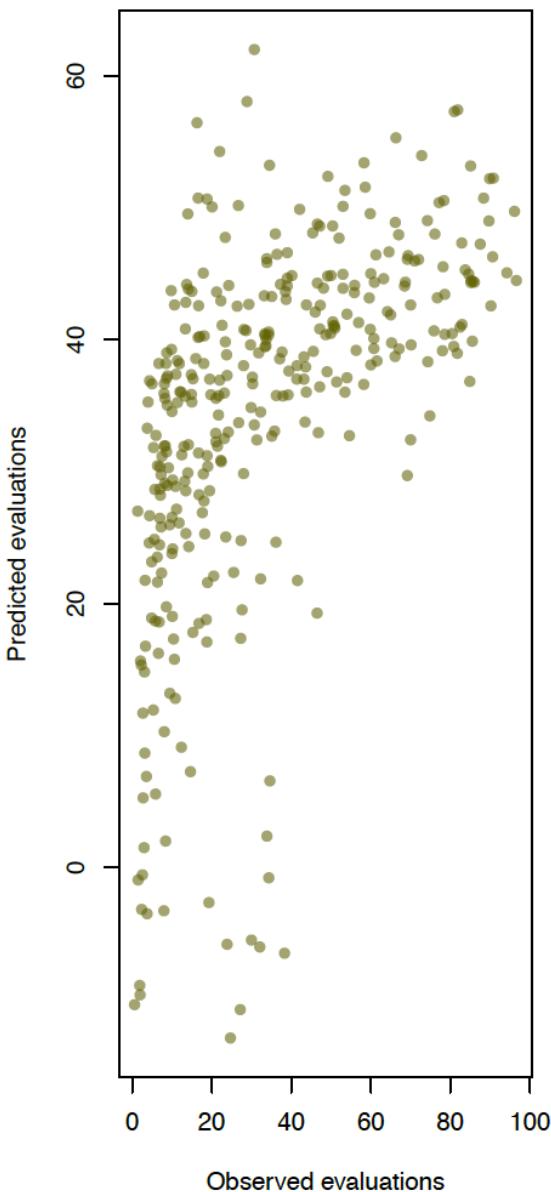
**Random forest**  
**(in-sample) predictions**

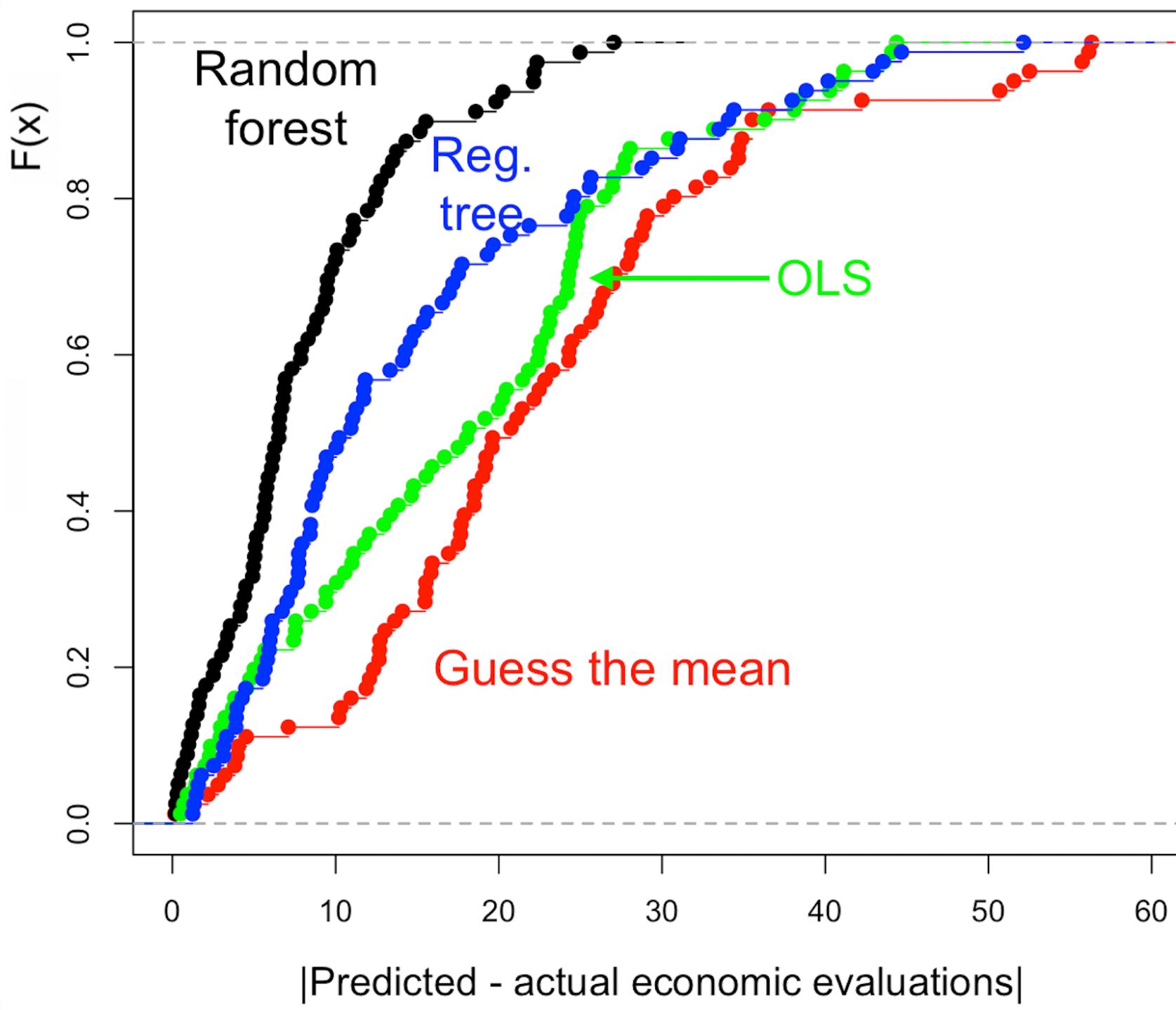


**Single tree**  
**(in-sample) predictions**



**OLS**  
**(in-sample) predictions**





# Model comparisons

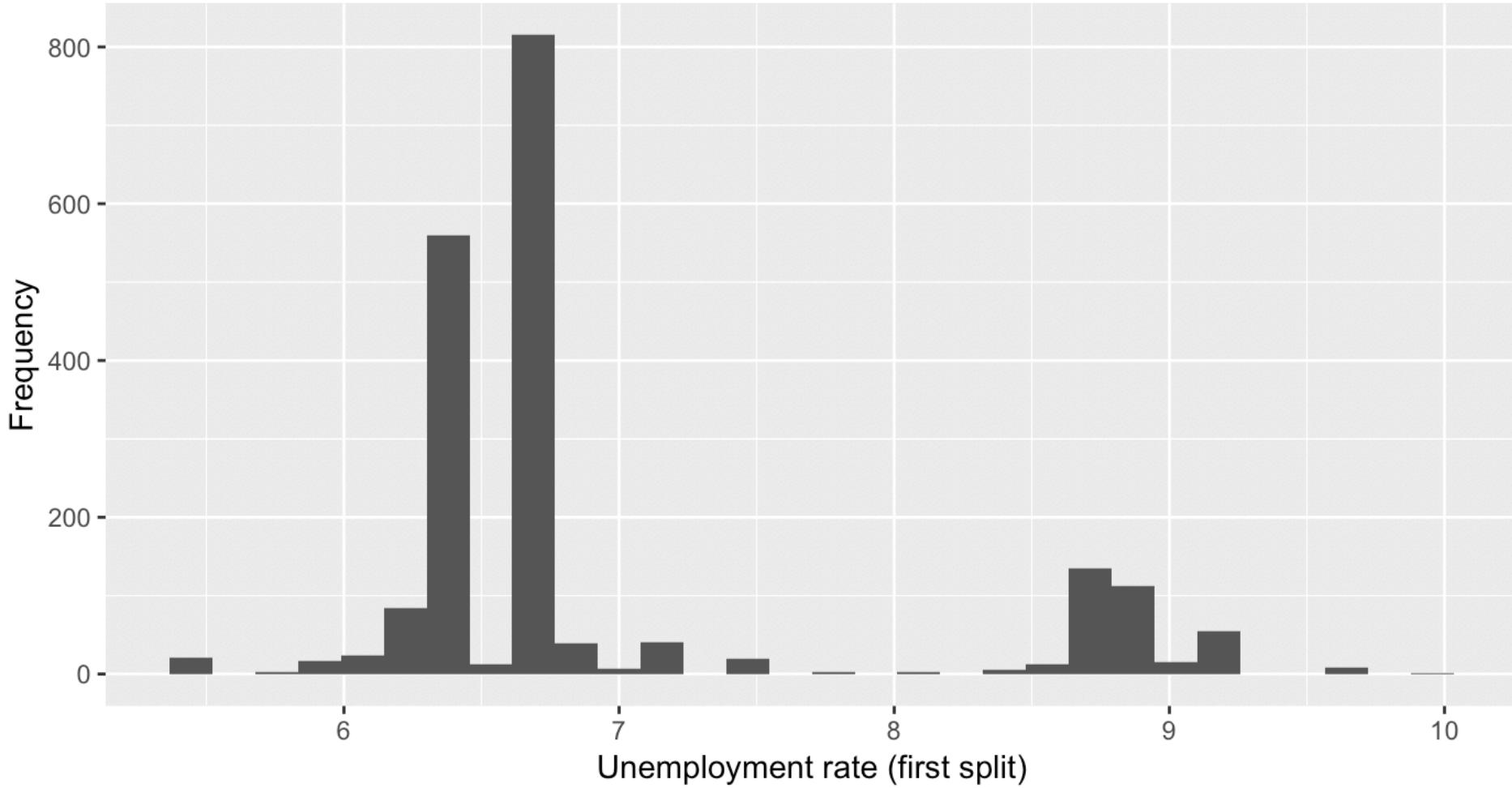
- RF OOS predictions are on average 9.91 p.p. closer to actual economic evaluations compared to OLS.
- RF is powerful but requires a richer set of economic indicators.
- So suppose we do not want to grow 1000 trees...

# How robust is the split at the initial node?

- Is the unemployment rate truly more informative than GDP growth? Single trees are known to be fragile.
- Proposed approach: grow 2,000 trees with bootstrapped samples.
- Root node stability: the unemployment rate is selected in 99.4% of all trees. (GDP is never chosen.)
- Percentile confidence intervals: 6.4%-8.8% (95% of trees).

## Distribution of unemployment rate cutoffs

Thresholds for regression trees from 2,000 bootstrapped samples



# One final approach to variable selection

# Penalized regressions: a refresher

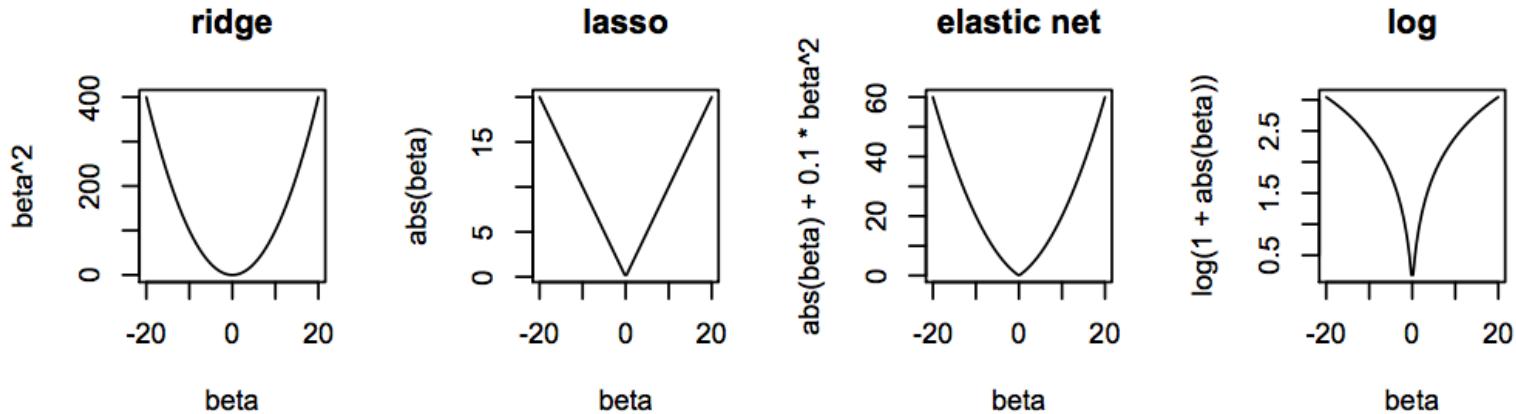
Given  $n$  observations, a  $y$  outcome of interest and  $k$  columns of  $\mathbf{x}$ ,  
put a cost on the magnitude of each coefficient:

$$\min \left\{ -\frac{2}{n} \underbrace{\log[p(y_1|x_{11}, \dots, x_{1k}) \times \dots \times p(y_n|x_{n1}, \dots, x_{nk})]}_{LHD(\beta)} + \lambda \sum_k c(\beta_k) \right\}$$

Let the cost function be  $c(\beta_k) = |\beta_k|$ , and estimate  $\hat{\beta}$  for a sequence  
of 100 distinct cost parameters  $\lambda_1 > \dots > \lambda_{100}$ .

# Penalized regressions: a refresher

- Terminology: least absolute shrinkage and selection operator (Lasso)
- Lasso will produce models that are more sparse compared to ridge regressions
- May not necessarily perform better in terms of prediction
- Easier to interpret
- Less likely to overfit



Options: ridge  $\beta^2$ , lasso  $|\beta|$ , elastic net  $\alpha\beta^2 + |\beta|$ , log( $1 + |\beta|$ ).

# Gamma lasso: a flexible approach to the cost function

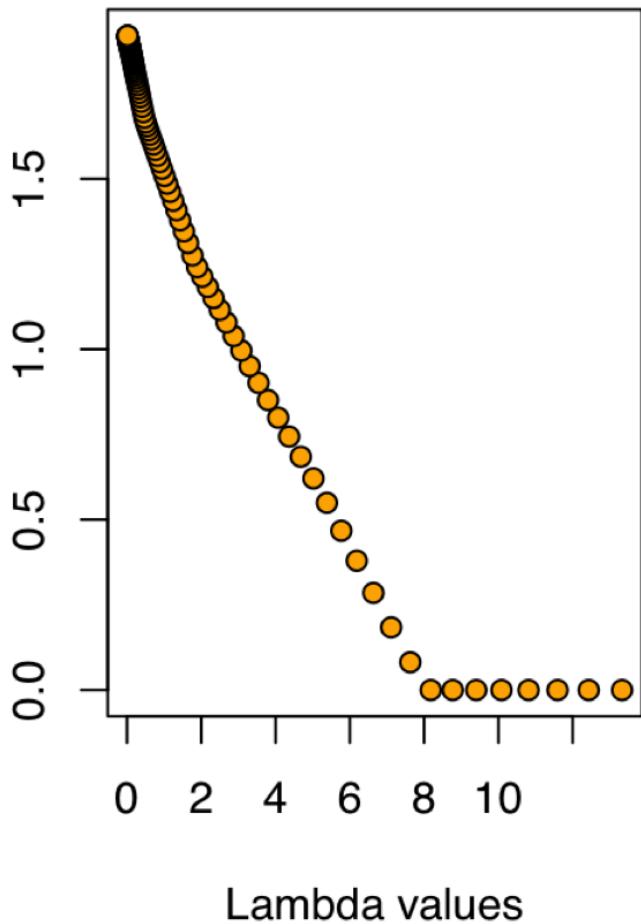
- Setting  $\gamma=0$  yields traditional lasso
- Allow faster addition of covariates by raising  $\gamma$
- Larger “shoulder paths” when visually exploring path plots

$$c(\beta_j) = \gamma^{-1} \log(1 + \gamma |\beta_j|)$$

U-rate, unlike GDP, enters even for large lambda values:

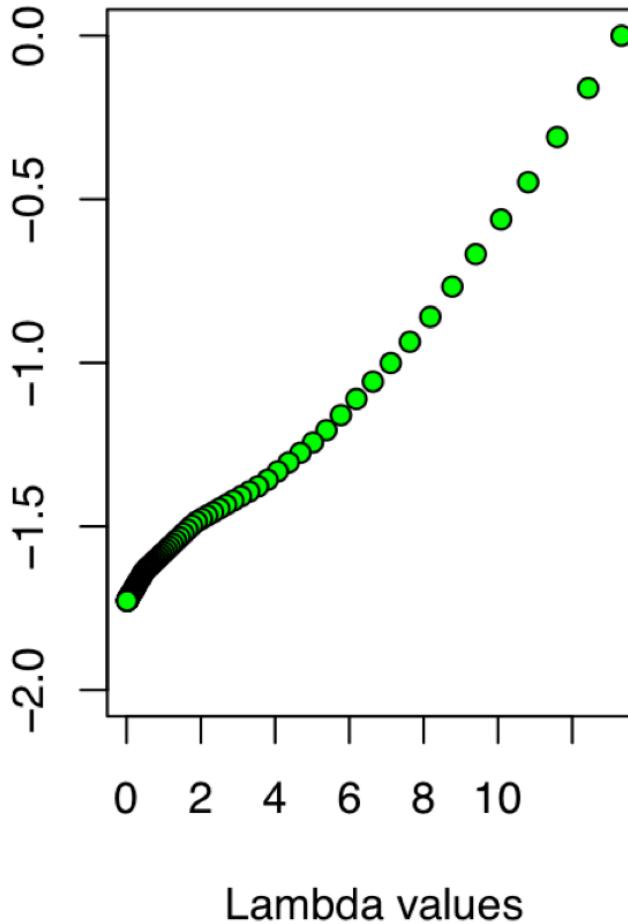
**GDP**

GDP growth coefficient

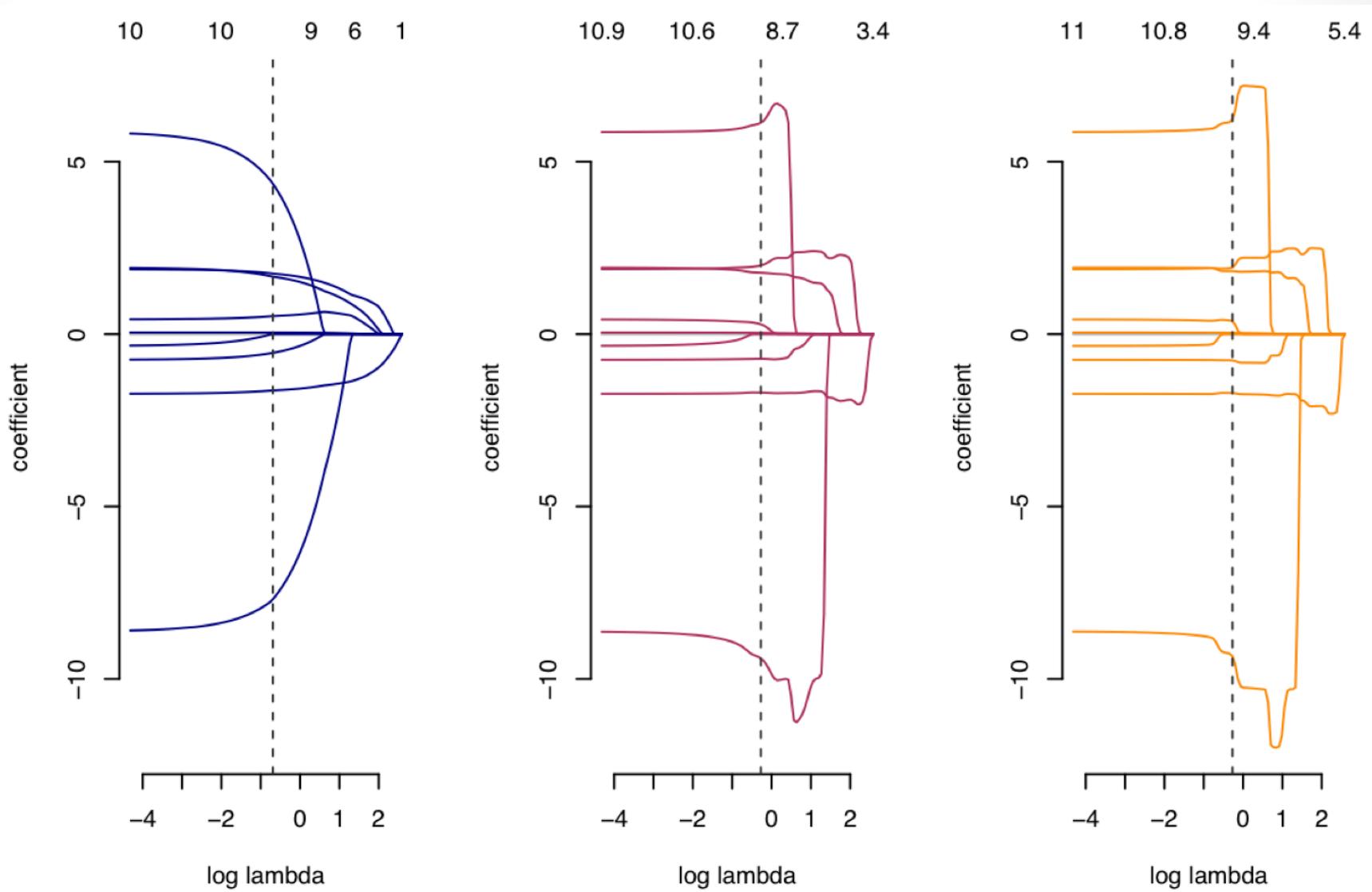


**Unemployment**

Unemployment coefficient



# Setting $\gamma=0$ , $\gamma=2$ , $\gamma=10$



## Selected variables at the optimal penalty $\lambda=.502$

	seg48
intercept	-91.53666881
gdpgrowth	1.66532688
unemployment	-1.63407920
inflation	.
lfp	0.52220479
lfp_men	1.75640945
manufacturing	-0.54344666
trade	0.04434477
ineq_low	4.35976598
ineq_medium	.
ineq_high	-7.68985165

# Conclusion

- Agnostic methods from ML predict economic sentiment well.
- They choose objective economic indicators that make sense
- Earlier research has emphasized the importance of income growth for economic sentiment
- This paper shows that the state of the labor market is a better predictor of subjective economic evaluations than changes in national GDP.

# Thank you

*Please send feedback to [zilinsky@nyu.edu](mailto:zilinsky@nyu.edu)*

# Hidden deck

(discussion / appendix material)

# Concerns

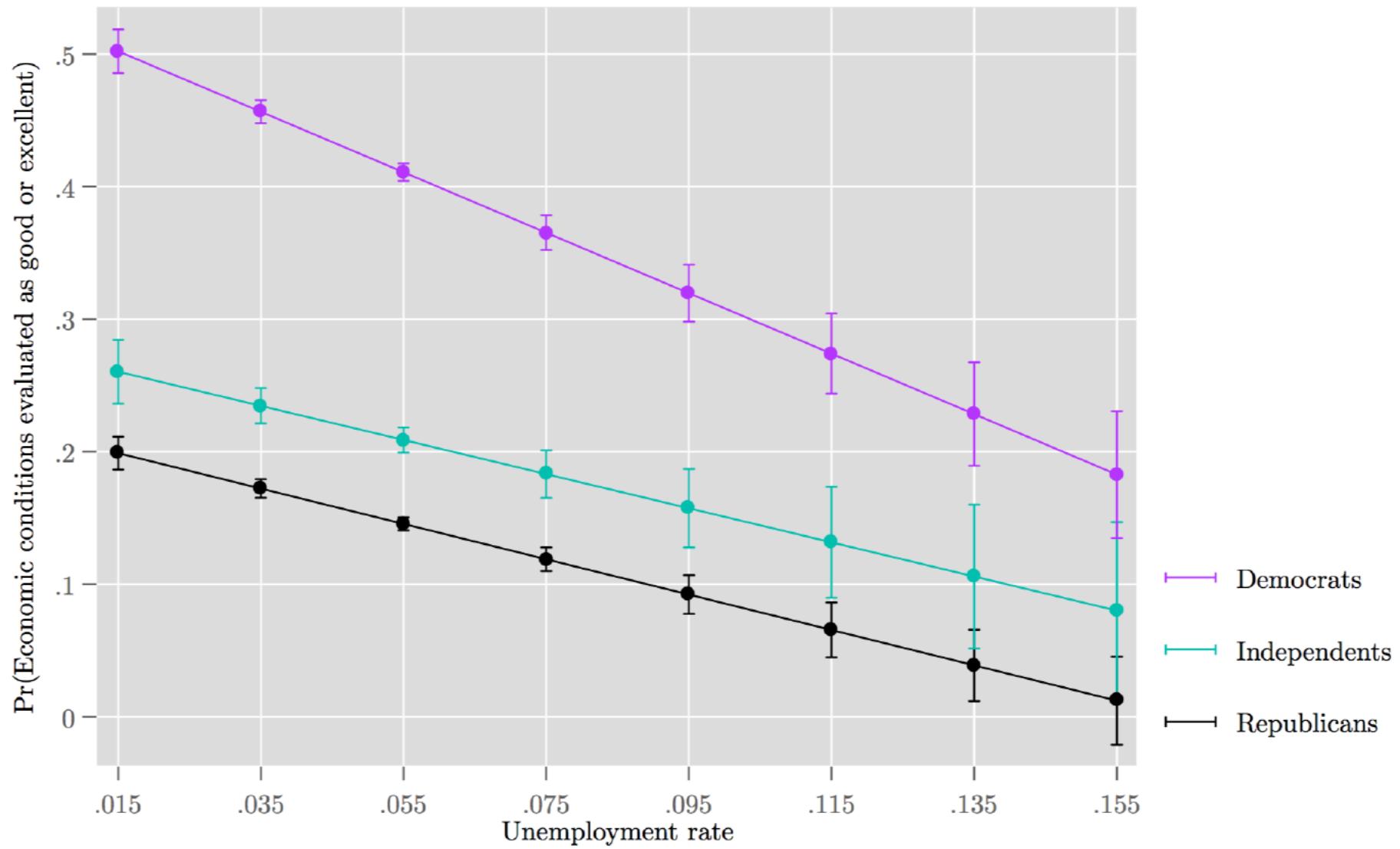
- Main and Sufi (2017): evidence of partisan bias
- Possibility: Economic evaluations are really measuring political opinions
- Only some citizens (non-partisans) are actually evaluating the economy
- Only in some (non-polarized) countries can we gather meaningful data on economic sentiment.

# Testing partisan bias

When Obama holds elected office...

... are Republicans in low-unemployment counties unwilling to say that the state of the economy is good?

### Positive economic evaluations in Jan.-Oct.2016



Controls: Age, race, income.

# Take-away

- Around the world, public opinion reflects objective economic conditions
- Partisan bias is real (shifts in evaluations) but evaluations correlate with the local economy for both Democrats and Republicans

# CV

Athey and Imbens (2016): “Although the gap between in-sample and out-of-sample fit is by definition unobserved at the time the model is estimated, when  $\lambda$  is chosen by cross-validation, its value is chosen to balance in-sample and out-of-sample prediction in a way that minimizes mean-squared error on an independent dataset”

# Background

## **Current source**

Eurobarometer: "How would you judge the current situation in each of the following?"

Option: "The situation in the (national) economy" (Very good / Rather good / Rather bad / Very bad / DK)

## **Possible sources**

- Gallup: "How would you rate economic conditions in this country today -- as excellent, good, only fair, or poor?"
- [If there is value in including Central Asian / post-Soviet countries as well, then results from the Life in Transition Survey could be incorporated as well]

# Does GDP growth translate into beliefs/evaluations?

(Obama) was “animated by a sense that, looking at the world around him, the U.S. economy is in much **better shape than the public appreciates**”

## President Obama Weighs His Economic Legacy

Eight years after the financial crisis, unemployment is at 5 percent, deficits are down and G.D.P. is growing. Why do so many voters feel left behind? The president has a theory.

BY ANDREW ROSS SORKIN APRIL 28, 2016



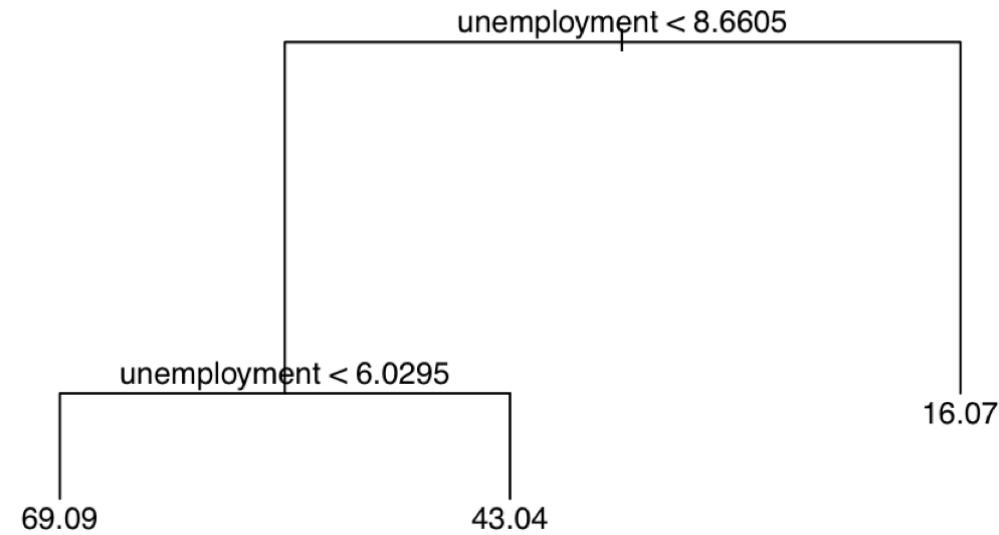
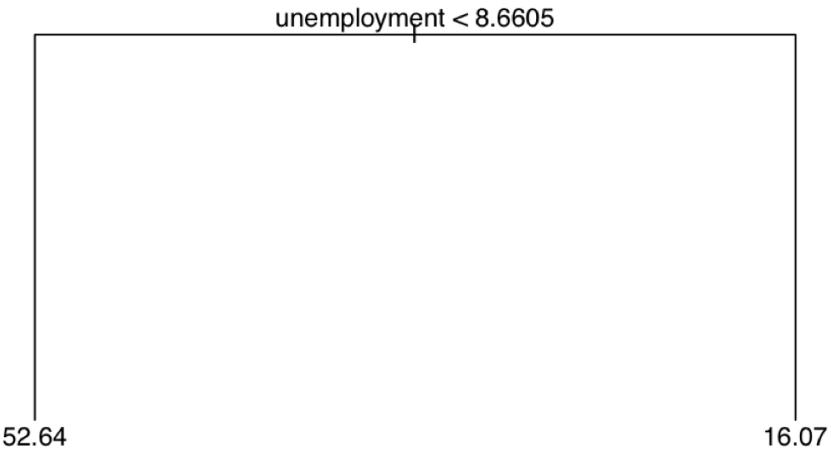
Some actors claim perceptions are sufficient outcomes themselves

≡ B BREITBART

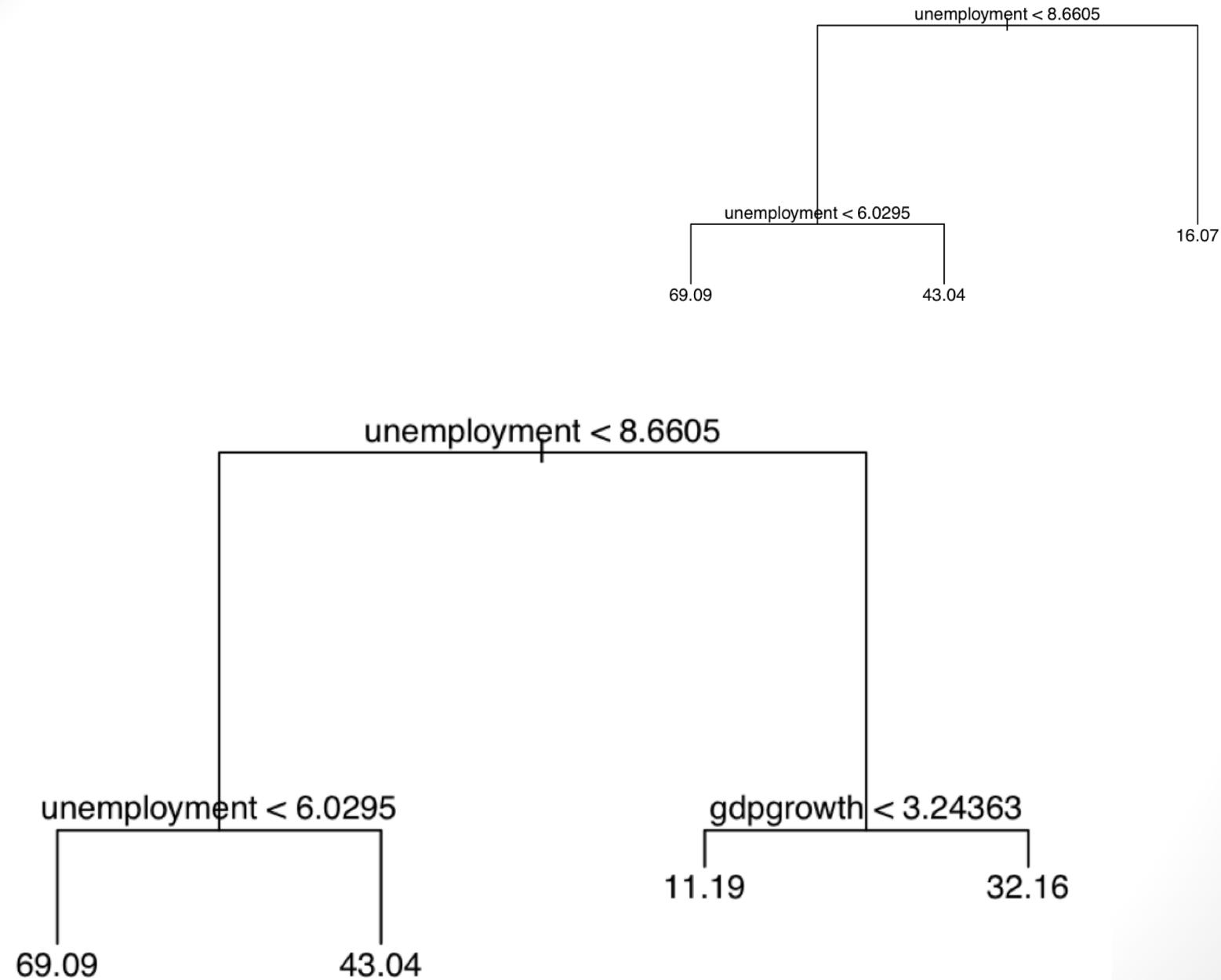
**POLL: SINCE TRUMP TOOK  
OFFICE PEOPLE WHO  
BELIEVE ECONOMY IS  
GETTING BETTER HIGHEST  
IN 15 YEARS**



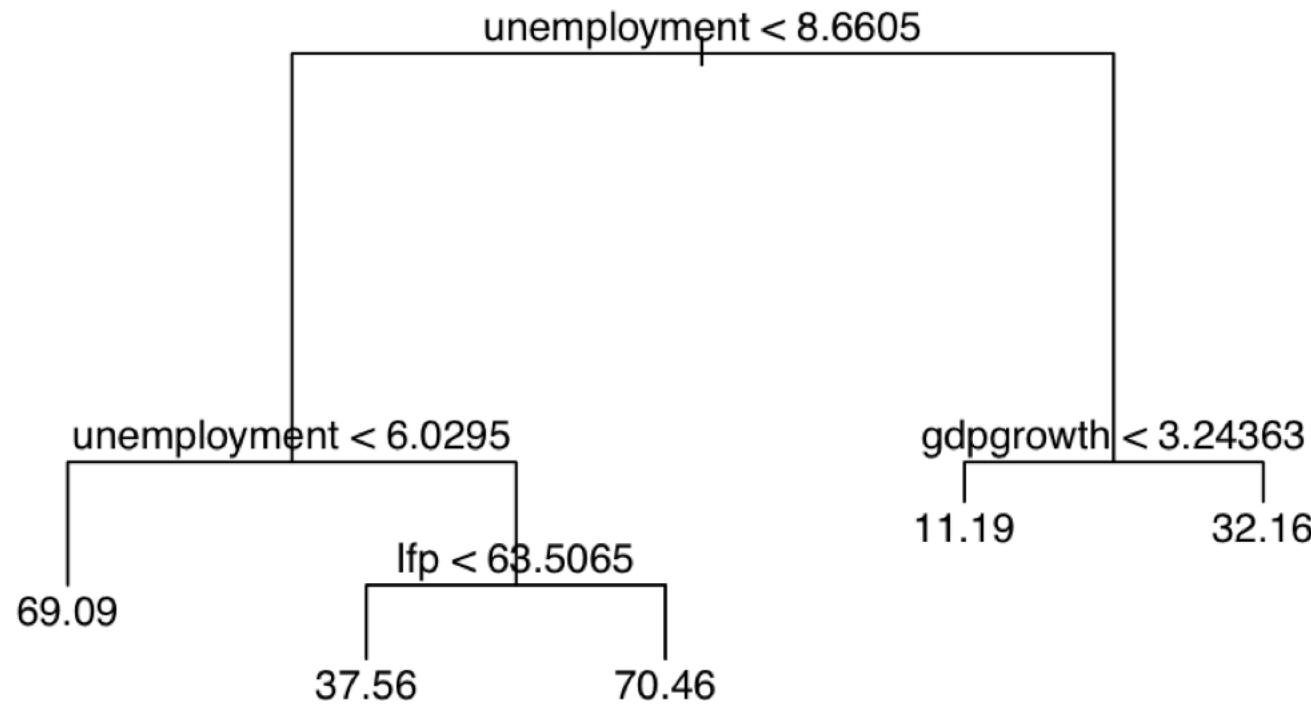
## How to grow a regression tree: when 1-2 splits are allowed



# How to grow a regression tree



# How to grow a regression tree



# Issues / open questions

- Quantifying “mistakes” is difficult. A survey answer “at odds with objective data” (e.g. a claim that the economy is bad when GDP growth is high and the labor market is tight) could reflect any of the below:
  1. A correct statement about **local** conditions (i.e. measurement error because a survey question about national economy was misunderstood)
  2. (Possibly rational) inattention to data
  3. A statement that the respondent’s expectations were not met
  4. Mistaken beliefs about the data
  5. Mis-calibrated expectations (believing that a 4% growth rate is “standard” or easily achieved). The notion that a “4% unemployment rate is too high” would be mistaken according to economists – but who can be an arbiter of what are “reasonable expectations”?

# Issues / open questions

- It seems that some politicians are lucky based on how election time is situated relative to the business cycle.
- A first-order question seems to be: do voters recognize that **evaluations of politicians ought to be adjusted for the business cycle?**
  - In some cases, the answer seems to be yes: Obama was not held “accountable” for the abysmal economy in 2009.
  - But what if elections were held later, as the economy started to recover?