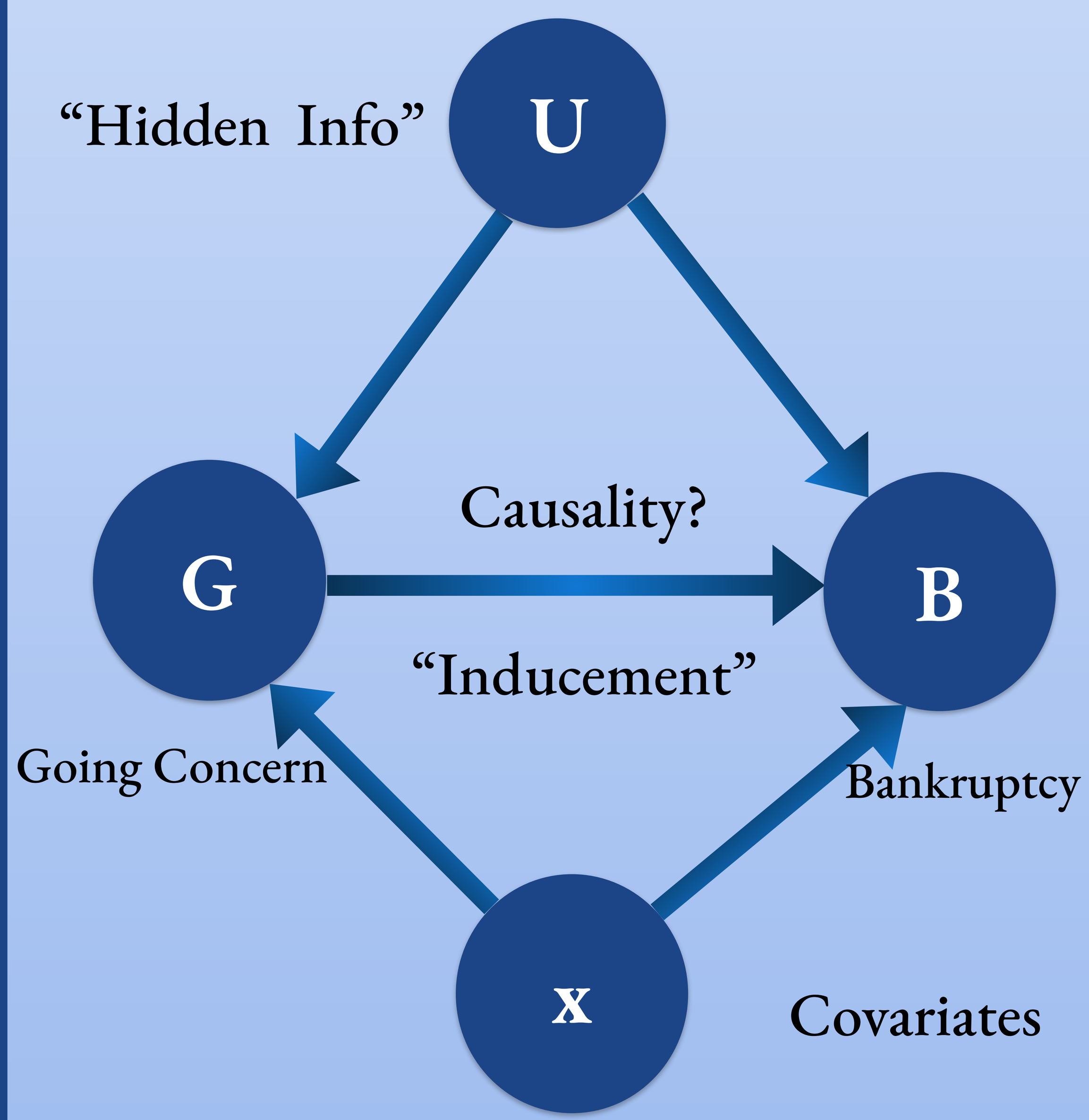
# Do Forecasts of Bankruptcy Cause Bankruptcy?

Demetrios Papakostas and P. Richard Hahn
School of Mathematics and Statistics, Arizona State University

## Problem at Hand




We introduce the following system of equations:

### System of Equations

$$P(B=1,G=1|\mathbf{x}) \approx \int_{\mathbb{R}} \Phi(g(\mathbf{x})+u)\Phi(b_1(\mathbf{x})+u)f(u)\mathrm{d}u$$

$$P(B=1,G=0|\mathbf{x}) \approx \int_{\mathbb{R}} \left(1-\Phi(g(\mathbf{x})+u)\right)\Phi(b_0(\mathbf{x})+u)f(u)\mathrm{d}u$$

$$P(B=0,G=1|\mathbf{x}) \approx \int_{\mathbb{R}} \Phi(g(\mathbf{x})+u)\left(1-\Phi(b_1(\mathbf{x})+u)\right)f(u)\mathrm{d}u$$

We incorporate the hidden information U by noting that as u →∞, P(B)=1, as u →- ∞, P(B)=0 regardless of any inducement. At u=0, there is no confounding and the inducement is the difference in observed outcomes. The treatment effect (aka the inducement effect) is defined in our framework as the following:

$$\tau(\mathbf{x}_i) = \int_{\mathbb{R}} \Phi(b_1(\mathbf{x})+u)f(u)\mathrm{d}u - \int_{\mathbb{R}} \Phi(b_0(\mathbf{x})+u)f(u)\mathrm{d}u$$

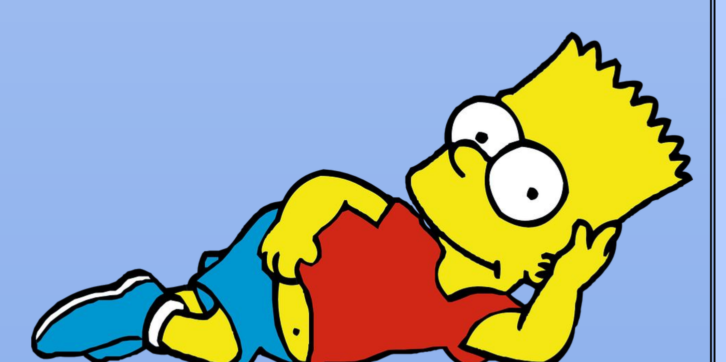
## Abstract

When auditors express concern about a company going bankrupt in the following year, there is reason to believe that them making this information public in fact *causes* said firms to go bankrupt, essentially via the mechanism of a self-fulfilling prophecy. We propose a sensitivity analysis approach based off a bivariate probit model that allows researcher to incorporate their beliefs as to what auditors know but do not disclose in their decision to issue a going concern. While this method does not provide full-identification, it provides a robust methodology that is very flexible in terms of assumptions.

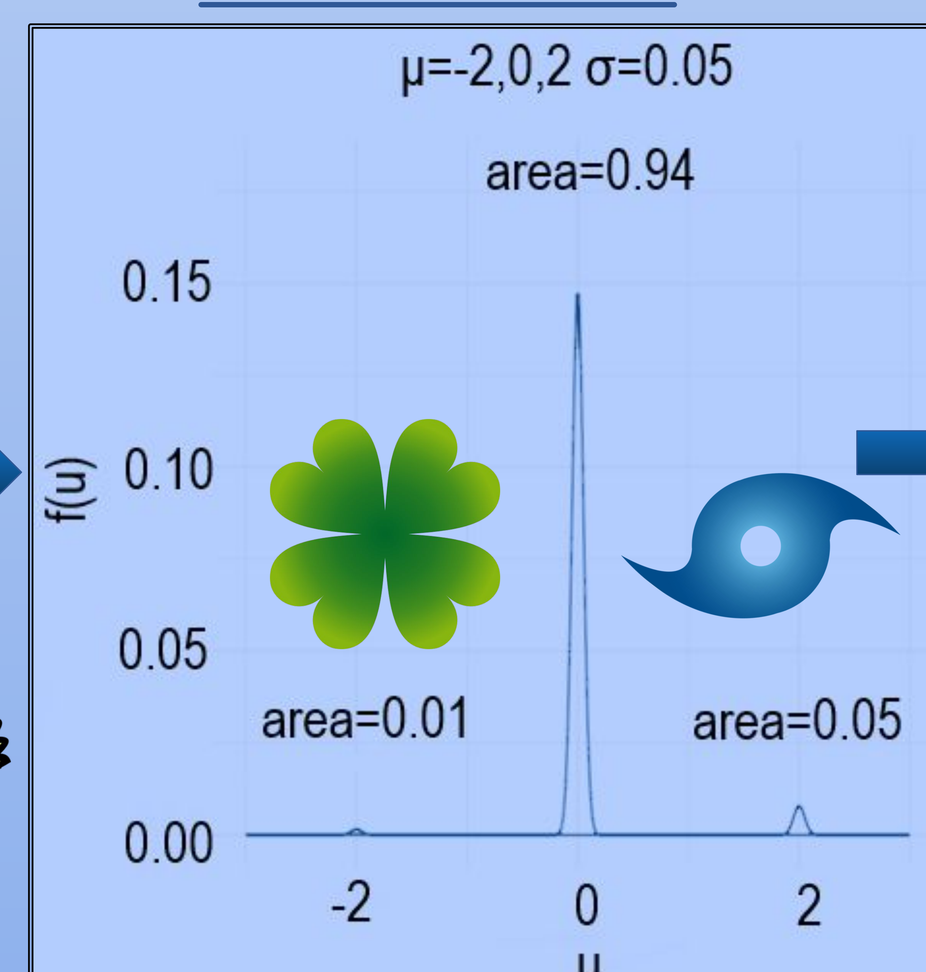
## Methodology

### Estimate Probabilities

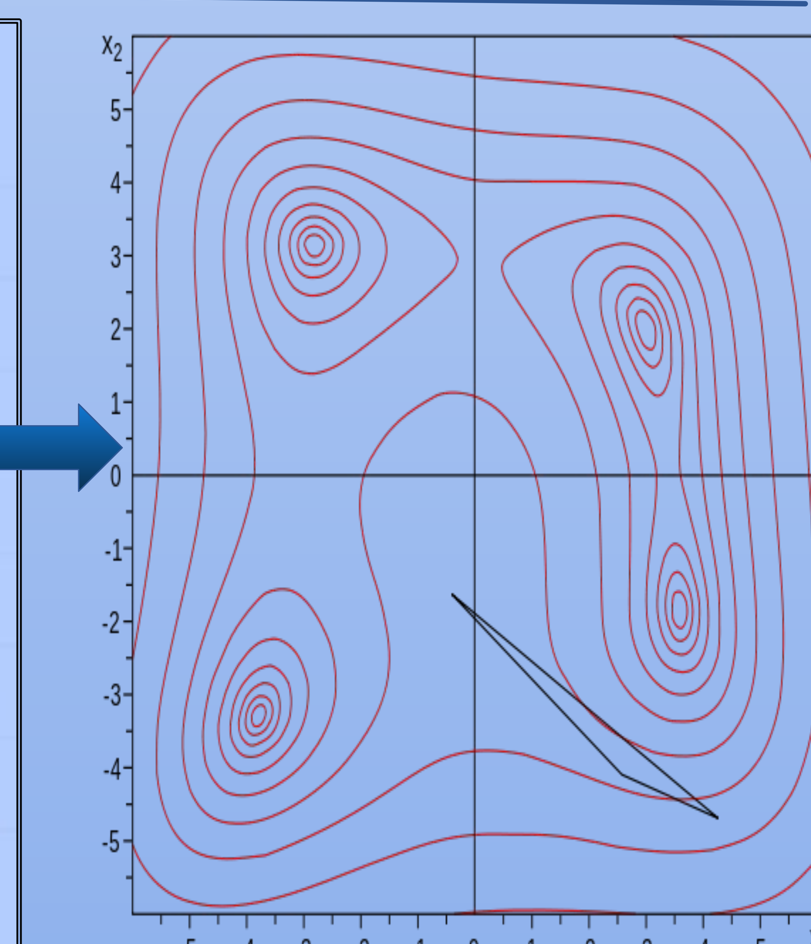
We use non-parametric regression techniques (such as BART) to solve the LHS of our system of equations, using public data as our covariates we predict on, and outcomes derived from data.

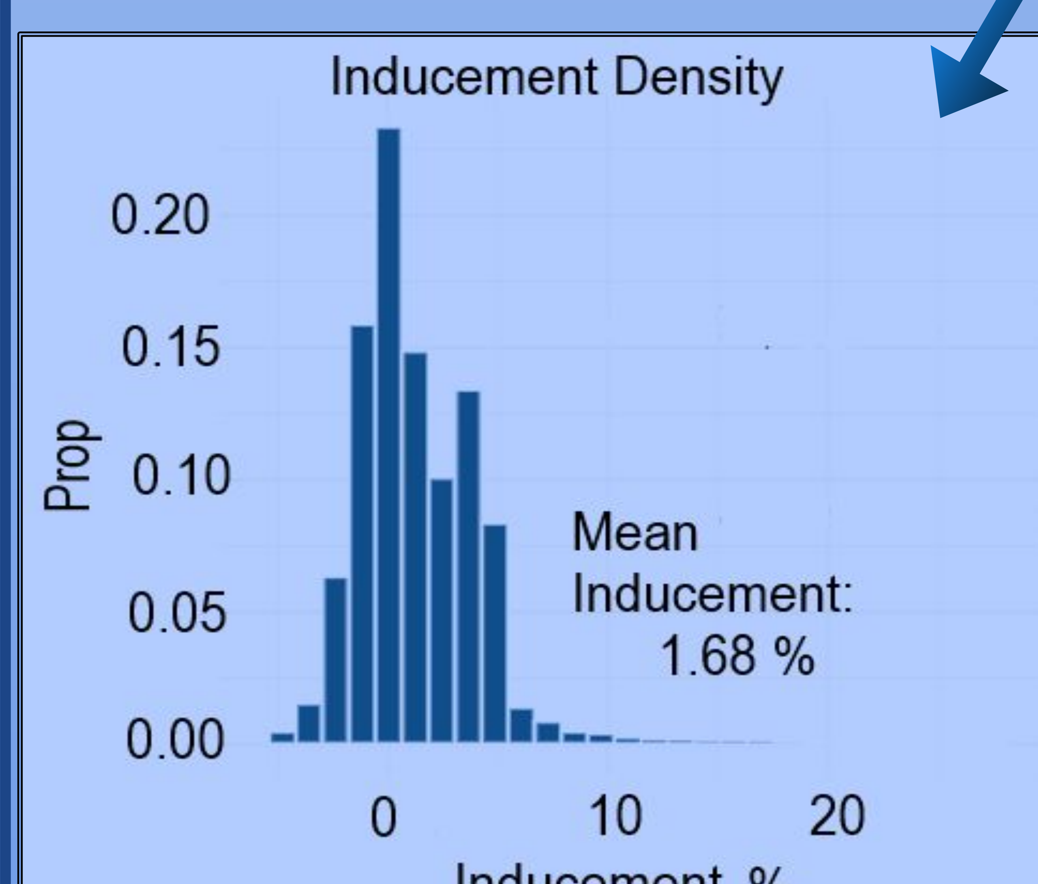


### Add distribution to U




### Minimize distances in System of Eq.






## Results (From Sensitivity Analysis)

| Distribution of $f(u)$ | mean $\tau$ (%) | mean $\tau$ post | mean $B_1$ (%) | mean $\frac{B_1}{B_0}$ | 95% Credible interval for $\tau$ (%) |
|---|---|---|---|---|---|
| $N(0,\sigma=0.1)$ | 8.89 | 8.91 | 10.3 | 29.2 | (6.95, 11.2) |
| $N(0,\sigma=0.5)$ | 3.62 | 3.76 | 5.29 | 9.32 | (2.78, 4.97) |
| $N(0,\sigma=1)$ | 0.41 | 0.63 | 2.57 | 1.56 | (0.37, 0.97) |
| Shark q=0.25, $\sigma=0.5$; var=1.11 | 0.11 | 0.24 | 2.44 | 1.08 | (0.13, 0.40) |
| Shark q=0.75, $\sigma=1.25$; var=0.77 | 2.39 | 2.57 | 4.30 | 7.53 | (1.82, 3.52) |
| "Right Bump" $\sigma=0.05$ | 1.98 | 2.17 | 4.10 | 5.21 | (1.78, 2.69) |
| 98% peak | 6.85 | 7.08 | 8.62 | 24.6 | (5.41, 9.06) |
| 90% peak | 1.85 | 2.03 | 4.02 | 4.98 | (1.68, 2.51) |

LHS of system of equations estimated using BART with monotonicity constraint.

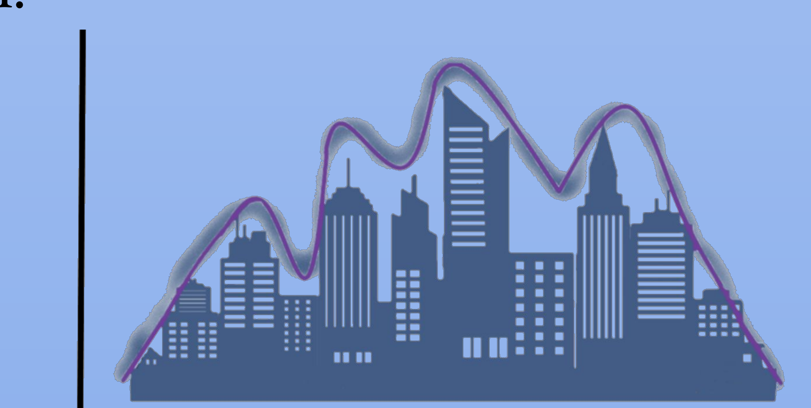
## Discussion

We found an upper bound (no confounding) of about 10% inducement, with more "realistic" distributions of U yielding around 2 or 3 percentage point increases in probability of bankruptcy after a going concern is issued. We have also developed a fully identified model, as well as showing in a robust simulation study that we can recover true treatment effects, see QR-code for details.

Ongoing work includes showing the uniqueness of our integrals and performing an IV analysis, although no valid instruments have been found yet.

## Acknowledgments

We acknowledge NSF-RTG grant at ASU for funding. Additionally, we thank Jared Murray and Frank Zhou for previous substantial work on the project. The data were sourced from Audit Analytics, Compustat, and BankruptcyData.com, encompassing 2000-2014.



## For More Information and Ongoing Work