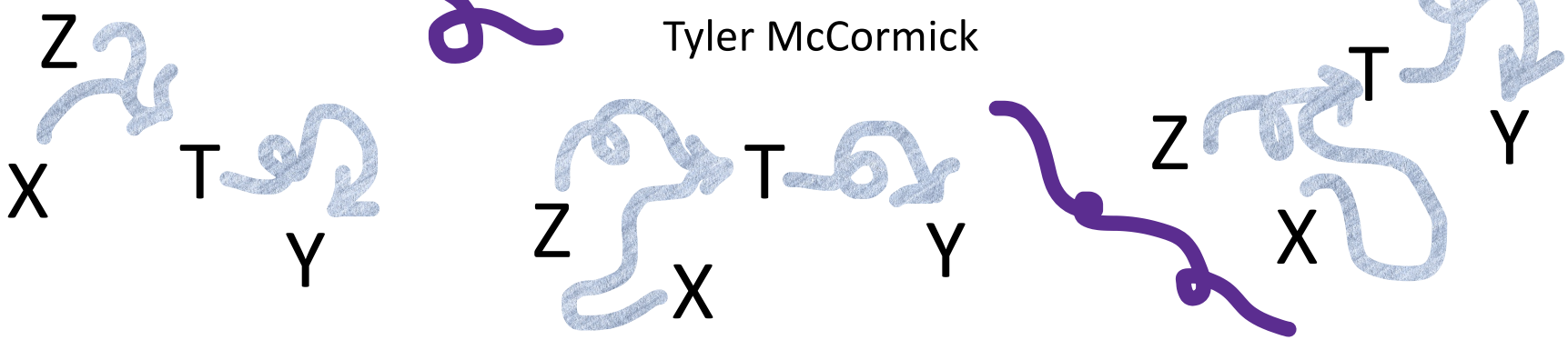
Rethinking Nonlinear Instrumental Variable Models through Prediction Validity

Chunxiao Li

Cynthia Rudin

Tyler McCormick



Instrumental variables are useful when would like to measure a causal effect but cannot perform an experiment.

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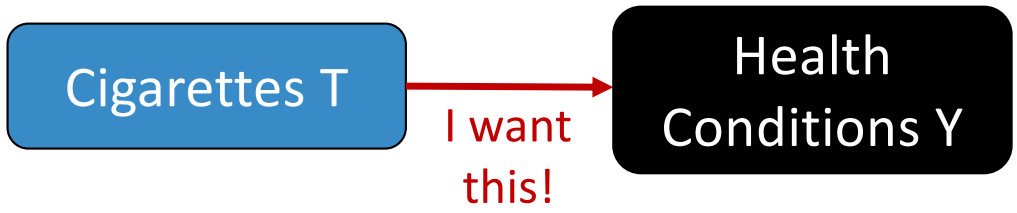

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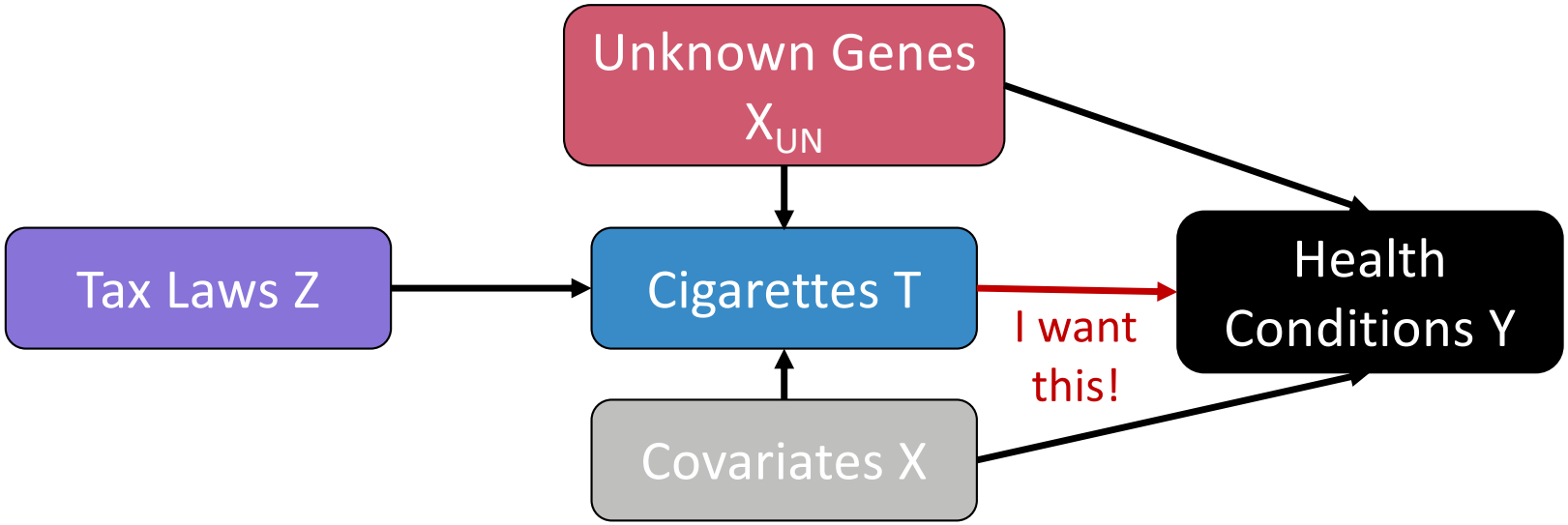

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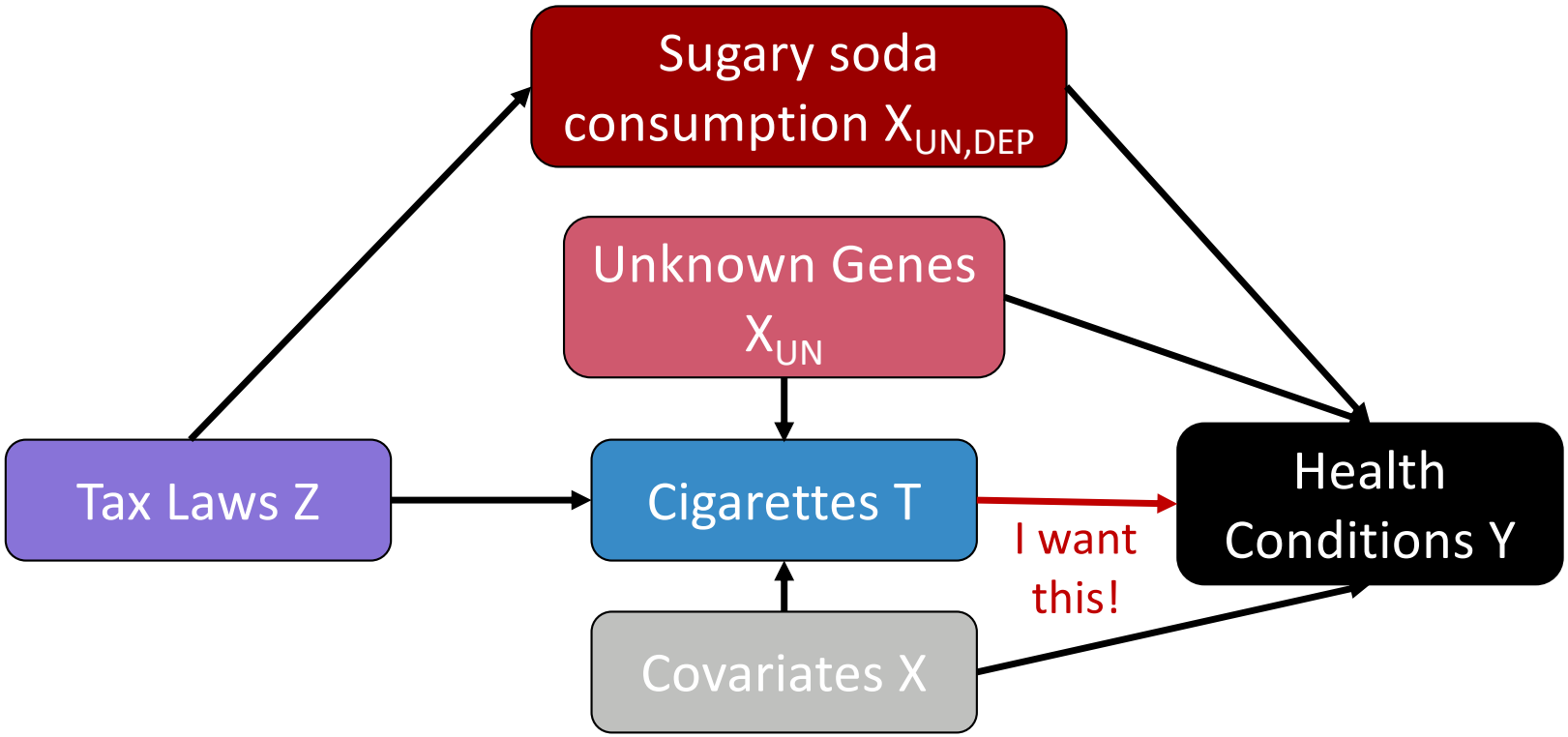

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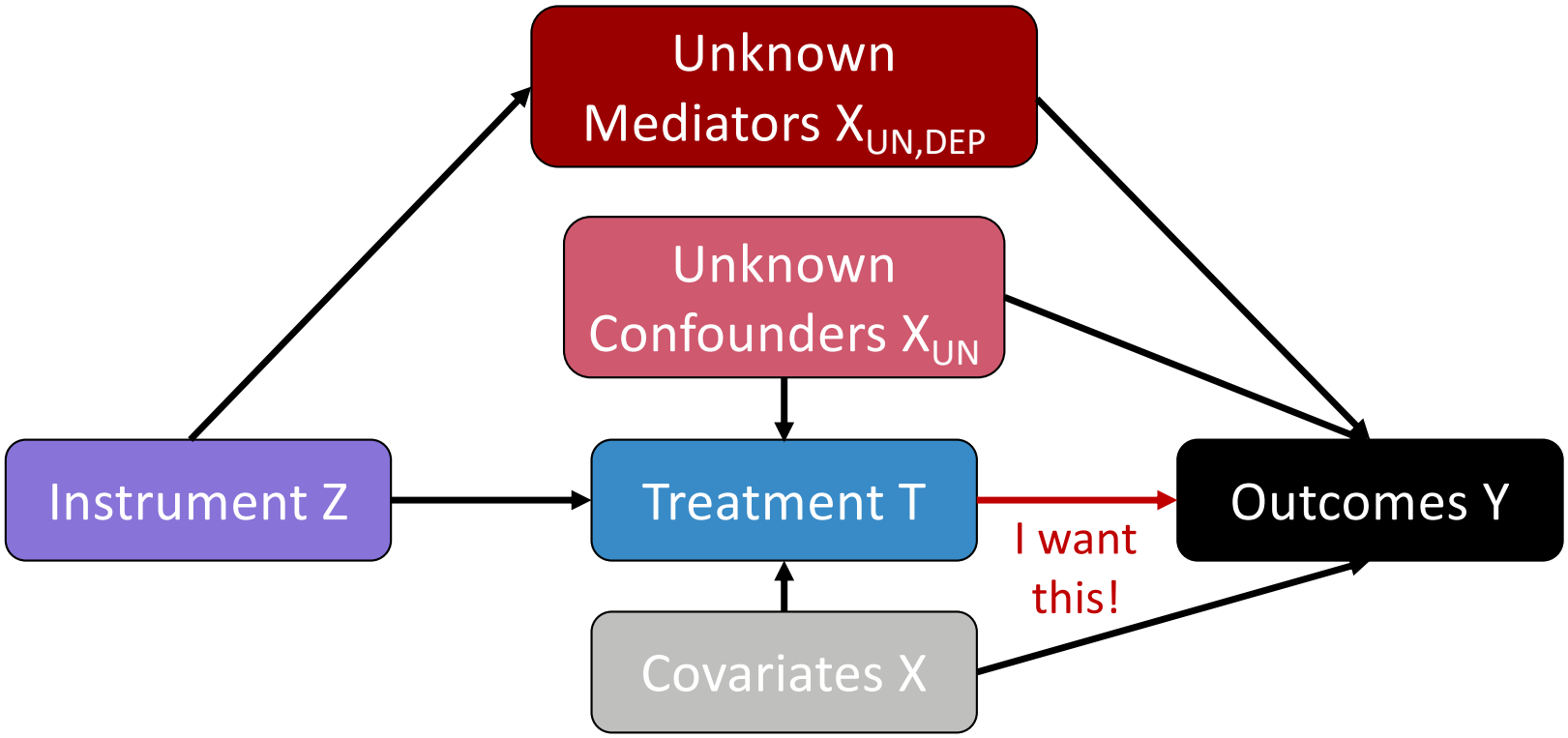
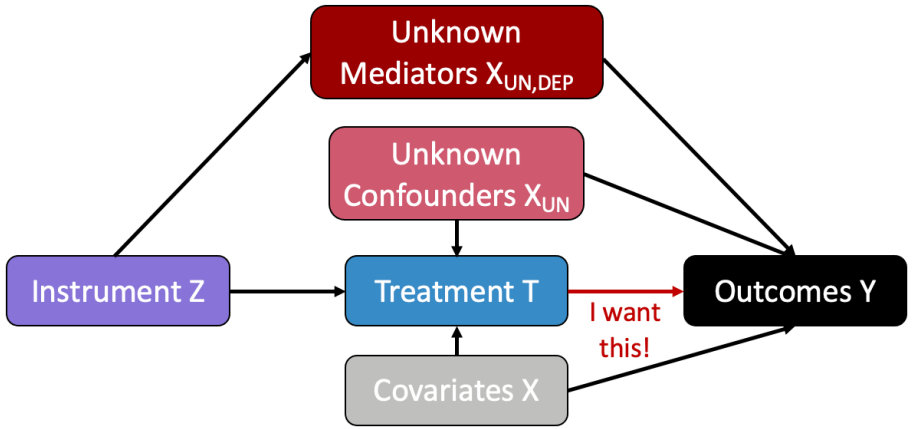


Two Critical Assumptions:

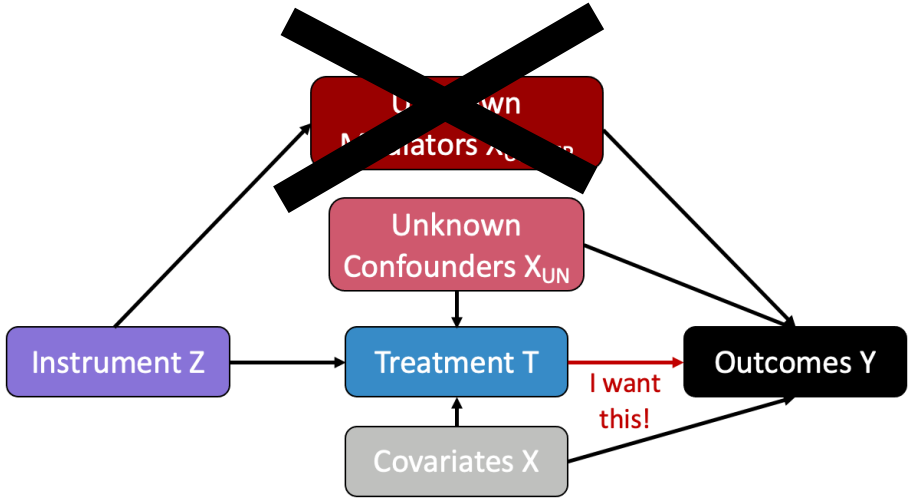
Relevance Assumption: variation in the instrument Z leads to meaningful variation in the treatment T



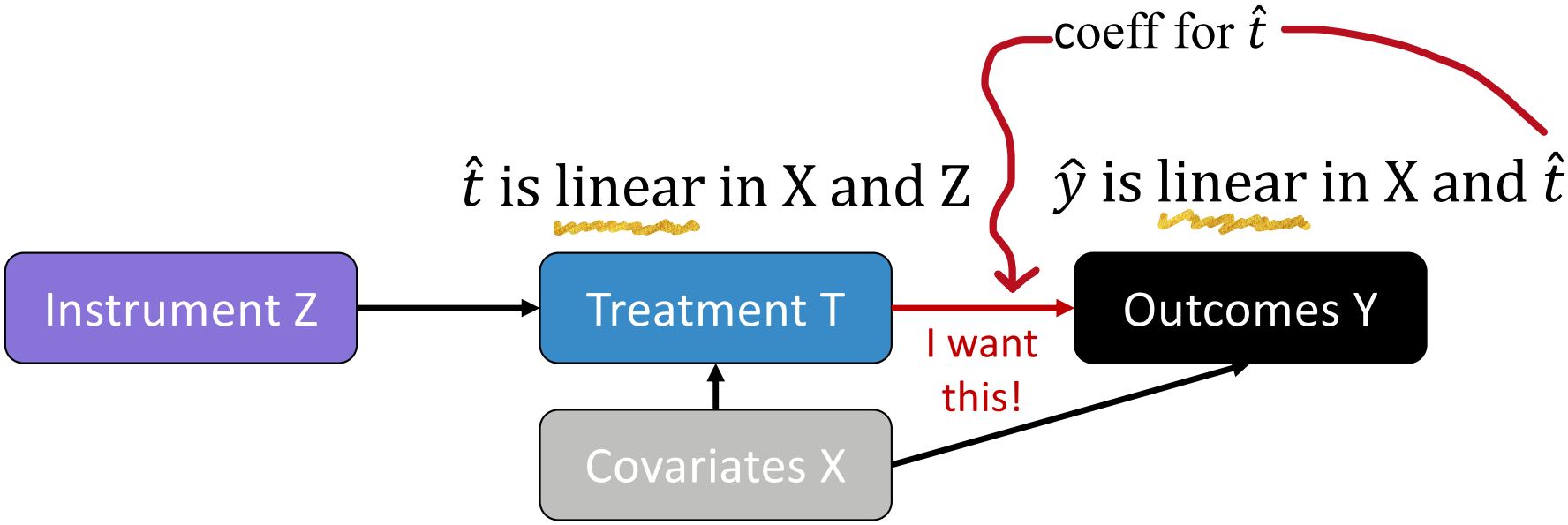
Two Critical Assumptions:

Relevance Assumption: variation in the instrument Z leads to meaningful variation in the treatment T

Exclusion Restriction: the only source of variation in Y from Z through T



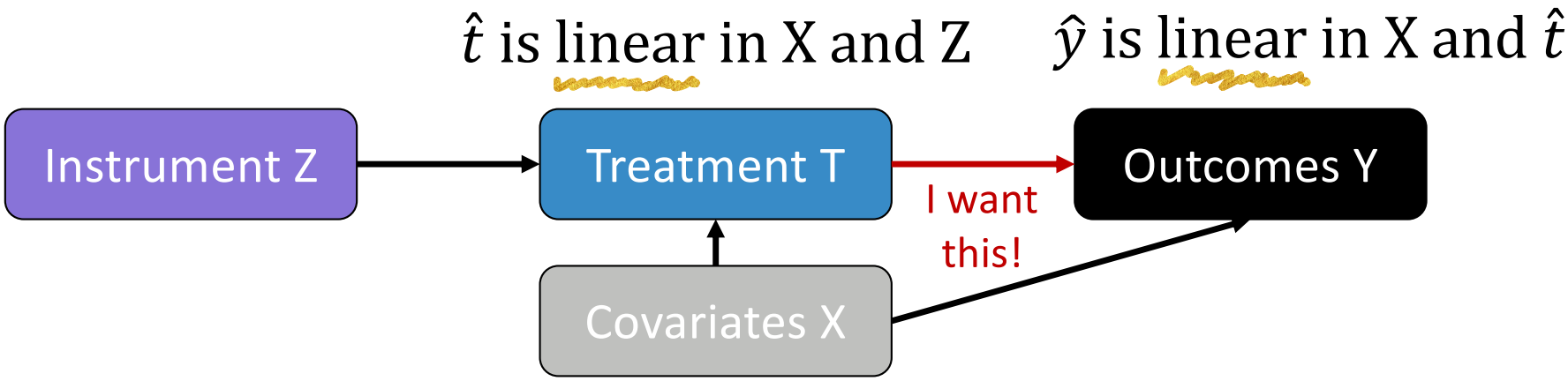
Traditional Instrumental Variable Analysis



Traditional Instrumental Variable Analysis

Exclusion Restriction

Since $\hat{y}$ contains information about Z through $\hat{t}$,
Corr$(y - \hat{y}, \mathrm{Z})$ should be 0



Prediction Validity

- replaces correlation with prediction

$\text{Corr}(y - \hat{y}, \text{Z})$ should be 0

Can we predict $y - \hat{y}$ using Z and X?

Prediction Validity

- replaces correlation with prediction

$\text{Corr}(y - \hat{y}, \text{Z})$ should be 0

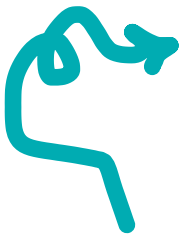
Can we predict $y - \hat{y}$ using Z and X

better than we can predict $y - \hat{y}$ with **0**? No!

Prediction Validity Exclusion Restriction

Prediction Validity

Relevance Assumption: variation in Z leads to variation in T



Can we predict t using X and Z better than X alone?

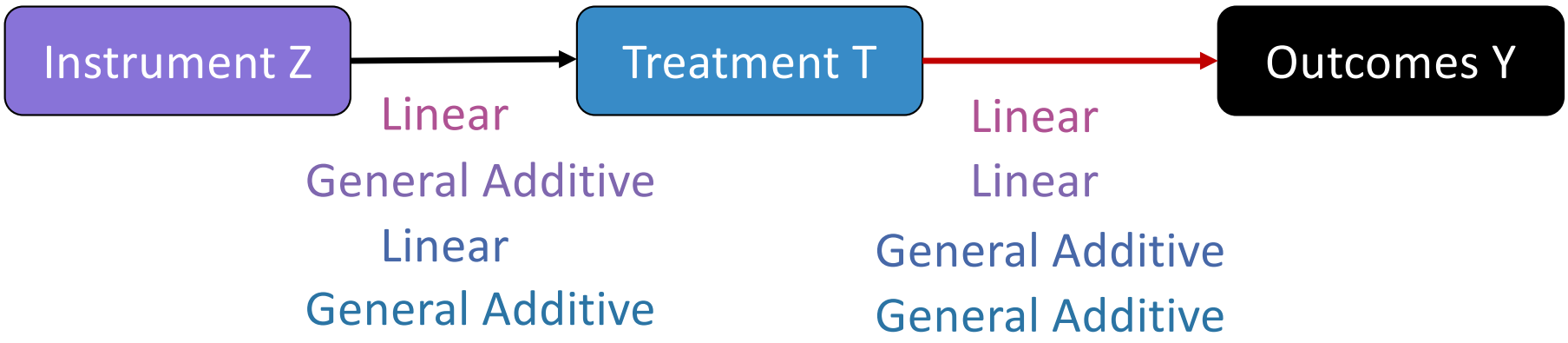
Yes!

Prediction Validity Relevance Assumption!

Prediction Validity

In the paper

- Introduce prediction validity
- New 2-stage & 1-stage prediction validity instrumental variable analysis
- Feasibility proofs for different model forms
- An application to climate policy perspectives



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