Opportunity Unraveled: Private Information and Missing Markets for Human Capital

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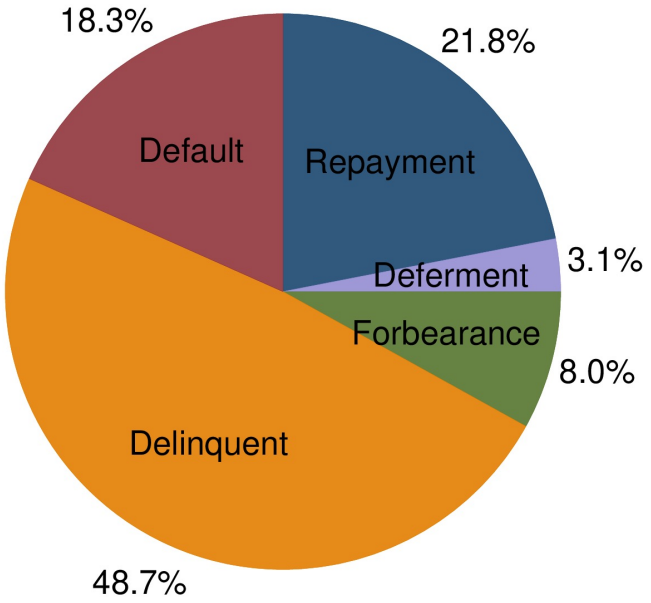
Going to College in the US is Risky

- Investing in college in the US carries high returns but also high risks
  - Almost half 2012 college enrollees failed to complete their degrees within six years
  - Among those who graduated, only 85% find jobs by 2017
  - By age 40, over 15% of college graduates have household incomes below $40,000 per year

- Primary method of financing is student debt, which does little to mitigate this risk
  - Among 2012 student borrowers, 67% experienced delinquency or default on their student loans by 2017



Most severe non-repayment event within six years of enrollment

Economists' Solution: Risk-Mitigating Financing for Human Capital

- Economists often promote financial contracts that mitigate college-investment risk:

> *"[Human capital] investment necessarily involves much risk. The device adopted to meet the corresponding problem for other risky investments is equity investment...The counterpart for education would be to `buy' a share in an individual's earnings prospects; to advance him the funds needed to finance his training on condition that he agree to pay the lender a specified fraction of his future earnings."*
>
> *- Milton Friedman (1955)*

1. **Earnings-equity contracts**: Borrower pays X% of earnings
2. **State-contingent debt contracts**: Borrower pays $X only if event occurs
   - **Completion-contingent loan**: Debt forgiveness for college dropouts
   - **Employment-contingent loan**: Debt that's forgiven in unemployment
   - **Dischargeable loan**: Debt that's dischargeable in delinquency/default

Equity and state-contingent debt are common in markets for *physical* capital investment

Research Question: Why don't we see similar financial markets for *human* capital investments?

This Paper: Adverse Selection has Unraveled These Markets

1. Develop model of financial markets for human capital to characterize when risk-mitigating financial markets can exist
   - Clarify role of adverse selection vs. other forces such as moral hazard in market existence
   - Two curves determine market (non)existence in the spirit of Akerlof (1970)
     - "Willingness to Accept" (WTA) in exchange for a future share of an outcome
     - "Average value" (AV) of worse risks of future outcomes

This Paper: Adverse Selection has Unraveled These Markets

1. Develop model of financial markets for human capital to characterize when risk-mitigating financial markets can exist

2. Use subjective expectations as noisy/potential biased measures of beliefs about future outcomes to provide evidence of private information
   - Find predictive power of elicitations conditional on rich set of publicly observable characteristics
   - Suggests a potential for adverse selection for markets that insure against these risks

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1. Develop model of financial markets for human capital to characterize when risk-mitigating financial markets can exist

2. Use subjective expectations as noisy/potential biased measures of beliefs about future outcomes to provide evidence of private information

3. Empirically test unraveling condition (WTA>AV) using subjective elicitations
   - Non-parametric lower bounds and semi-parametric point estimates of unraveling conditions
   - In all four market settings, find WTA>AV so that the market unravels
   - Example: Earnings-equity market
     - Median student would have to repay $1.64 in expectation for every $1 of financing to make the contract profitable, but is only willing to repay $1.28

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4. Measure welfare impact of government subsidies to open up these markets
   - Estimate the $MVPF = \frac{Benefits}{Net\ Govt\ Cost}$ of subsidies for these contracts
   - Should government offer college financing in exchange for higher future tax rate?
   - Find high MVPFs for equity contracts because insurance value > earnings disincentive

Related Work

- Information asymmetries in household finance:
  - Akerlof (1970); Stroebel (2016); Gupta and Hansman (2019); Adams, Einav and Levin (2009); Einav, Jenkins and Levin (2012); Dobbie and Skiba (2013); DeFusco, Tang and Yannelis (2020); Karlan and Zinman (2009); Einav et al. (2010)
- Belief measurement and estimation
  - Hendren (2013, 2017); Conlon et al. (2018); Gong et al. (2019); Guvenen (2007); Wiswall and Zafar (2021); Arcidiacono et al. (2020); Stantcheva (2020); Bursztyn et al. (2020)
- Earnings risk and college financing:
  - Friedman (1955); Nerlove (1975); Palacios (2004); Chapman (2006); Field (2009); Barr et al. (2017); Abraham et al. (2018); Bachas (2019); Mumford (2020); Britton and Gruber (2020); Mueller and Yannelis (2020); Herbst (2021); Cox et al. (2018)
- Optimal taxes/subsidies for human capital
  - Mirrlees (1978); Bovenberg and Jacobs (2006); Jacobs and van Wijnbergen (2007); Stantcheva (2017)

Outline

1. Model of Market Unraveling
2. Data and Reduced Form Evidence of Private Information
3. Lower-Bound on Magnitude of Private Information
4. Estimation of Average Value and Willingness to Accept Curves
5. Welfare Impacts of Government Subsidies

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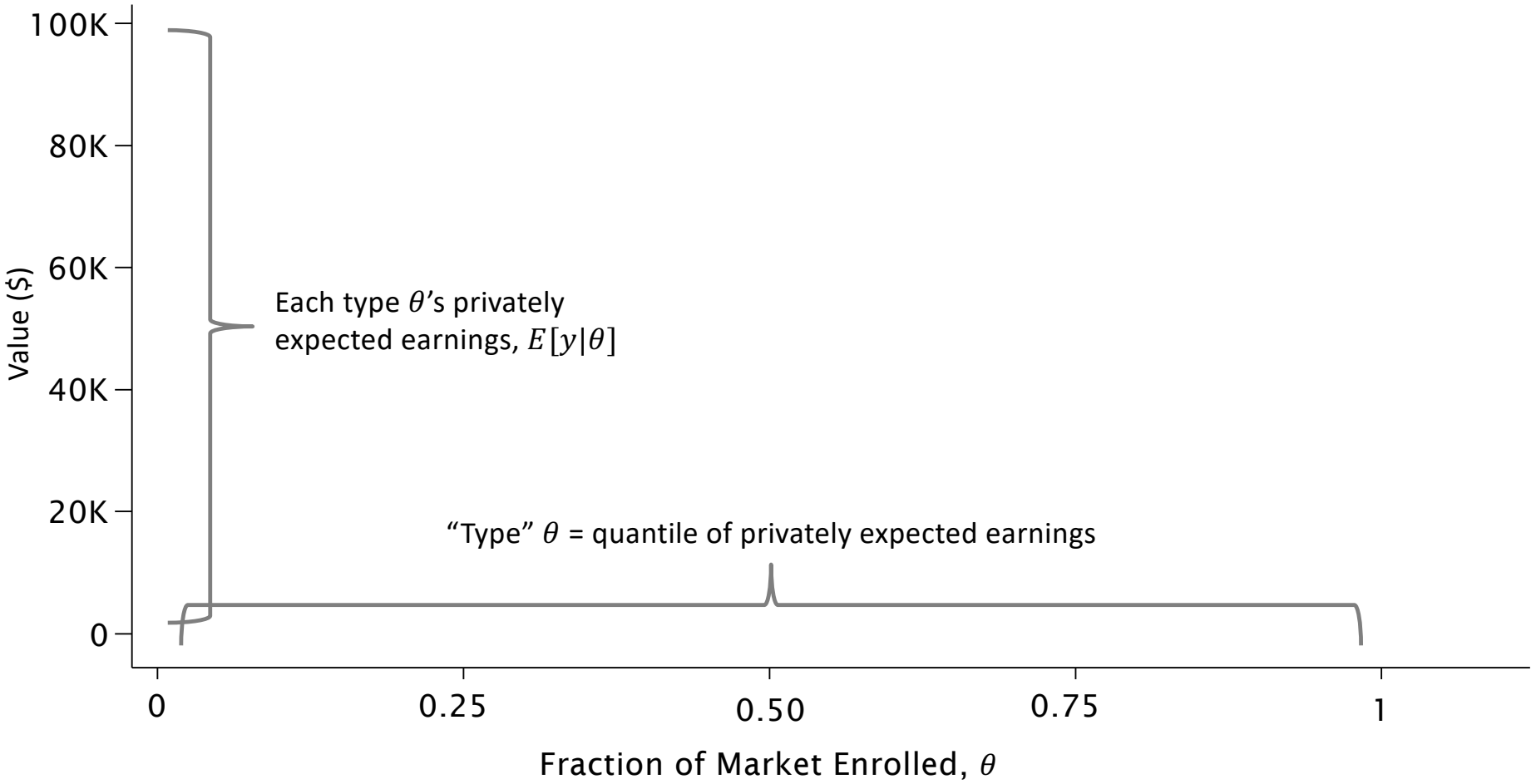
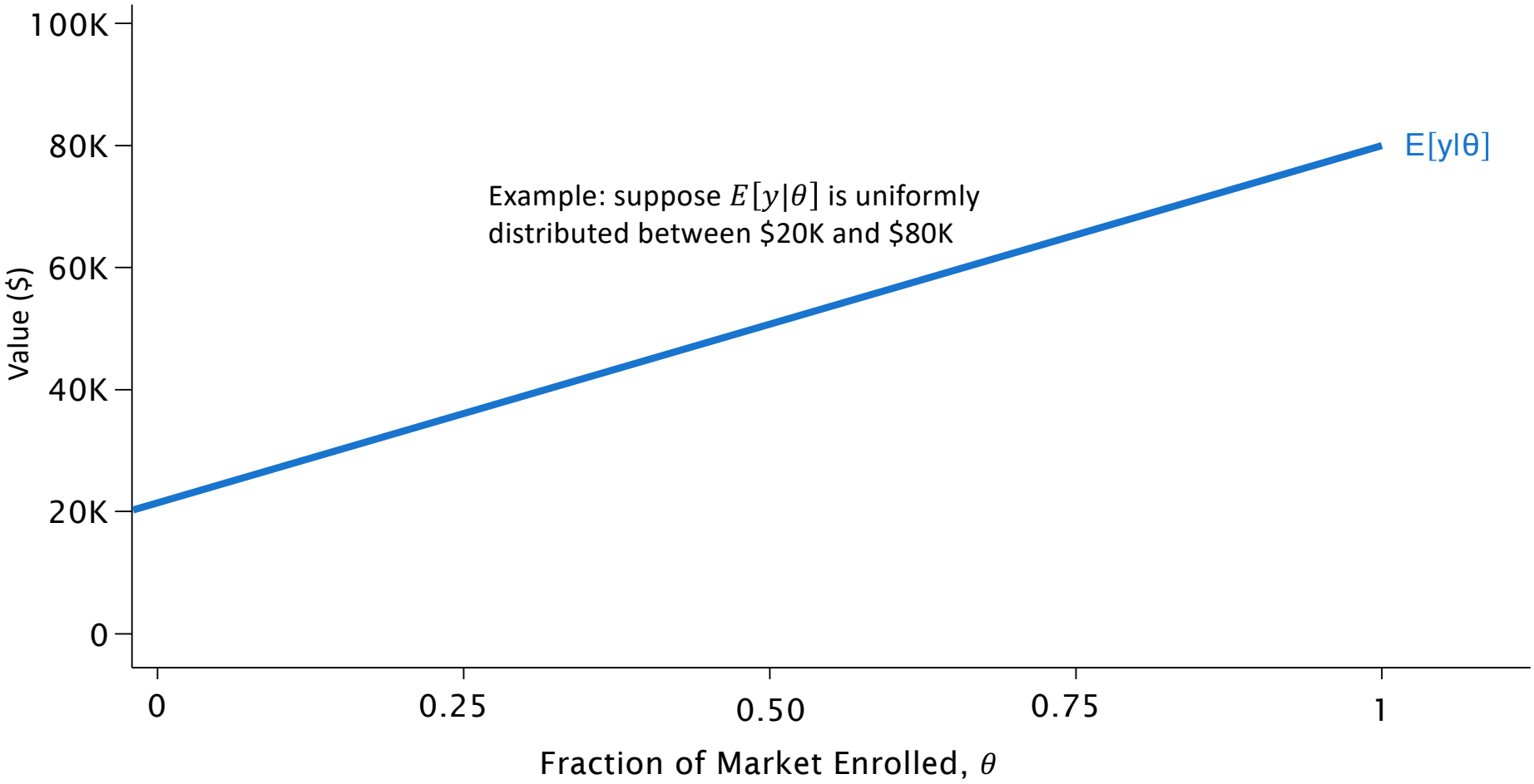
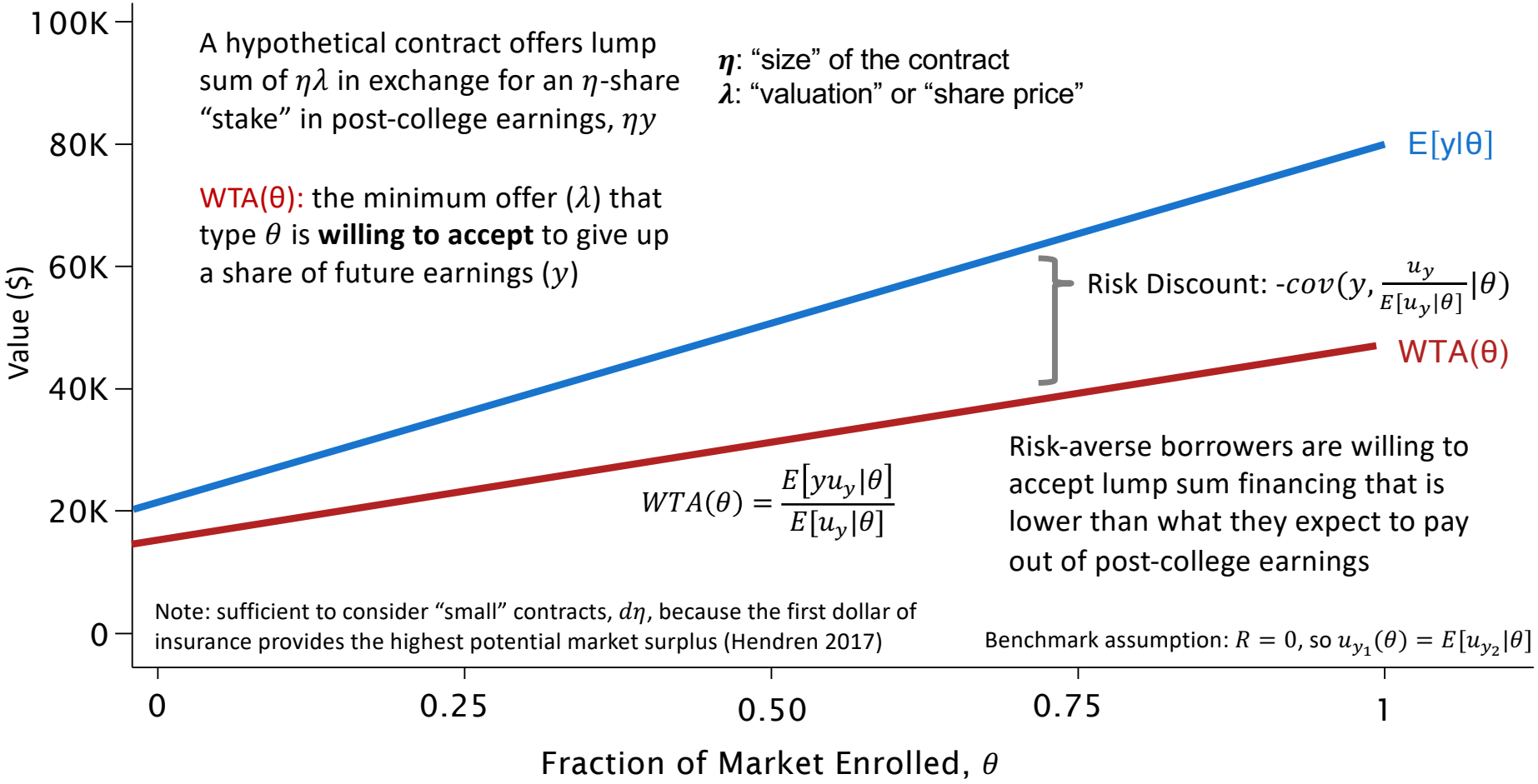
Model of Market Unraveling



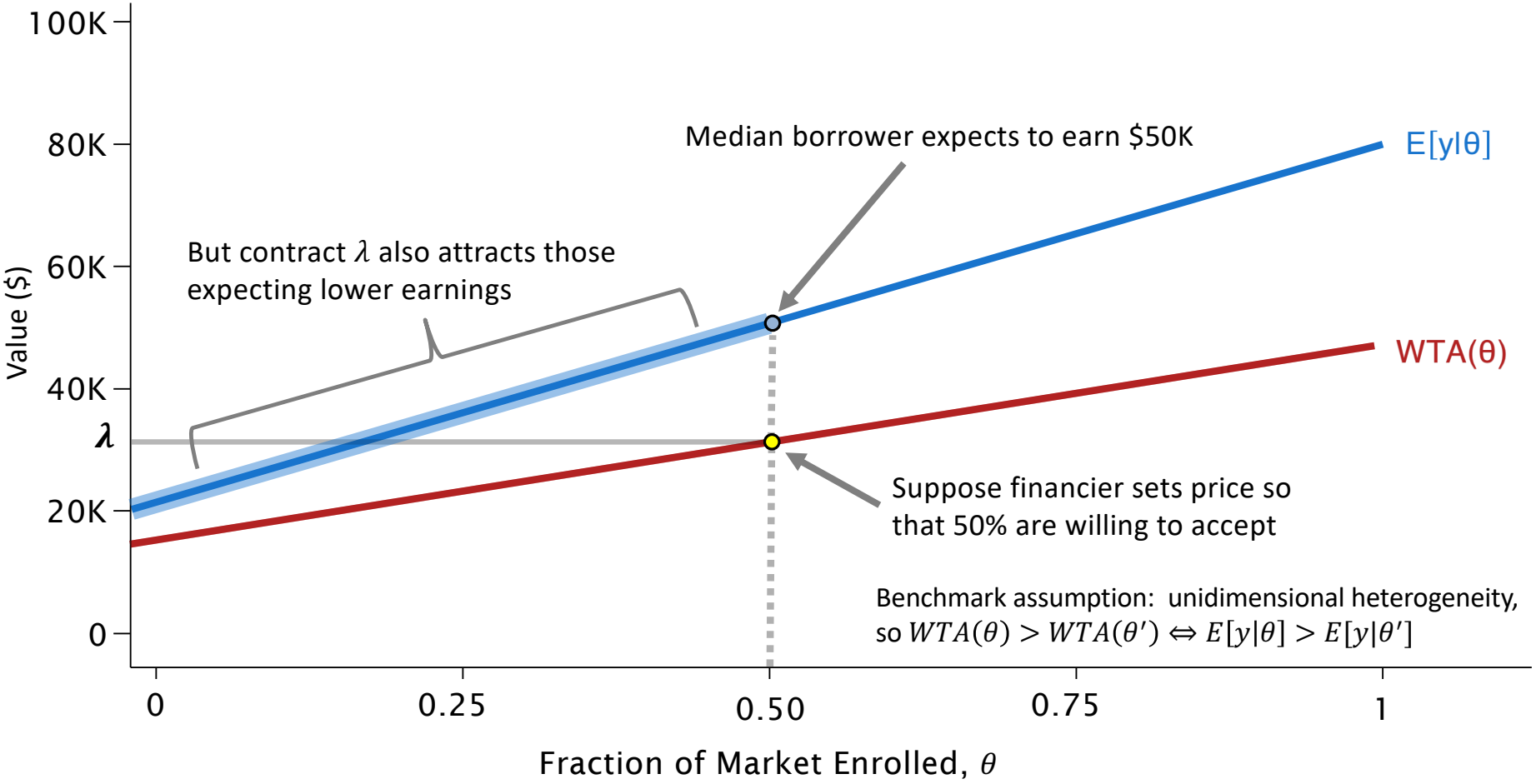
Privately Expected Earnings: $E[y|\theta]$



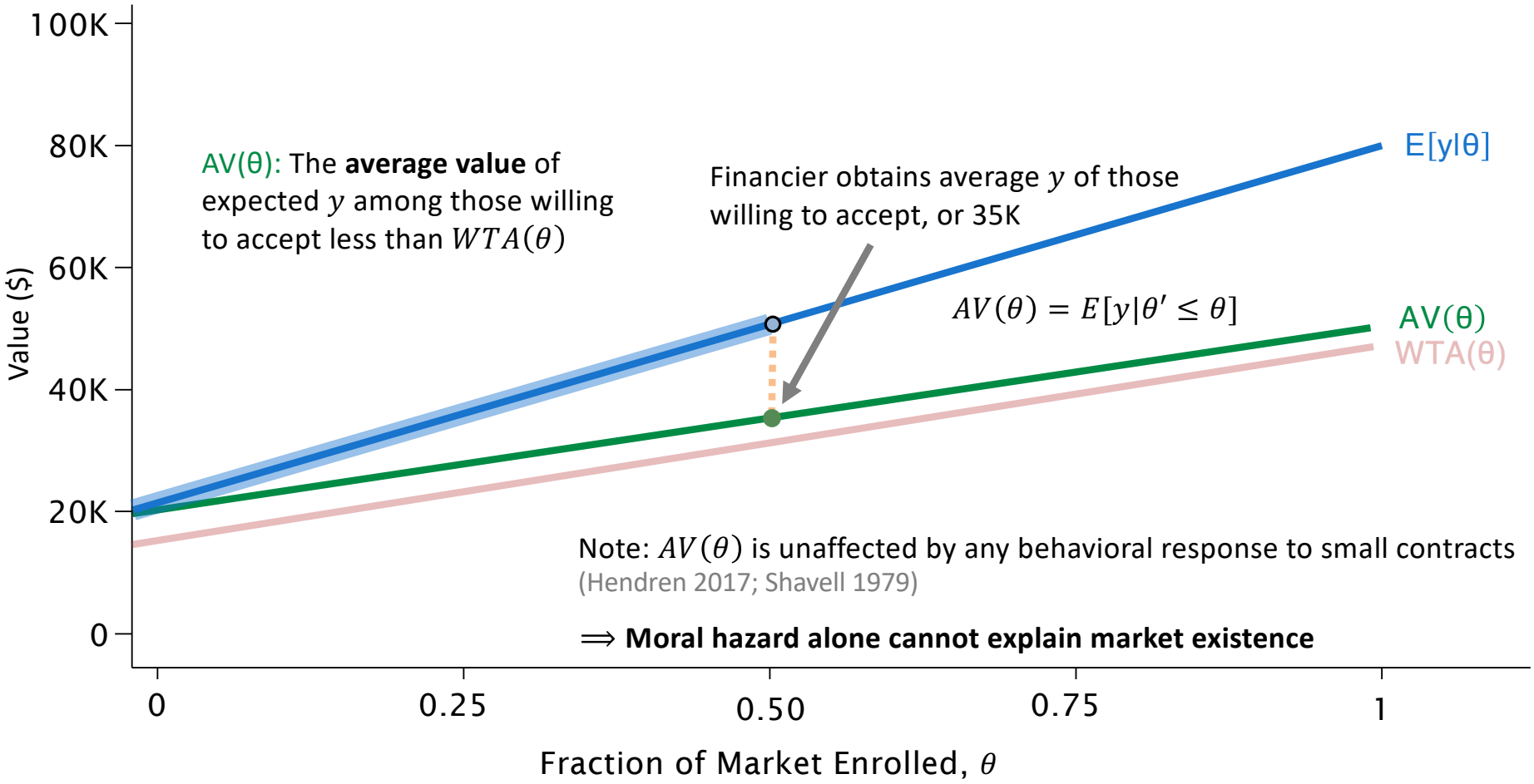
Willingness to Accept: $WTA(\theta)$



Can Financiers Make Profits?



Average Value Curve, $AV(\theta)$



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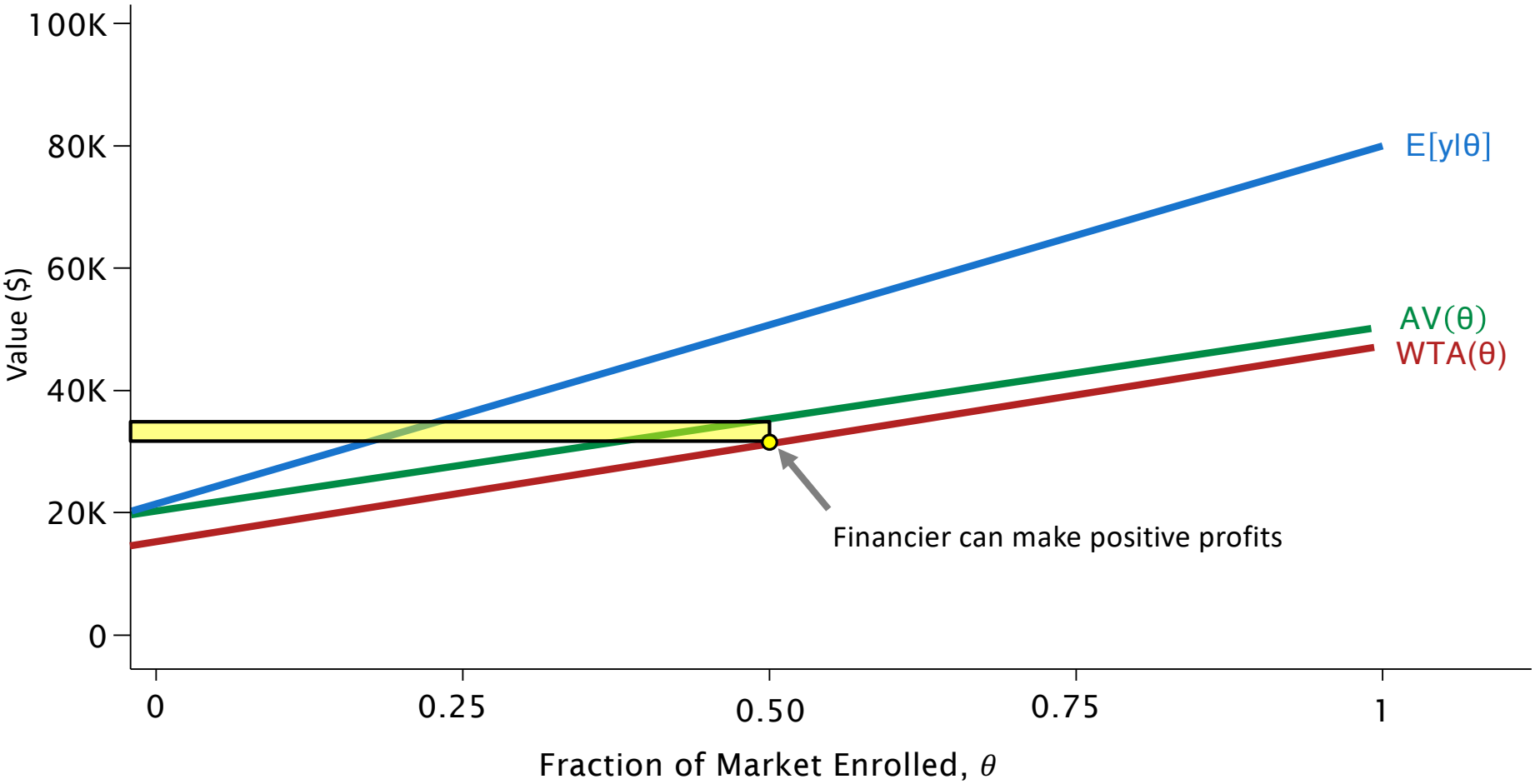
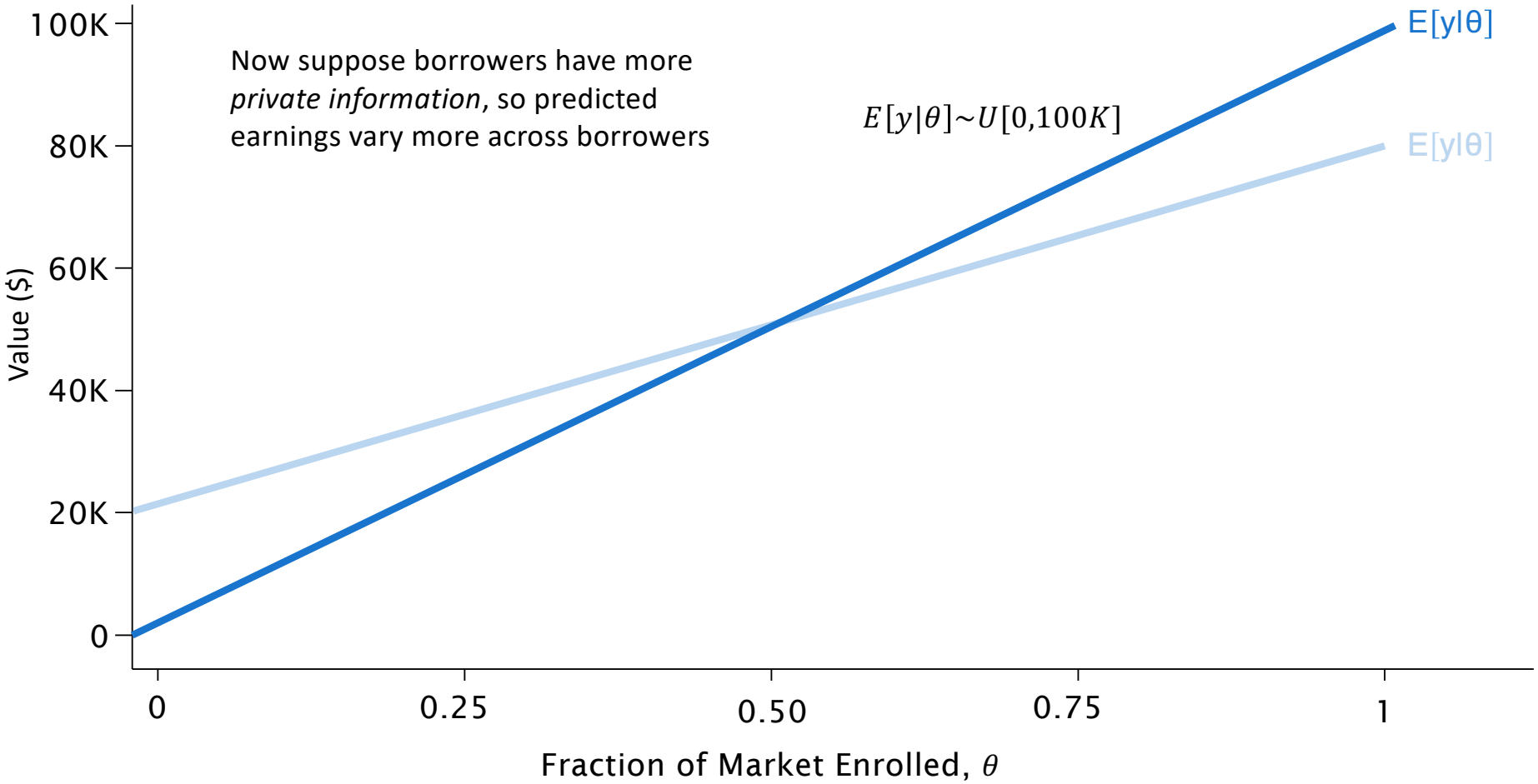


Can Financiers Make Profits? Scenario #2



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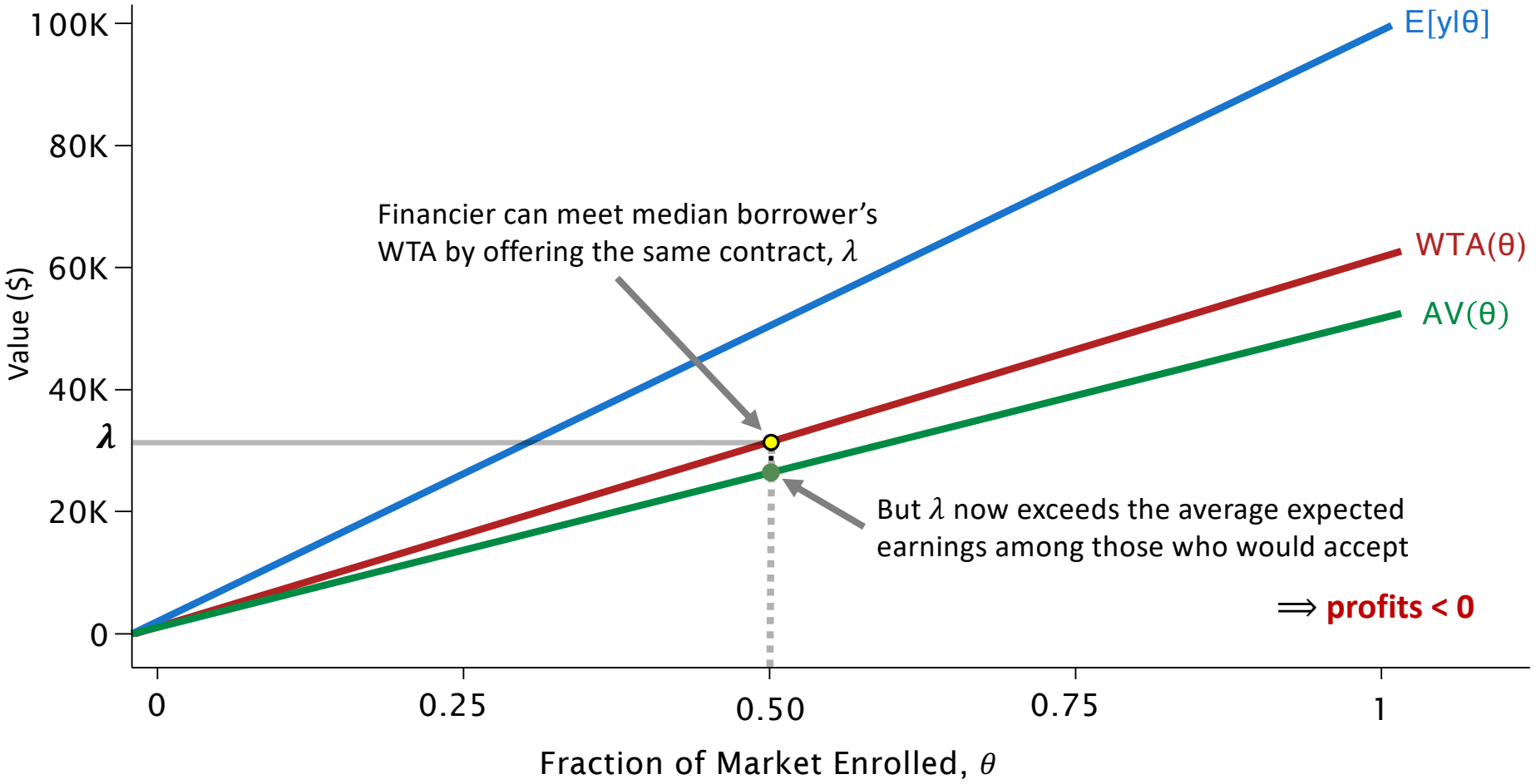

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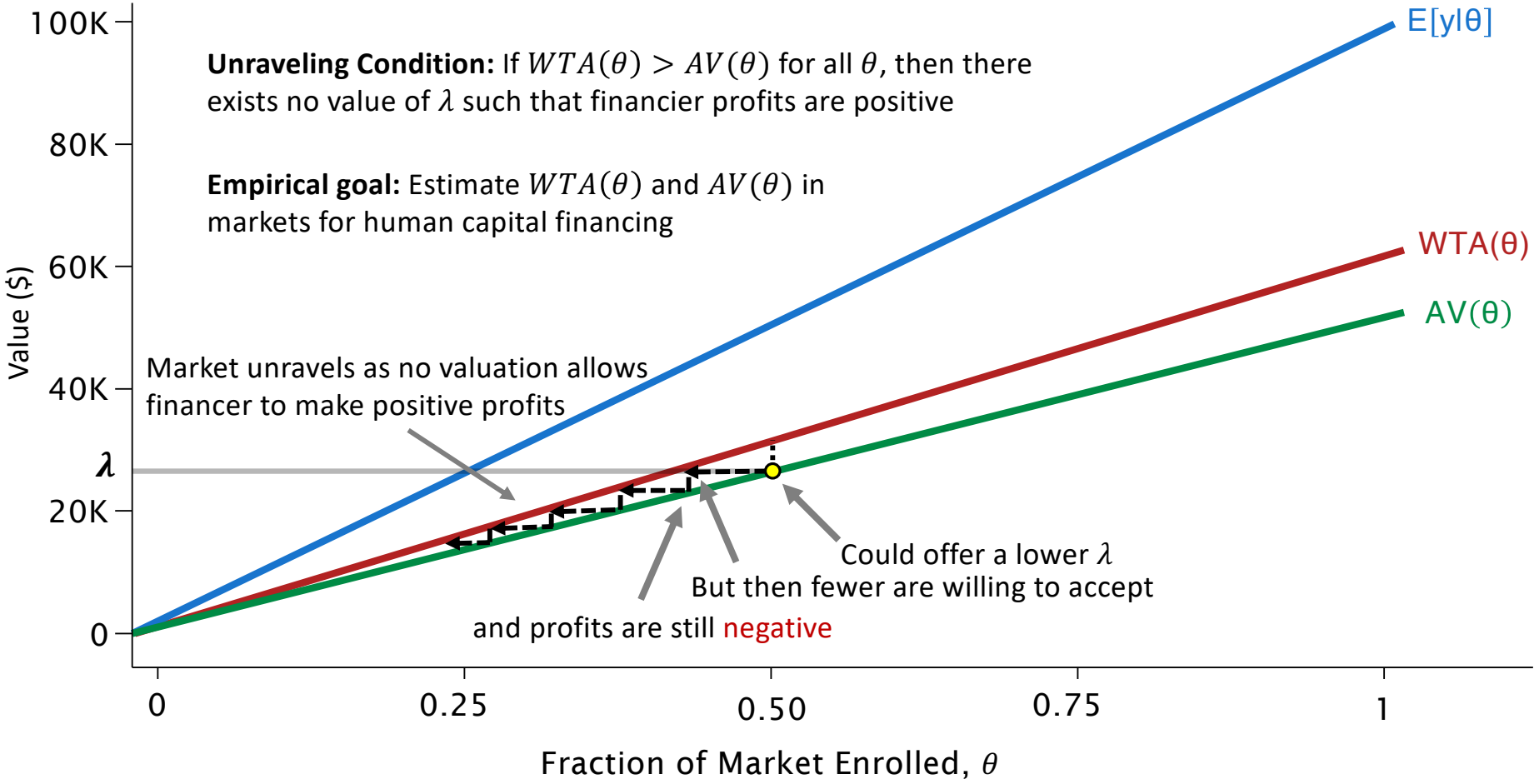

Which Markets Unravel?

Empirical goal: Estimate $WTA(\theta)$ and $AV(\theta)$ in markets for human capital financing

We consider four hypothetical markets:

1. *Earnings-Equity Contract*: y = earnings
2. *Completion-Contingent Loan*: y = complete degree
3. *Employment-Contingent Loan*: y = employed
4. *Dischargeable Loan*: y = no delinquency

(continuous y)

(binary y)

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Data: Beginning Postsecondary Students Survey (BPS)

- 2012/2017 Beginning Postsecondary Students (BPS)
  - First-year college students in Spring 2012
  - Follow up in 2017

- Links data across several sources
  1. FAFSA records (parental income, sex, age, etc.)
  2. Administrative loan data (National Student Loan Database System)
  3. Administrative academic information (major, GPA, SAT scores)
  4. Survey data (beliefs, employment outcomes, salary)

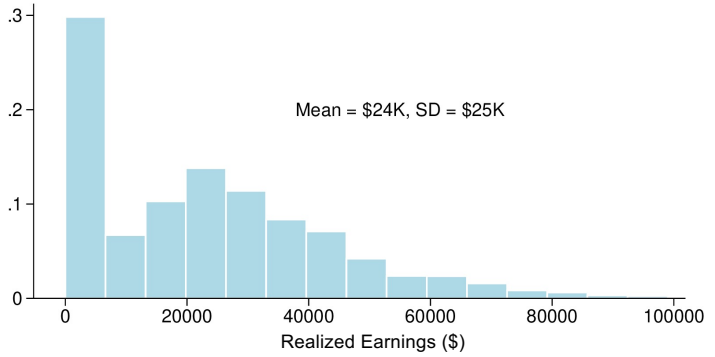
Empirical Approach Relies on Three Types of Variables

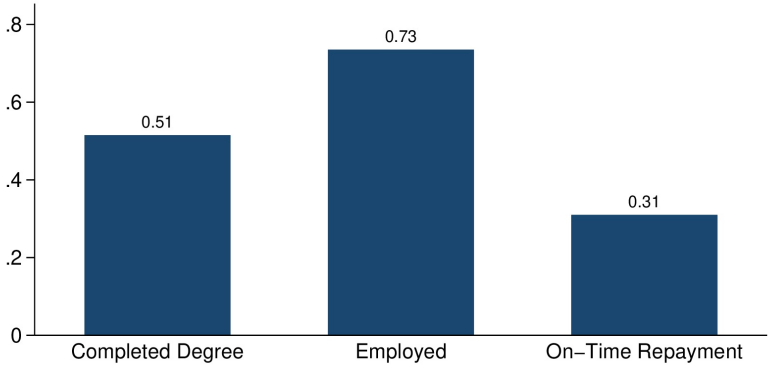
- Y: Outcomes corresponding to each of the four hypothetical markets we consider
- Z: Subjective elicitations of future outcomes
- X: Observable information about borrowers that financiers could use to price contracts

Summary Statistics

Empirical Approach Relies on Three Types of Variables

- Y: Outcomes corresponding to each of the four hypothetical markets we consider
  - *Earnings-Equity Contract* (continuous y):
    - $y =$ Annual salary from last job held in January and June 2017
  - Three state-contingent debt contracts (binary y):
    - *Completion-Contingent Loan*: $y =$ completed degree by June 2017 (6 years post-enrollment)
    - *Employment-Contingent Loan*: $y =$ held at least one job between January and June 2017
    - *Dischargeable Loan*: $y =$ no delinquencies or defaults on student loans as of June 2017





Summary Statistics

Empirical Approach Relies on Three Types of Variables

- Y: Outcomes corresponding to each of the four hypothetical markets we consider

- Z: Subjective elicitations of future outcomes
  - On-time Degree Completion: *"On a scale from 0-10, how likely is it you will finish your degree by [expected date]"*
  - Occupation: *"What do you think the job title and duties of the occupation you intend to hold will be after having completed your education?"*
  - Employment in Occupation: "*On a scale from 0-10, how likely do you think it is that you will hold a(n) [EXPECTED OCC] job?"*
  - Salary: "*Once you begin working [in EXPECTED OCC], what is your expected yearly salary?"*
  - Expected Salary without College: *How much do you think you would have earned from working if you had not attended college at all in the 2011- 2012 school year?*
  - Parental Support: "*On a scale of 1-5, how much do agree with the following statement: "My parents encourage me to stay in college"*
  - Parental Financial Support: *"Through the end of the 2011-2012 school year (July 1, 2011-June 30, 2012), will your parents (or guardians) have helped you pay for any of your education and living expenses while you are enrolled in school?...How much?"*

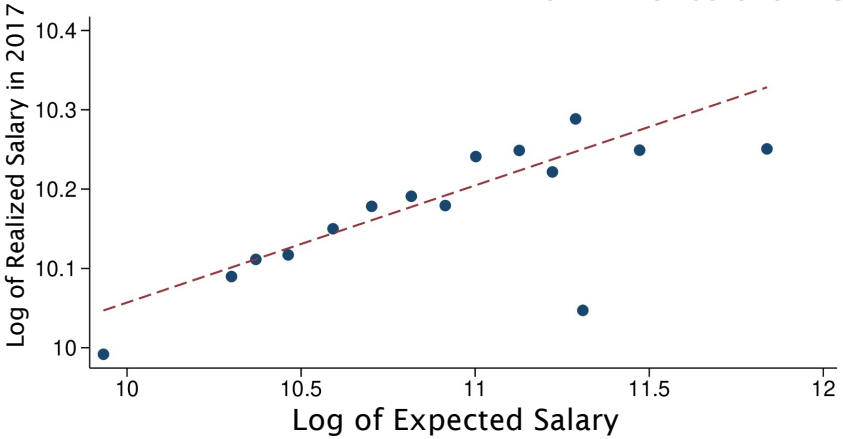
Summary Statistics

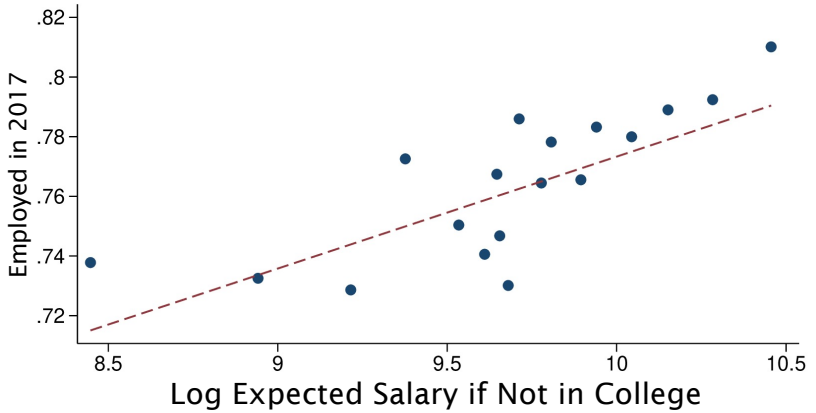
Empirical Approach Relies on Three Types of Variables

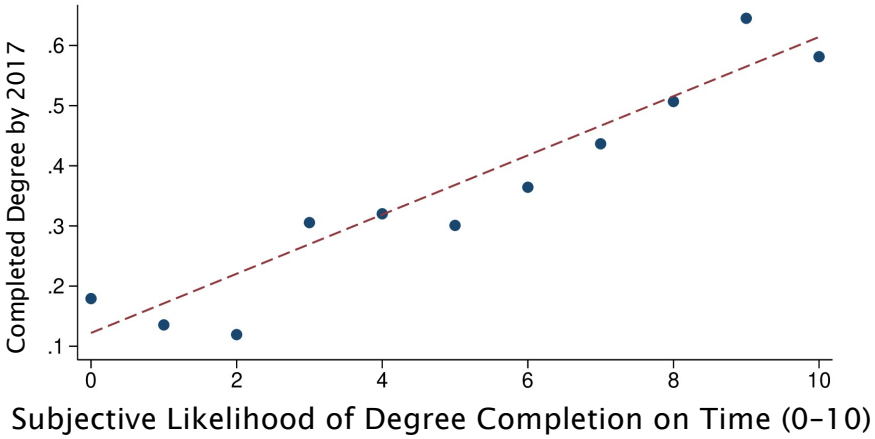
- Y: Outcomes corresponding to each of the four hypothetical markets we consider
- Z: Subjective elicitations of future outcomes
- X: Observable information about borrowers that financiers could use to price contracts
  - **Institutional Characteristics:** enrollment size, admit rate, tuition charged, degree offerings, region, urban/rural, avg. demographics and test scores
  - **Academic Program Characteristics:** degree type (BA, AA), field of study, years since HS
  - **High School Performance Measures:** HS GPA, SAT/ACT (verbal, math, combined)
  - **Demographics:** age, citizenship status, marital status, no. of children, prior state of residence
  - **Parental Characteristics:** marital status, no. of children, annual income, EFC
  - **Protected Classes:** race, gender *(illegal to use in pricing, but we can evaluate its impact)*

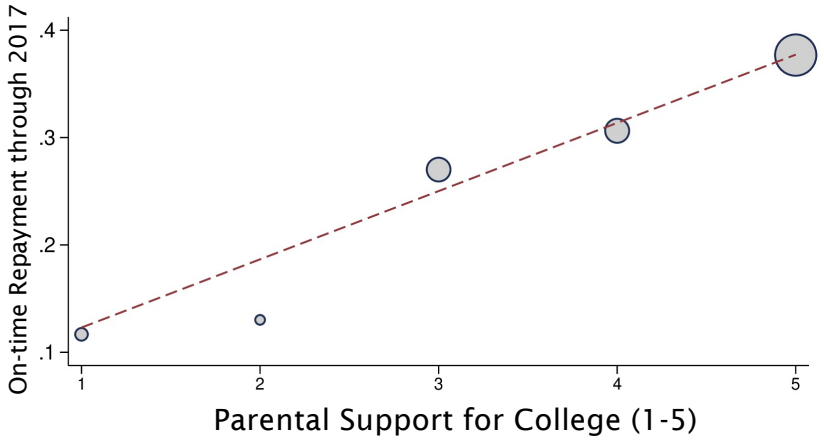
Summary Statistics

Do Elicitations Predict Outcomes?









How about conditional on observables, X, that financiers might use to price the contracts?

Predictive Information in Z Conditional on X: Salary

	(1)	(2)	(3)	(4)	(5)	(6)
	Log Salary	Log Salary	Log Salary	Log Salary	Log Salary	Log Salary
Log Expected Salary	0.113***	0.0602***	0.0446***	0.0432***	0.0327**	0.0314**
	(0.0159)	(0.0159)	(0.0161)	(0.0160)	(0.0158)	(0.0158)
Institution		X	X	X	X	X
Academic			X	X	X	X
Performance				X	X	X
Demographics					X	X
Parental						X
Partial R-Squared	0.009	0.003	0.002	0.001	0.001	0.001
R-squared	0.009	0.067	0.101	0.104	0.119	0.123
N	12580	12580	12580	12580	12580	12580

Predictive Information in Z Conditional on X: Degree Completion

	(1) Degree Completion	(2) Degree Completion	(3) Degree Completion	(4) Degree Completion	(5) Degree Completion	(6) Degree Completion
On-Time Completion Likelihood	0.0492***	0.0365***	0.0364***	0.0345***	0.0343***	0.0332***
	(0.00223)	(0.00223)	(0.00224)	(0.00225)	(0.00221)	(0.00220)
Institution		X	X	X	X	X
Academic			X	X	X	X
Performance				X	X	X
Demographics					X	X
Parental						X
Partial R-Squared	0.045	0.029	0.028	0.028	0.028	0.026
R-squared	0.045	0.215	0.222	0.239	0.249	0.264
N	22340	22340	22340	22340	22340	22340

Predictive Information in Z Conditional on X: Employment

	(1)	(2)	(3)	(4)	(5)	(6)
	Employed	Employed	Employed	Employed	Employed	Employed
Log Expected Salary if No College	0.0313***	0.0243**	0.0212**	0.0199*	0.0175	0.0169
	(0.0107)	(0.0109)	(0.0108)	(0.0107)	(0.0106)	(0.0106)
Institution		X	X	X	X	X
Academic			X	X	X	X
Performance				X	X	X
Demographics					X	X
Parental						X
Partial R-Squared	0.012	0.008	0.007	0.007	0.006	0.006
R-squared	0.012	0.026	0.035	0.038	0.042	0.046
N	17480	17480	17480	17480	17480	17480

Predictive Information in Z Conditional on X: On-Time Repayment

	(1) On-Time Repayment	(2) On-Time Repayment	(3) On-Time Repayment	(4) On-Time Repayment	(5) On-Time Repayment	(6) On-Time Repayment
Supportive Parents	0.0635***	0.0349***	0.0336***	0.0305***	0.0301***	0.0285***
	(0.00505)	(0.00502)	(0.00497)	(0.00491)	(0.00488)	(0.00483)
Institution		X	X	X	X	X
Academic			X	X	X	X
Performance				X	X	X
Demographics					X	X
Parental						X
Partial R-Squared	0.030	0.014	0.014	0.015	0.015	0.014
R-squared	0.030	0.114	0.123	0.136	0.144	0.155
N	15520	15520	15520	15520	15520	15520

Open Questions: Quantifying Private Information

- Individuals have private knowledge about future outcomes
- But is this “enough” private information to cause the market to unravel?
- Need to estimate willingness to accept (WTA) and Average Value (AV) curves

Out-of-Sample Predictions

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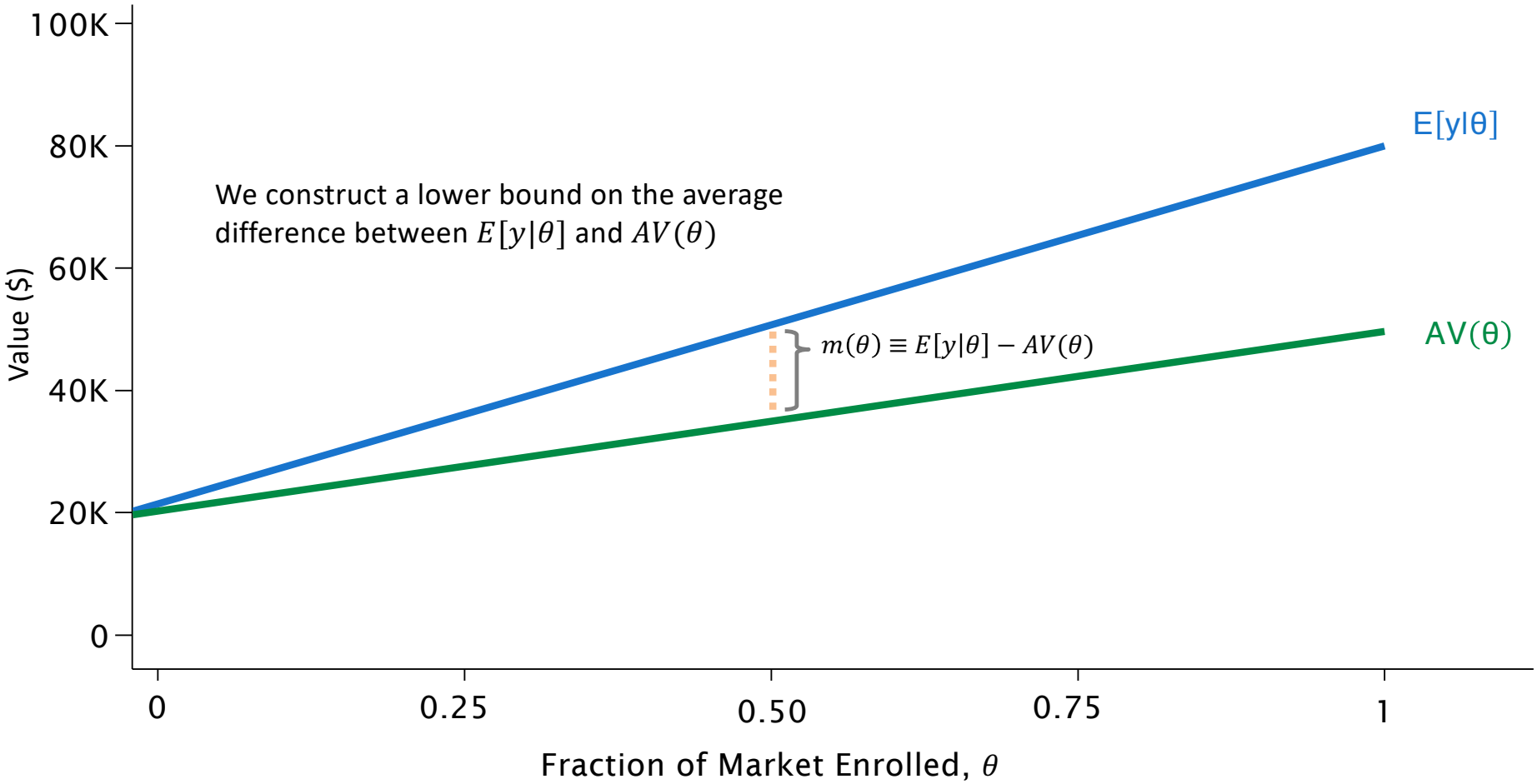
Lower Bound on Magnitude of Private Information



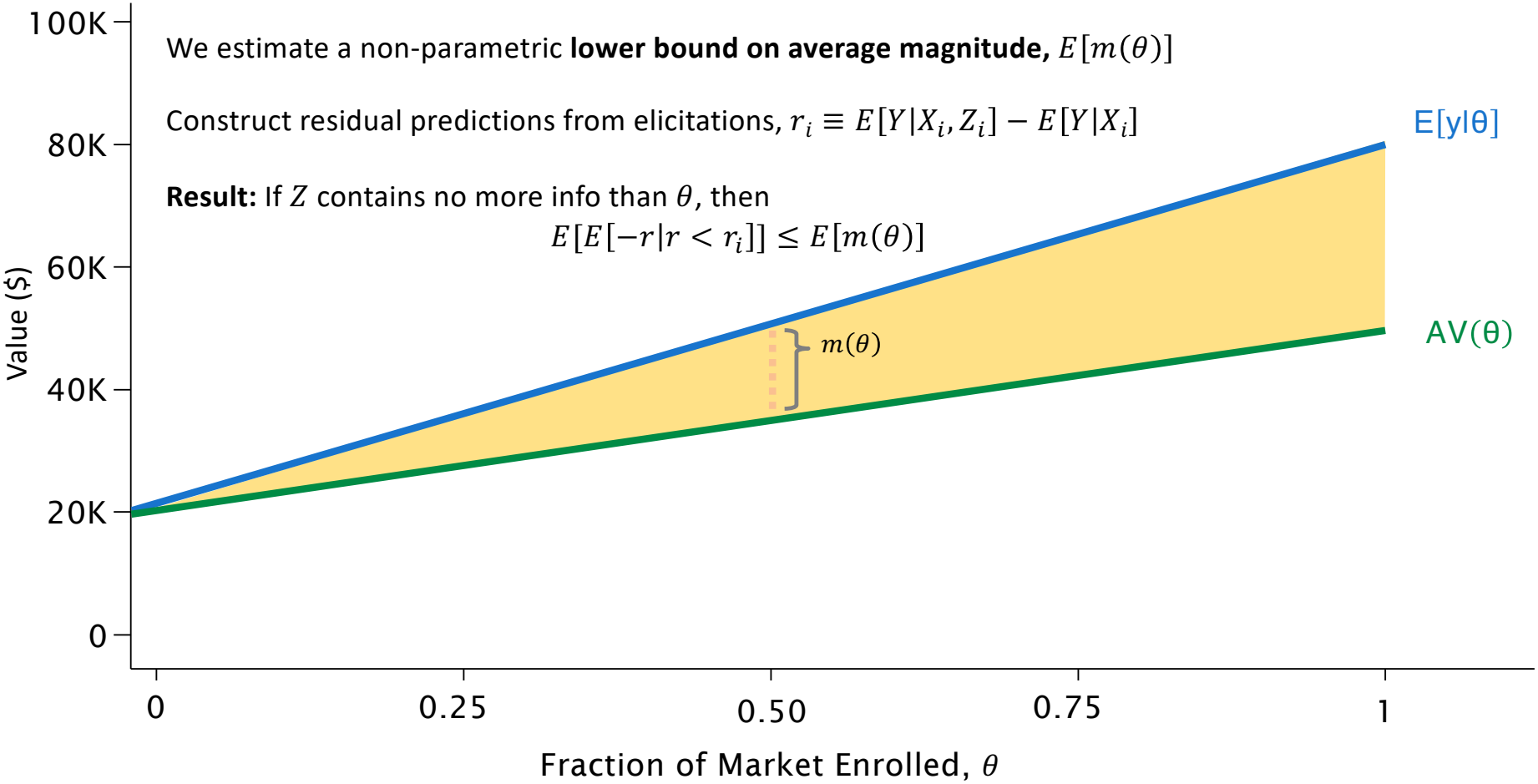
Lower Bound on Magnitude of Private Information

We estimate a non-parametric **lower bound on average magnitude,** $E[m(\theta)]$

Construct residual predictions from elicitations, $r_i \equiv E[Y|X_i, Z_i] - E[Y|X_i]$

Result: If Z contains no more info than θ, then

$$E[E[-r|r < r_i]] \leq E[m(\theta)]$$



Lower-Bound on Magnitude of Private Information

	Category				
	(1) *No Public Info*	(2) *Institution + Academic*	(3) *Institution + Academic + Performance + Demographics*	(4) *Institution + Academic + Performance + Demographics + Parental*	(5) *Institution + Academic + Performance + Demographics + Parental + Protected*
Earnings Equity	5765	5314	3797	2907	2381
Completion-Contingent Loan	0.20	0.16	0.13	0.11	0.11
Employment-Contingent Loan	0.09	0.11	0.07	0.05	0.04
Dischargeable Loan	0.13	0.13	0.07	0.05	0.04

- $E[m(\theta)] > \$5{,}314$, or 20% discount relative to average incomes of \$24K
  - $\approx$ \$0.27 loss for \$1 earnings-equity
- Large discounts for other markets as well:
  - $\approx$ \$0.47 loss for \$1 completion-contingent loan
  - $\approx$ \$0.18 loss for \$1 employment-contingent loan
  - $\approx$ \$0.72 loss for \$1 dischargeable loan

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Estimating $AV(\theta)$ and $WTA(\theta)$ Curves

1. Identify relationship between beliefs, $\mu_\theta \equiv E[y|\theta]$, and elicitations, Z
2. Estimate distribution of μ_θ, conditional on observables, X
3. Calculate $AV(\theta) \equiv E[y|\mu_{\theta'} \leq \mu_\theta]$

- General strategy: infer beliefs from joint distribution of elicitations (Z) and outcomes (Y), conditional on observables (X)
- Builds on approach in Hendren (2013, 2017), with two key advances:
  - Allow for outcome y to be continuous (e.g., earnings-equity contract)
  - Allow elicitations to not correspond directly to beliefs

Estimating $AV(\theta)$ and $WTA(\theta)$ Curves

1. Identify relationship between beliefs, $\mu_\theta \equiv E[y|\theta]$, and elicitations, Z

Realized outcome, y:

$$y = \mu_\theta + \epsilon$$

Belief

Elicitation, z:

$$z = \alpha + \gamma\mu_\theta + v$$

estimated using IV and second elicitation

Details

Estimating $AV(\theta)$ and $WTA(\theta)$ Curves

1. Identify relationship between beliefs, $\mu_\theta \equiv E[y|\theta]$, and elicitations, Z

2. Estimate distribution of μ_θ, conditional on observables, X
   - Continuous y: Non-parametric $\hat{G}(\mu_\theta)$ using a linear deconvolution (Bonhomme & Robin 2010)
   - Binary y: Semi-parametric $\hat{G}(\mu_\theta)$ using MLE, where $G(\mu_\theta) = \sum_j \xi_j \mathbf{1}\{\mu_\theta \leq a_j\}$

(Note: In both cases, we allow for conditioning on observables)

Estimating $AV(\theta)$ and $WTA(\theta)$ Curves

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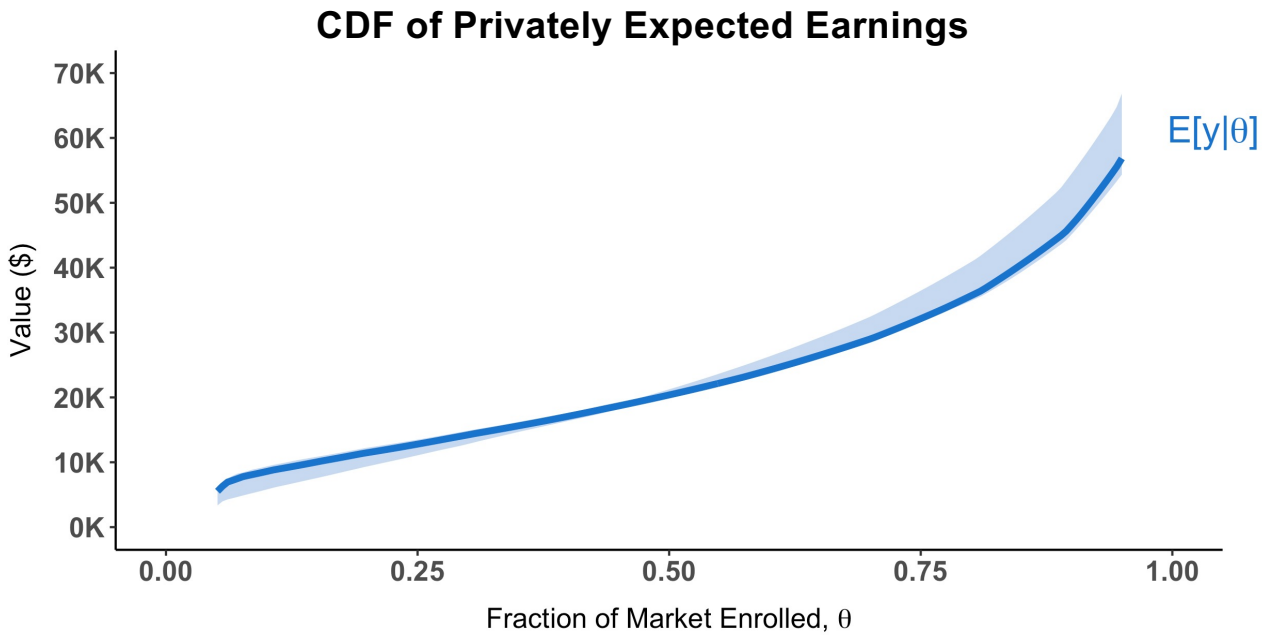

Estimating $AV(\theta)$ and $WTA(\theta)$ Curves

1. Identify relationship between beliefs, $\mu_\theta \equiv E[y|\theta]$, and elicitations, Z
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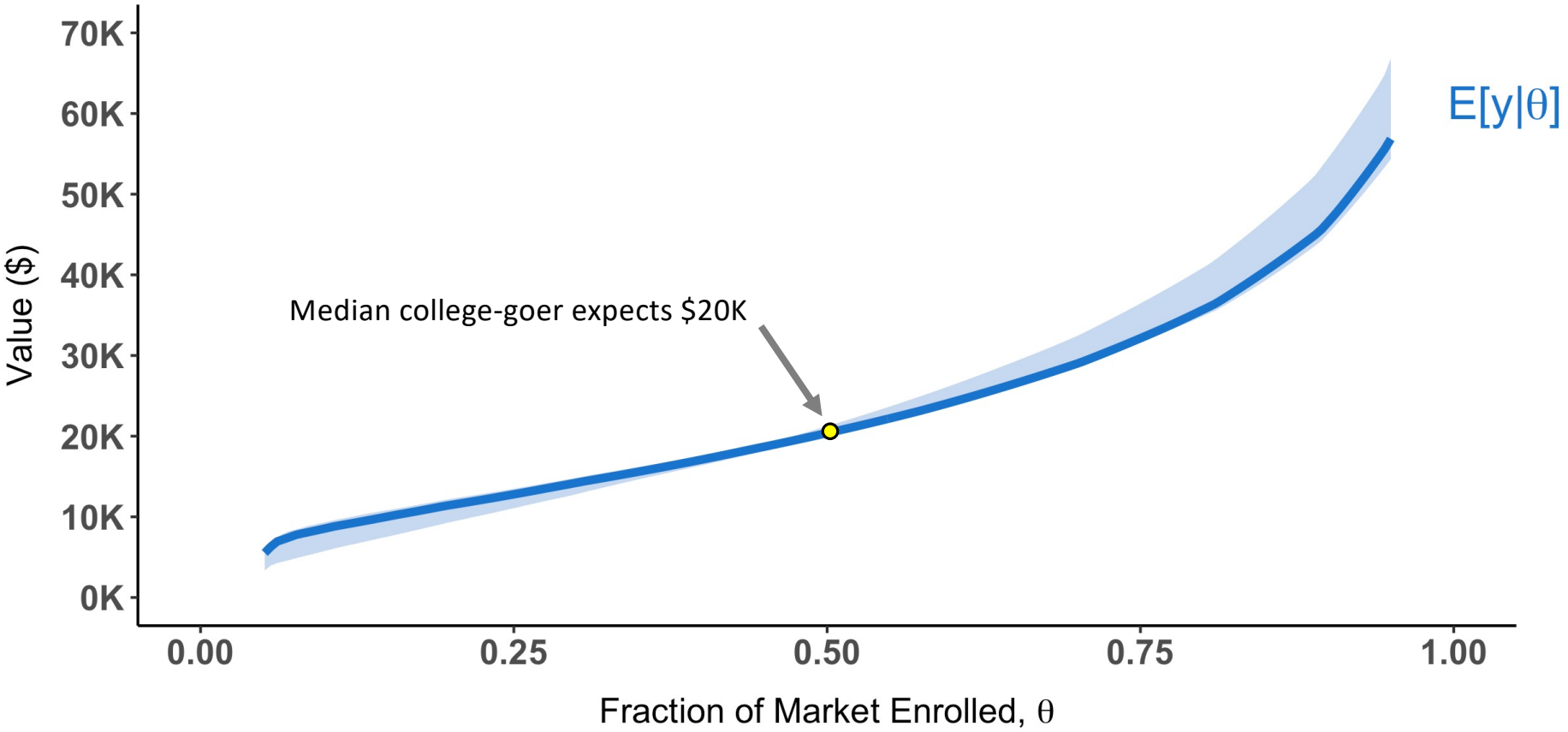
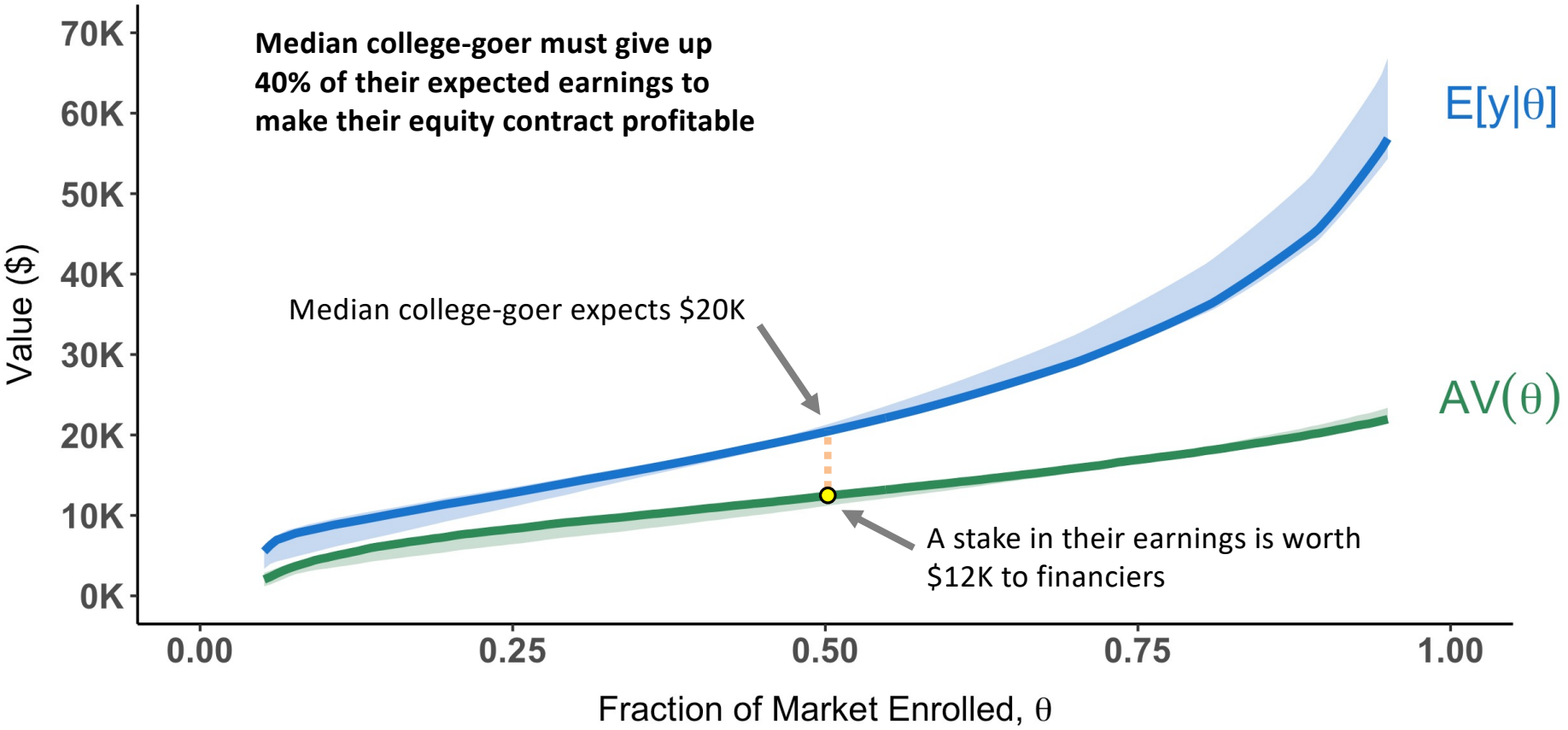
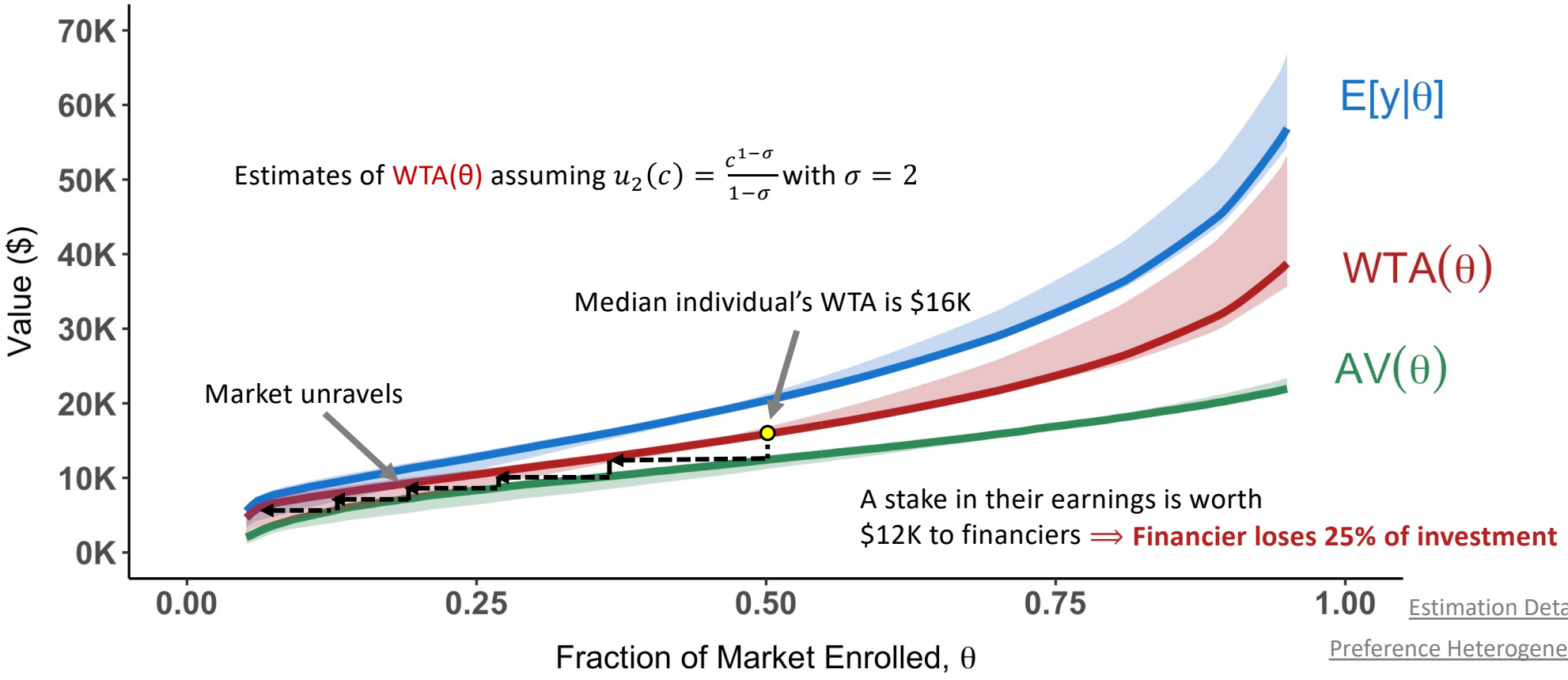
Unraveling of the Earnings-Equity Market



Unraveling of the Earnings-Equity Market

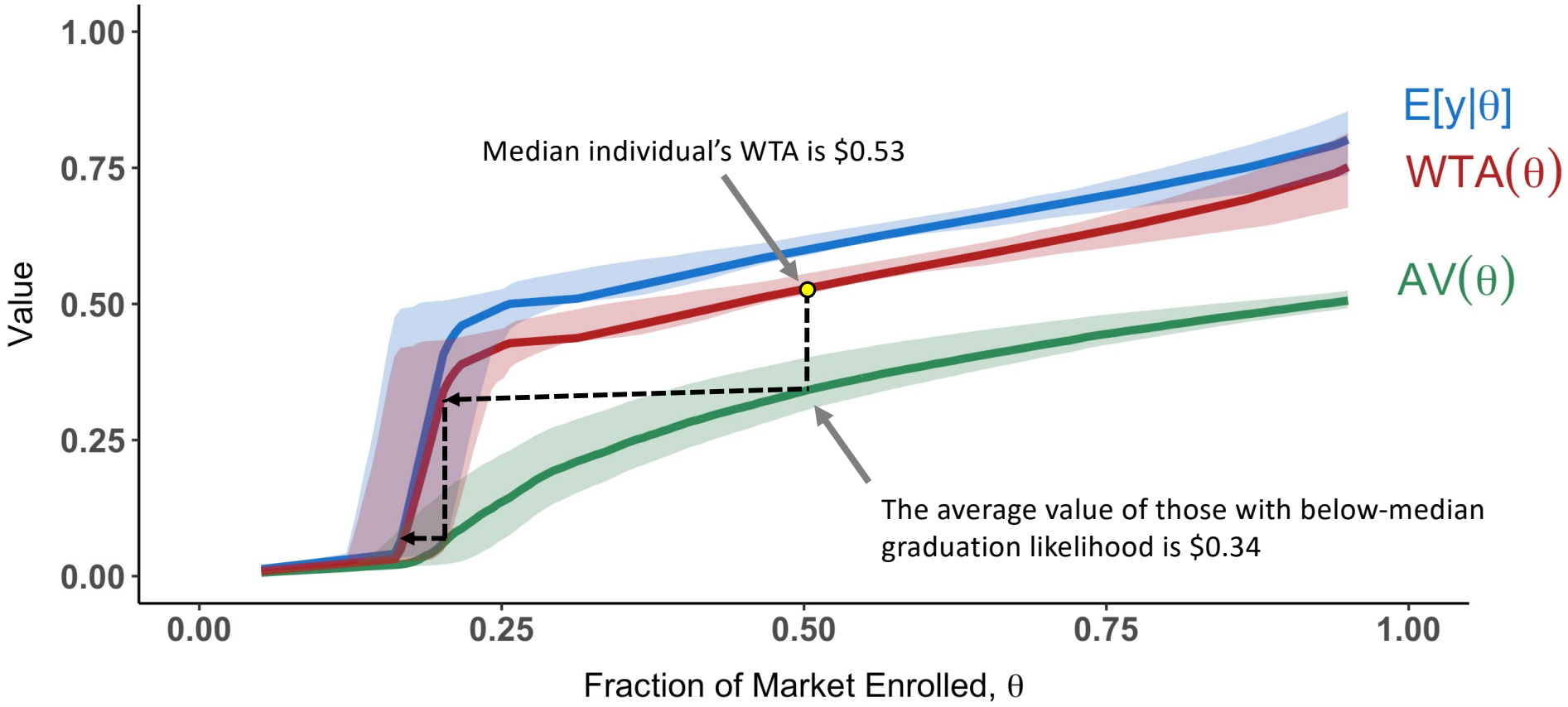


Unraveling of the Earnings-Equity Market

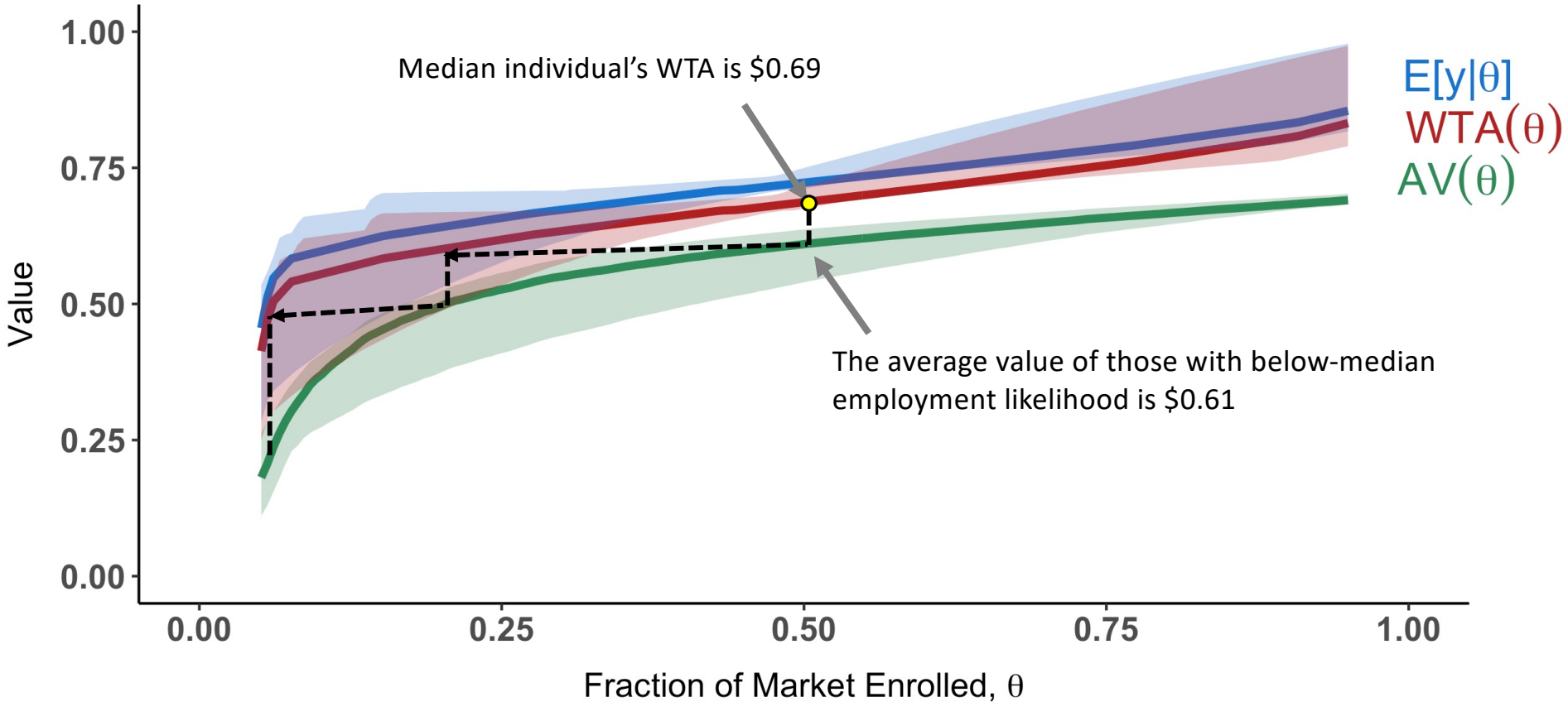


Estimation Details
Preference Heterogeneity
Alt. Interest Rates

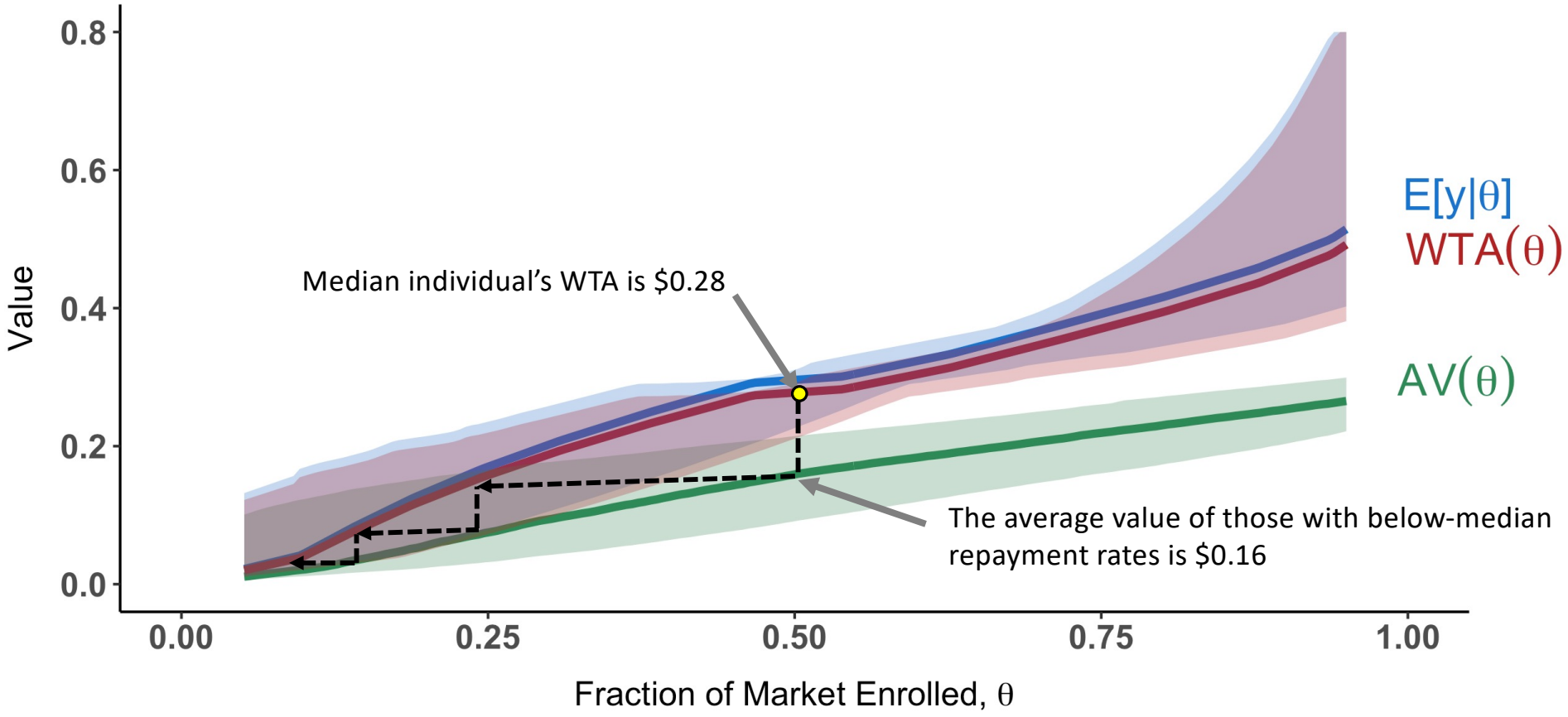
Unraveling of Completion-Contingent Loan Market



Unraveling of Employment-Contingent Loan Market



Unraveling of Dischargeable Debt Market



Outline

1. Model of Market Unraveling
2. Data and Reduced Form Evidence of Private Information
3. Lower-Bound on Magnitude of Private Information
4. Estimation of Average Value and Willingness to Accept Curves
5. Welfare Impacts of Government Subsidies

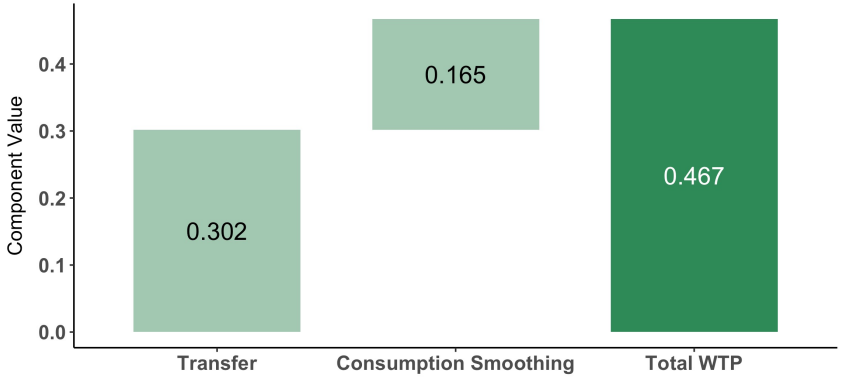
Measuring the Welfare Impact Using the MVPF

- **Marginal Value of Public Funds (MVPF)** on government subsidies for each contract:

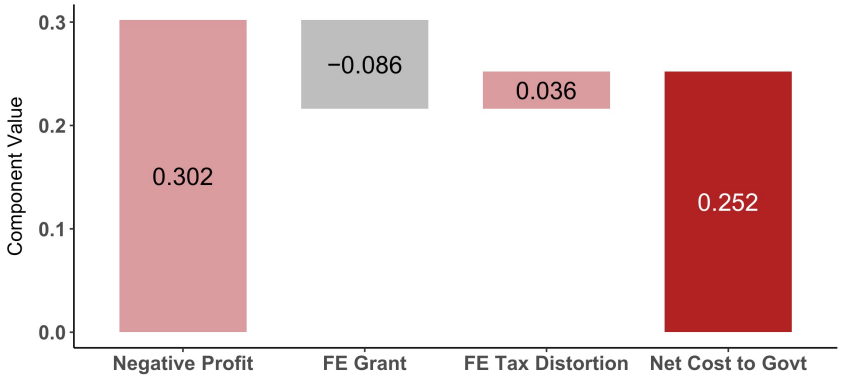
$$MVPF = \frac{Benefits}{Net\ Cost\ to\ Govt}$$

- $Benefits$: The aggregate amount borrowers would be willing to pay for the option to contract λ.
  - Net transfer from subsidy
  - Smoothing benefit from mitigating risk

- $Net\ Cost\ to\ Govt$: The aggregate amount spent, less program revenue or increased tax receipts
  - Net transfer from subsidy
  - Fiscal externalities from behavioral responses



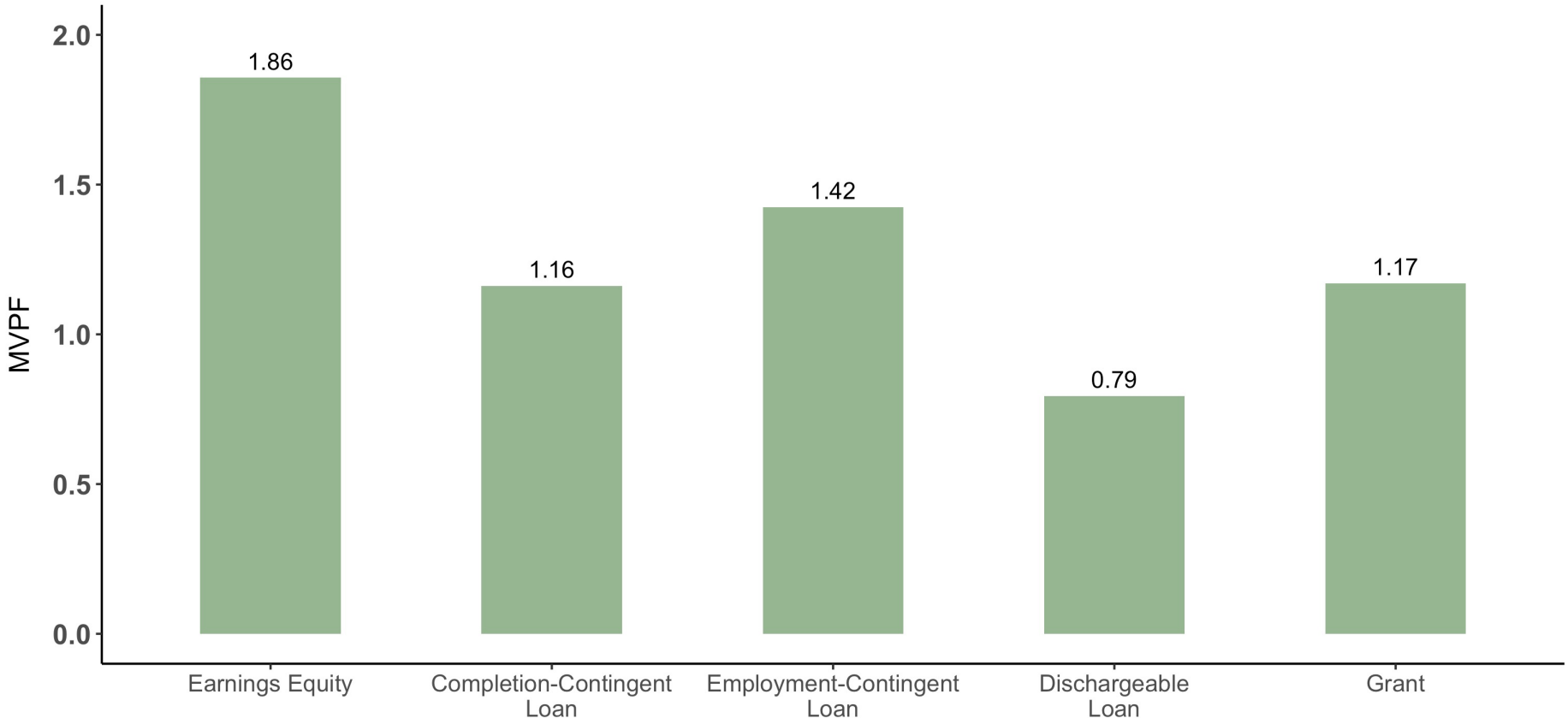
Benefits of Subsidizing $1 Equity Contract



Net Costs of Subsidizing $1 Equity Contract

MVPF Details

Measuring the Welfare Impact Using the MVPF



MVPF Details

Conclusion

- Evidence of unraveling in several markets for financial contracts that mitigate college-going risks
  1. *Earnings-Equity Contract*
  2. *Completion-Contingent Loan*
  3. *Employment-Contingent Loan*
  4. *Dischargeable Loan*
- Suggests a high value to government policies promoting student loan alternatives
- Unraveling results and empirical approach may extend to other settings:
  - Income insurance / compensation schemes
  - Small-business investments
  - Union formation / collective action settings
- More generally, results suggest market frictions inhibit economic opportunity