Empirical Methods in Corporate Finance
FNCE 9260

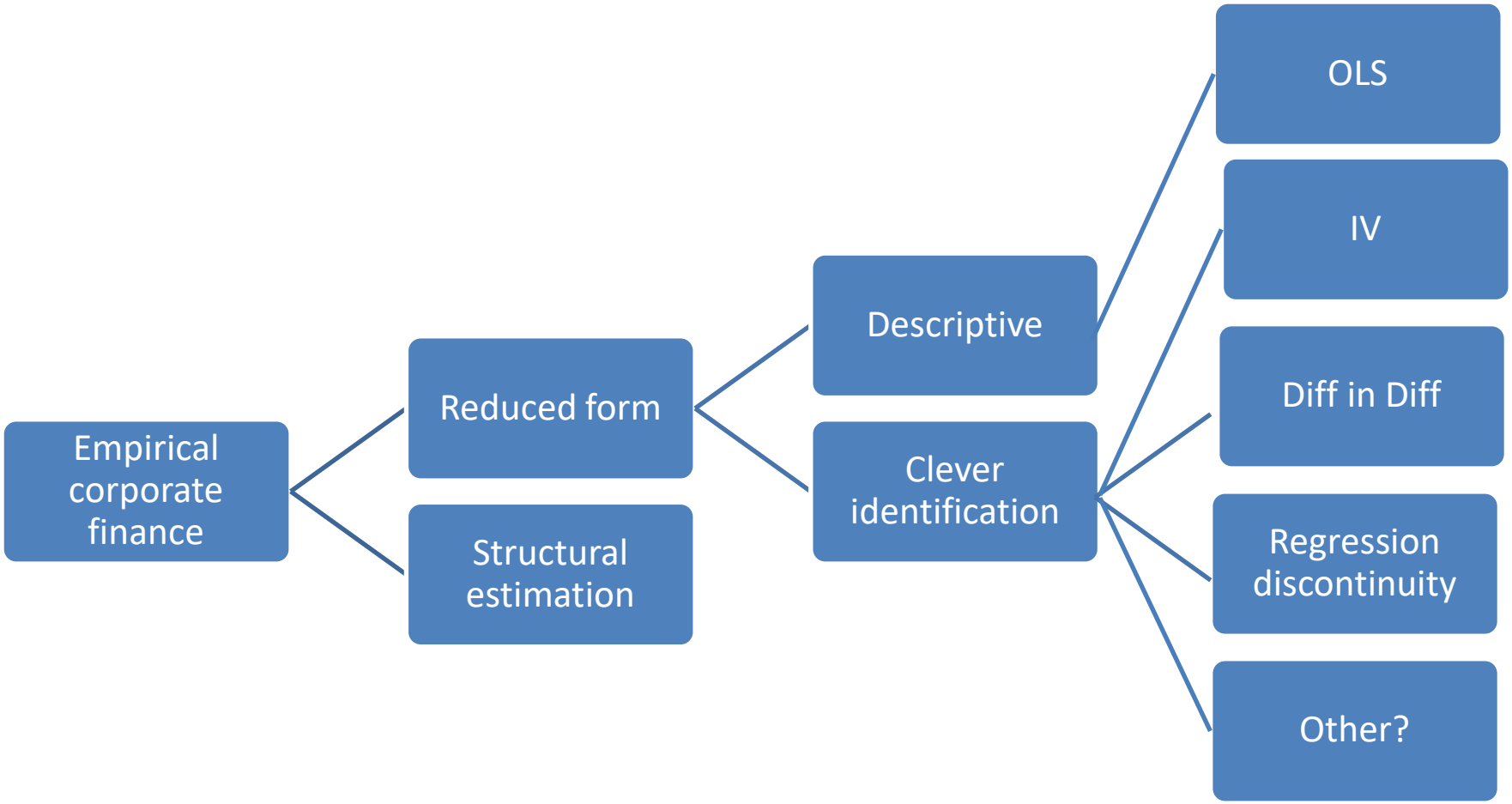
Luke Taylor

Lecture 9: Introduction to Structural Estimation

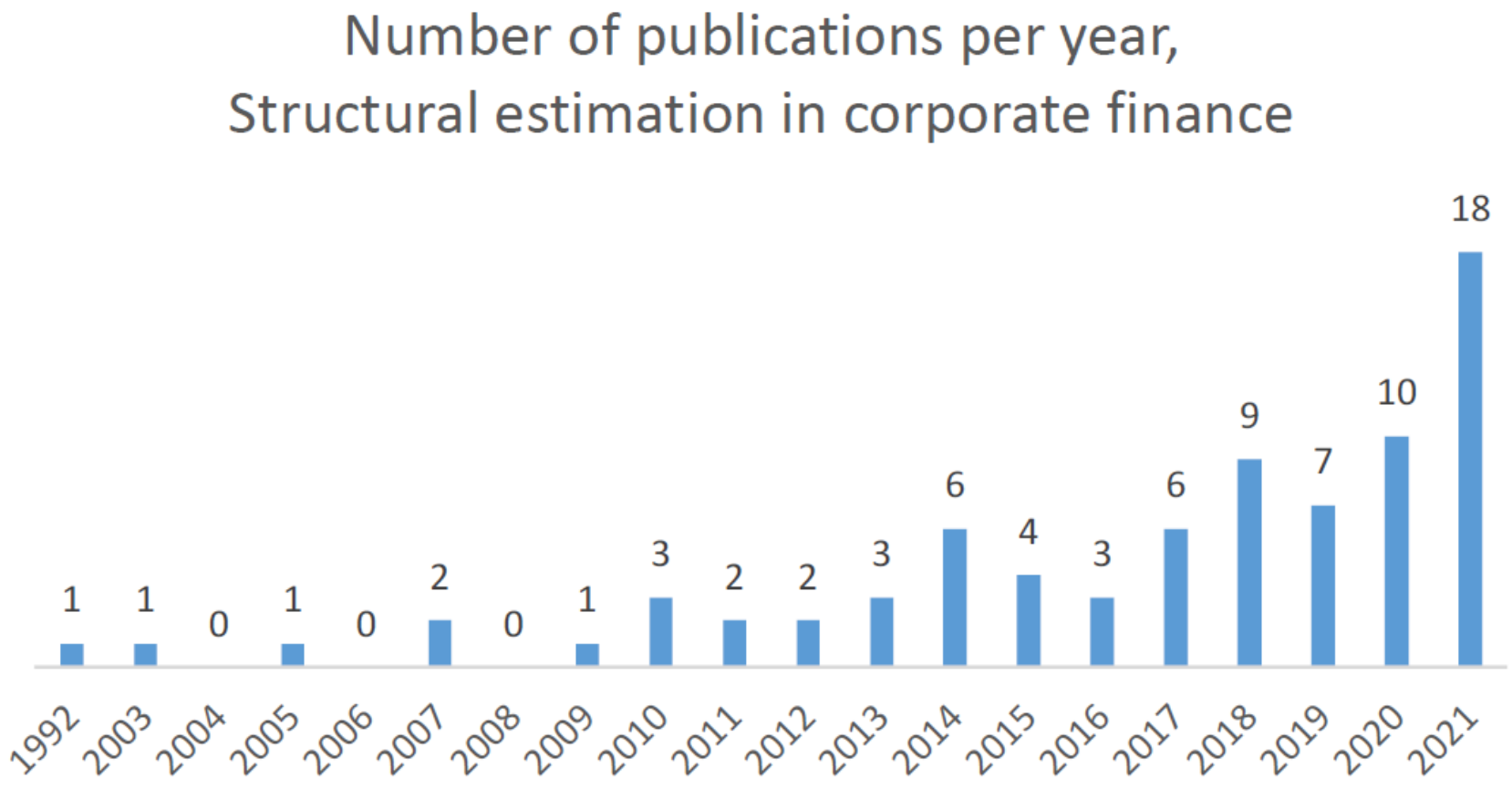
PLAN FOR REST OF THE SEMESTER

- Today (Mar. 21): Introduction to structural estimation
- Mar. 28: Simulation estimators (note change to syllabus)
- Apr. 4: Solving models using GPUs (note change to syllabus)
- Apr. 11: Inference
- Apr. 18: Structural estimation applications
- Apr. 25: TBD

THE BIG PICTURE



STRUCTURAL IS ON THE WAY UP



Many PhDs placing well with structural JMPs

Job market candidate	Year	Placement	Topic
Lulu Wang	2023	???	Credit-card market
Tong Liu	2022	MIT	Healthcare and PE
Mehran Ebrahimian	2021	Stockholm	Student loans
Sam Antill	2020	HBS	Corporate bankruptcy
Sophie Calder-Wang	2020	Wharton	Sharing economy
Erica Jiang	2020	USC	Shadow banks
Greg Buchak	2019	Stanford	Gig economy
Claudia Robles-Garcia	2019	Stanford	Mortgage market
Matteo Benneton	2018	Berkeley	Mortgage market
Sylvain Catherine	2018	Wharton	Entrepreneurship
Daniel Green	2018	HBS	Debt covenants
Yiming Ma	2018	Columbia	Interbank lending market
Scott Nelson	2018	U Chicago	Credit card market
Kairong Xiao	2017	Columbia	Shadow banks
Olivier Darmouni	2016	Columbia	Credit reallocation

PLAN FOR TODAY

- **What is structural estimation?**
  - Terminology
  - A short example
  - Structural vs. reduced-form estimation

- **Why do it?**
  - What structural estimation buys you
  - How to motivate a structural estimation paper
  - Advantages and disadvantages vs. reduced-form estimation
  - Is structural estimation good for your career?

- **How to referee a structural estimation paper**

- **Brief overview of the literature**

- **A long example:** “Dissecting Bankruptcy Frictions”

FIRST, SOME TERMINOLOGY

- I'm not a big fan of the phrase "structural model"

- All economic models are "structural"
  - Every model imposes structure on the world

- Usually when people say "structural model," they really mean "economic model" or "dynamic model"

- It makes a lot of sense to talk about "structural-" versus "reduced-form estimation"

STATISTICAL AND ECONOMIC MODELS

- A **statistical model** describes the relation between two or more random variables. Example:

$$Y=X'b+e$$

- An **economic model** starts with assumptions about
  - Agents' preferences
  - Constraints
  - Information environment
  - Firms' production functions
  - Some notion of equilibrium, etc.

- Then it makes predictions about the relation between observable, often endogenous variables

WHAT IS STRUCTURAL ESTIMATION?

- **Structural estimation** is an attempt to
  - Estimate an **economic model's** parameters,
  - Assess model fit, and
  - Run counterfactual experiments
- Parameters to estimate often include
  - Preference parameters (e.g., risk aversion coefficient)
  - Technology parameters (e.g. production function's curvature)
  - Other time-invariant institutional features
    (e.g. agents' bargaining power, financing frictions)

SHORT EXAMPLE: "DYNAMIC DEBT RUNS..." from 2014 JFE

Economic model:

- **Setting**: Continuous time, 1 borrowing firm, continuum of lenders
- **Production function**:
  Asset value follows geometric Brownian motion
- **Financing**: Firm buys an asset by issuing equity & short-term debt
- **Preferences**: Risk-neutral lenders optimally choose whether to roll over debt or "run"
- **Information**: a lender's decision depends on beliefs about other lenders' decisions (strategic complementarity)
- **Equilibrium**: debt is priced in competitive market

SHORT EXAMPLE: “DYNAMIC DEBT RUNS...”

Parameters to estimate:

1. Volatility for asset’s Brownian motion
2. Drift “ “ “ “ *
3. Average debt maturity
4. Average asset maturity
5. Perceived weakness of firm’s backup credit guarantee
6. Asset’s liquidity = recovery rate in default
7. Cap on yield spreads
8. Investors’ discount rate

* Drift is not identified. We assume a value, use alternative values in robustness section.

SHORT EXAMPLE: “DYNAMIC DEBT RUNS...”

Data:

- Panel data on firms issuing ABCP (short-term debt) in 2007
- Variables:
  - Weekly spreads (i.e. prices) on ABCP
  - Indicator for whether firm is experiencing a run

SHORT EXAMPLE: “DYNAMIC DEBT RUNS...”

Assessing model fit: How well does model fit

- Frequency and timing of “recoveries” from runs
- Average debt yields in event time leading up to runs
- Yield volatility and its relation to yield levels
- Probability of future run, given current yield level (forecasting regression)

SHORT EXAMPLE: “DYNAMIC DEBT RUNS...”

Experiments (counterfactual exercises):

- How can we prevent financial crises?

- How does the probability of a run react to a (counterfactual)
  - Equity injection:
    - Reducing leverage by 1% lowers Pr{run} by 45%
  - Improvement in asset liquidity
  - Reduction in asset volatility
  - Strengthening of backup credit guarantees
  - Longer debt maturity or shorter asset maturity

WHAT KIND OF MODEL TO USE

Structural estimation determines whether optimal decisions implied by a model resemble actual decisions made by firms (or banks or individuals).

⇒ **Requirements for the model:**

1. Should be an economic rather than statistical model

2. Should include the most important economic forces

3. Should produce realistic magnitudes and distributions

- No two-state, "profits-are-either-high-or-low" models

- Usually (but not always) requires a dynamic model
  - Schroth, Suarez, and Taylor (2014) → Dynamic
  - Li, Taylor, and Wang (2017) → Static

WHAT KIND OF ECONOMETRICS

- GMM
- MLE (maximum likelihood)
- **SMM (simulated method of moments)**
- **Indirect Inference**
- SMLE (simulated maximum likelihood)
- All of the two-step methods used by structural IO folks

MOMENTS AND LIKELIHOODS

- The moment estimators determine whether model-implied moments resemble real-data moments
- The likelihood estimators use the economic models to construct the likelihoods for MLE
- In both cases:
  - The simulation estimators (SMM and SMLE) are used with models that don’t have closed-form estimating equations
  - GMM and MLE are used with models that have closed-form estimating equations

WHICH ESTIMATOR SHOULD YOU USE?

Estimator	Pros / cons
GMM	- Need closed-form solution + Fast
SMM	+ Don't need closed-form solutions - Extremely slow (use parallel computing as much as possible) + Can use "complicated" moments, sample the data in realistic ways….
GMM & SMM	- Choice of moments is subjective and arbitrary (sometimes a +) + *Semi*parametric: Does not require a complete specification of the probability distribution of the data + Have control over weights put on each moment + Delivers a test of over-identifying restrictions

WHICH ESTIMATOR SHOULD YOU USE?

Estimator	Pros / cons
Maximum likelihood (ML)	+ Fast + Asymptotically efficient: consistent, asymptotically normal, "smallest standard errors" - Need closed-form solutions + Don't need to subjectively choose moments +/- "Uses all the moments" predicted by the model - Fully parametric
Simulated maximum likelihood (SML)	[All the same pros / cons as ML, except slower than ML] + Easy to accommodate heterogeneity in parameter values

WHICH ESTIMATOR SHOULD YOU USE?

Estimator	Pros / cons
Markov chain Monte Carlo	+ Good at estimating non-linear models with many latent variables that require high-dimensional integration to evaluate the likelihood function + Good at handing hierarchical models + Good at handling missing data + Faster than SMM + Good small-sample properties See Arthur Korteweg's webpage for more info

WHICH ESTIMATOR SHOULD YOU USE?

Bottom line:

I don’t care much which estimator you use.

As long as the model is well identified, it should not matter much.

CALIBRATION VERSUS STRUCTURAL ESTIMATION

Calibration	Structural estimation
• Take parameter values from other papers	• Infer parameter values from the data
• Usually have more parameters than moments → model isn't identified, can't put standard errors on parameters	• Get standard errors for parameters
• Mainly a theoretical exercise	• An empirical exercise

Both:

- Can assess how well model fits the data– but no statistical tests with calibration
- Can use model to ask counterfactual questions:
  - What would happen if we shocked this variable?
  - How would world look if we changed that parameter's value?

STRUCTURAL VS. REDUCED-FORM ESTIMATION

	Reduced-form	Structural estimation
Questions	What is the (causal) effect of X on Y?	• Why does X affect Y? • What are the parameters' magnitudes? "Parameters" = economic primitives "Parameters" ≠ slopes, correlations • How well does theory line up with data? • How would the world look if one of the parameters (counterfactually) changed? • What would happen if you (counterfactually) shocked the system

STRUCTURAL VS. REDUCED-FORM ESTIMATION

	Reduced-form	**Structural**
Tools	Estimators: • OLS • IV • Diff-in-diff • Regression discontinuity Software: Stata, R, …	Estimators: • GMM • SMM • MLE • SMLE • Etc. Software: Matlab, C++, Julia, Fortran, etc. Solving the model: • Value function iteration • ODE/PDE solvers • Simulation

STRUCTURAL VS. REDUCED-FORM (TERMINOLOGY)

- Economic models often imply a "reduced-form," meaning a statistical model describing the relation between observables generated by the model

- Example from "Dynamics debt runs…":

  One reduced-form prediction from the model:

$$1(Debt\ Run)_{i,t\to t+\tau} = \beta_{0\tau} + \beta_{1\tau} YieldSpread_{it} + \ldots + \varepsilon_{it}$$

  The regression slopes β are nonlinear functions of the model's structural parameters.

  The true (no ε_{it}) reduced-form may actually be nonlinear in $YieldSpread$

IDENTIFICATION AND ENDOGENEITY

- "Endogeneity" is not necessarily a problem in structural estimation. Structural estimation accounts for and exploits endogeneity within the model to get parameter estimates.

- "Just as there does not exist any perfectly exogenous source of data variation in observational studies, structural estimation does not magically solve all endogeneity problems." (Strebulaev and Whited, 2012)

- An important, common criticism:
  "The economic model omits an important aspect of reality."

- Such omissions can create important estimation biases

- We'll discuss identification and endogeneity at length

A STRUCTURAL ESTIMATION PROJECT HAS SEVERAL STAGES

1. Theoretical model development
2. Practical specification issues
3. Solving the model
4. Understanding how the model works
5. Collecting and cleaning data
6. Estimation
7. Validation
8. Policy experiments

(And writing throughout)

Source: Michael Keane, “Practical issues in structural estimation,” https://www.youtube.com/watch?v=0hazaPBAYWE

PLAN FOR TODAY

- **What is structural estimation?**
- **Why do it?**
  - What structural estimation buys you
  - How to motivate a structural estimation paper
  - Advantages and disadvantages vs. reduced-form estimation
  - Is structural estimation good for your career?
- **How to referee a structural estimation paper**
- **Tour of syllabus**
- **Overview of the literature**
- **A long example**

STRUCTURAL ESTIMATION BUYS YOU THREE THINGS

From least to most interesting:

1. Estimates of interesting economic primitives

2. Deep tests of theory:
   - Formal, joint tests of multiple predictions
     (e.g., test of overidentifying restrictions in GMM or SMM)
   - Testing quantitative, not just directional, predictions
   - Seeing where models fail opens doors to future research
     (Example: equity premium puzzle from Mehra-Prescott (1985))

3. Can answer interesting counterfactual questions

Caveat: Reduced-form papers can also ask counterfactual questions, by changing a regressor from its actual value to a counterfactual value. But it's usually less convincing, because it's harder to believe "all else equal." Also, it's impossible to shock primitives in reduced-form papers….

EXAMPLE: "WHY ARE CEOS RARELY FIRED?..." from 2010 JF

1. Estimates of interesting economic primitives:
   I estimate a parameter that quantifies CEO entrenchment:
   Directors' disutility from firing a CEO

2. "Deep" tests of theory:
   Model does a good job fitting most moments but struggles to fit
   (1) changes in profitability in the year after CEOs fired, and
   (2) high rate at which CEOs are fired in their first 2 years in office

3. Can answer interesting counterfactual questions:
   How much would firm value change if we eliminated CEO entrenchment?
   Set the entrenchment parameter to zero→
   Firm value increases by 3%.

EXAMPLE: "DYNAMIC DEBT RUNS…."

1. Estimates of interesting parameters:
   Not so interesting in this paper

2. "Deep" tests of theory:
   Model does a good job fitting most moments, but, in one subsample, it overpredicts runs when yields are high.

3. Can answer interesting counterfactual questions:
   How can we prevent financial crises?
   How does the probability of a run react to a (counterfactual)
   - Equity injection:
     Reducing leverage by 1% lowers Pr{run} by 45%
   - Improvement in asset liquidity
   - Reduction in asset volatility
   - Strengthening of backup credit guarantees
   - Longer debt maturity or shorter asset maturity

MOTIVATING A STRUCTURAL PAPER

- Structural estimation imposes large costs on the reader
- Before going structural, convince yourself that a structural approach is absolutely necessary
- → Any structural paper must put great effort into convincing reader that it's worth going structural
- Next slide: an example

EXAMPLE: "DYNAMIC DEBT RUNS..."

Question: How sensitive are runs to their various potential determinants?

	Reduced-form estimation	Structural estimation
Approach	Regress 1(run) on determinants of runs (leverage, liquidity, volatility, guarantee strength…)	• Estimate structural parameters by SMM • Use counterfactual analysis to measure sensitivity of runs to determinants
Data challenges	• Tough to get data on leverage, liquidity, assets' value, assets' volatility, guarantee strength… • Need sufficient heterogeneity in determinants	• Estimate these quantities structurally from data on prices, runs, and recoveries • Do not need heterogeneity in determinants
Identifying assumptions	• Exogenous variation in determinants (i.e., regression does not omit any correlated determinants of runs) • Got the functional form right	• Model is true: - Includes all determinants of runs - Rational investors - Functional forms are correct

The structural approach complements existing reduced-form research by
(1) overcoming certain data challenges
(2) imposing a different type of identifying assumption

STRUCTURAL VS. REDUCED-FORM ESTIMATION

	Reduced-form	Structural estimation
Advantages	• "Fewer" assumptions? No, just as many assumptions (Kahn and Whited, 2018) • Easier to do • Easier to understand→ larger audience	• Often the only feasible option for answering certain important questions • Tough to find good instruments or natural experiments. • The connection between theory and the empirical test is extremely tight, which allows more transparent interpretation of any results. Structural estimation "puts the theory first" and makes it explicit. • Results generalize better • For job market: Makes you look smart

Bottom line:

- Do what lets you answer your research question most convincingly and easily
- If structural and reduced-form will both get the job done, go reduced-form!!

WHY GO STRUCTURAL? BECAUSE YOU GET TO DO IT ALL!

- Write down models, solve models numerically, gather data, do complicated econometrics….

Going structural may be right for you if…

- … you're emotionally robust
- … there's not much on your calendar for next few years

PLAN FOR TODAY

- What is it?
- Why do it?
- **How to referee a structural estimation paper**
- Overview of the literature
- A long example

QUESTIONS A REFEREE MIGHT ASK

- ☑ Am I convinced that we need structural estimation?
  - Why won't a reduced-form approach work?
- ☑ Is the economic question important?
  - Or are we using a large hammer to hit a small nail?
- ☑ Is the identification clear, or is it a black box?
  - Which features of the data identify each parameter, and why/how?
- ☑ Is model fitting the data reasonably well?
  - If not, what can we learn from its failure?
  - Usually not a deal-breaker
- ☑ Are moments contaminated by important omitted economic forces?
  - If so, how could the omission bias the estimates?
- ☑ Have authors explored interesting heterogeneity in the parameters?
  - E.g, estimate model in subsamples
  - Enriches paper, provides useful consistency checks
- ☑ Does the paper take full advantage of counterfactual exercises?

PLAN FOR TODAY

- What is it?
- Why do it?
- How to referee a structural estimation paper
- **Overview of the literature**
- A long example

OVERVIEW OF LITERATURE

- During summer 2021, I tried to find all publications that do structural estimation in corporate finance (broadly defined)

- I'm sure we missed some papers

- We excluded
  - Unpublished papers (including many good, recent papers!)
  - Papers outside certain top finance and economics journals
  - Methodological papers
  - Papers not about corporate finance
  - Papers that calibrate rather than estimate

(Big thanks to Luke Min for his help with this survey)

OVERVIEW OF LITERATURE

Topic	# papers 2020	# papers 2021
Investment, capital structure, financing policy	18	22
Corporate governance	8	14
Corporate control (M&A, activism, blockholders)	11	11
Banks, financial institutions, crises	8	13
Household finance	3	5
Entrepreneurship and innovation	2	5
Real estate finance	2	4
Labor and finance	2	2
Bankruptcy	1	3
Total	**55**	**79**

WANT A DETAILED LITERATURE REVIEW?

Yufeng Wu. What's behind smooth dividends? Evidence from structural estimation.

Review of Financial Studies, 31(10):3979–4016, 2018

Economic question	What fraction of dividend smoothing is due to career concerns? What fraction is due to rational signaling?
Main results	39% of observed dividend smoothness among U.S. firms is driven by managers' own career concerns This agency issue leads to a 2% drop in firm value
Also interesting	In actual and simulated data, changes in dividends are a strong predictor of manager turnover.
Estimator	SMM
Data	Compustat, Equilar, Execucomp

All 79 papers are summarized like this in Structural_Literature_Review_2021.pdf (in Readings folder on Canvas)

TONI WHITED

All my slides owe a huge debt to Toni Whited

PLAN FOR TODAY

- What is it?
- Why do it?
- How to referee a structural estimation paper
- Overview of literature
- **A long example: Dou, Taylor, Wang, and Wang (2021)**

Dissecting Bankruptcy Frictions

Winston W. Dou (Wharton)

Lucian A. Taylor (Wharton)

Wei Wang (Queens)

Wenyu Wang (Indiana)

How efficient is corporate bankruptcy in the U.S.?

1998–2017: 95 large U.S. corporate bankruptcies per year

2008–2009: $1.3 trillion in combined liabilities for large bankruptcies

Tradeoff theory: bankruptcy costs influence even healthy firms'

- Borrowing costs
- Leverage choices
- Risk and liquidity management
- Asset pricing and macro

How efficient is corporate bankruptcy?

Economic frictions:

- Asymmetric information
- Conflicts of interest

Potential inefficiencies caused by frictions:

- Excess liquidation (should be reorganized, instead liquidated)
- Excess continuation (vice-versa)
- Excess delay $\rightarrow$ direct/indirect bankruptcy costs $\uparrow$

Our goals:

- Quantify these inefficiencies
- Dissect their underlying causes

Our approach: Structural estimation

1. **Solve a new bankruptcy model**
   - Dynamic bargaining between a senior and junior creditor
   - Simultaneously bargain on financial + business plans
   - Creditor-specific reorganization skill
   - Frictions:
     - Two-sided private information about reorganization skill
     - Each creditor maximizes its own payout, not total payout

2. **Estimate by SMM**
   - Data on 311 large U.S. bankruptcies from 1996–2014

3. **Run counterfactual experiments**
   - Turn off frictions, what changes?

Summary of results

Bankruptcy process is quite inefficient (ex post)

- Remove information asymmetry $\Rightarrow$ 4% $\uparrow$ in recovery value
- Also remove conflicts of interest $\Rightarrow$ extra 18% $\uparrow$ in recovery value

Summary of results

Bankruptcy process is quite inefficient (ex post)

- Remove information asymmetry $\Rightarrow$ 4% $\uparrow$ in recovery value
- Also remove conflicts of interest $\Rightarrow$ extra 18% $\uparrow$ in recovery value

Main inefficiency: Excess delay

- Remove frictions $\Rightarrow$
  (1) Extra 14% cases resolved pre-court
  (2) Remaining court cases 73% shorter
- Less delay $\Rightarrow$ less costs (direct and indirect)

Other inefficiencies?

- Excess liquidation and continuation are small

Literature

Discussions/theories of bankruptcy inefficiencies

- Baird (1986), Bebchuk (1988), Giammarino (1989), Gertner-Scharfstein (1991), Aghion-Hart-Moore (1992), many more

Reduced-form evidence of bankruptcy frictions

- Conflicts of interest: Gilson (1990), Stromberg (2000), Ayotte-Morrison (2009)
- Coordination frictions: Ivashina-Iverson-Smith (2016)
- Search and financial frictions: Bernstein-Colonnelli-Iverson (2017)

Measuring bankruptcy costs (direct and indirect)

- Gruber-Warner (1977), Andrade-Kaplan (1998), Maksimovic-Phillips (1998), Bris-Welch-Zhu (2006), many others

Structural estimation and bankruptcy

- Eraslan (2008), Jenkins and Smith (2014), Antill (2019)

Trump Entertainment Resorts, Inc.

Three casinos in Atlantic City, New Jersey

Trump Entertainment Resorts, Inc.

Jan-2009 Misses interest payment
Creditors can't reach agreement $\rightarrow$ case goes to court

Feb-2009 Chapter 11 filing
At petition:
- Senior debt (1st lien): \$485 million (Beal Bank)
- Junior debt (2nd lien): \$1.25 billion (3 hedge funds)
- Book assets: \$2.06 billion
- Estimated liquidation value: \$388 million

Trump Entertainment Resorts, Inc.

Feb-2009: Chapter 11 filing

In-court bargaining:

Trump Entertainment Resorts, Inc.

Feb-2009: Chapter 11 filing

In-court bargaining:

				Recovery Rates	
	Proposal	Proposed by	Type	Senior	Junior
Apr-2009	#1	Junior	Reorganize	<100%	2.0%

Trump Entertainment Resorts, Inc.

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In-court bargaining:

				Recovery Rates	
	Proposal	Proposed by	Type	Senior	Junior
Apr-2009	#1	Junior	Reorganize	<100%	2.0%
Jul-2009	#2	Senior	Reorganize	100%	0.0%

Trump Entertainment Resorts, Inc.

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In-court bargaining:

	Proposal	Proposed by	Type	Recovery Rates	
				Senior	Junior
Apr-2009	#1	Junior	Reorganize	<100%	2.0%
Jul-2009	#2	Senior	Reorganize	100%	0.0%
Oct-2009	#3	Senior	Reorganize	94%	1.1%

Trump Entertainment Resorts, Inc.

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Jul-2009	#2	Senior	Reorganize	100%	0.0%
Oct-2009	#3	Senior	Reorganize	94%	1.1%
Nov-2009	#4	Junior	Reorganize	<100%	1.4%

Trump Entertainment Resorts, Inc.

Feb-2009: Chapter 11 filing

In-court bargaining:

				Recovery Rates	
	Proposal	Proposed by	Type	Senior	Junior
Apr-2009	#1	Junior	Reorganize	<100%	2.0%
Jul-2009	#2	Senior	Reorganize	100%	0.0%
Oct-2009	#3	Senior	Reorganize	94%	1.1%
Nov-2009	#4	Junior	Reorganize	<100%	1.4%
Feb-2010	#5	Senior	Reorganize	<100%	1.1%

Trump Entertainment Resorts, Inc.

Feb-2009: Chapter 11 filing

In-court bargaining:

				Recovery Rates	
	Proposal	Proposed by	Type	Senior	Junior
Apr-2009	#1	Junior	Reorganize	<100%	2.0%
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Oct-2009	#3	Senior	Reorganize	94%	1.1%
Nov-2009	#4	Junior	Reorganize	<100%	1.4%
Feb-2010	#5	Senior	Reorganize	<100%	1.1%
May-2010	#6	Junior	Reorganize	100%	1.28%

Trump Entertainment Resorts, Inc.

Feb-2009: Chapter 11 filing

In-court bargaining:

	Proposal	Proposed by	Type	Recovery Rates	
				Senior	Junior
Apr-2009	#1	Junior	Reorganize	<100%	2.0%
Jul-2009	#2	Senior	Reorganize	100%	0.0%
Oct-2009	#3	Senior	Reorganize	94%	1.1%
Nov-2009	#4	Junior	Reorganize	<100%	1.4%
Feb-2010	#5	Senior	Reorganize	<100%	1.1%
May-2010	#6	Junior	Reorganize	100%	1.28%

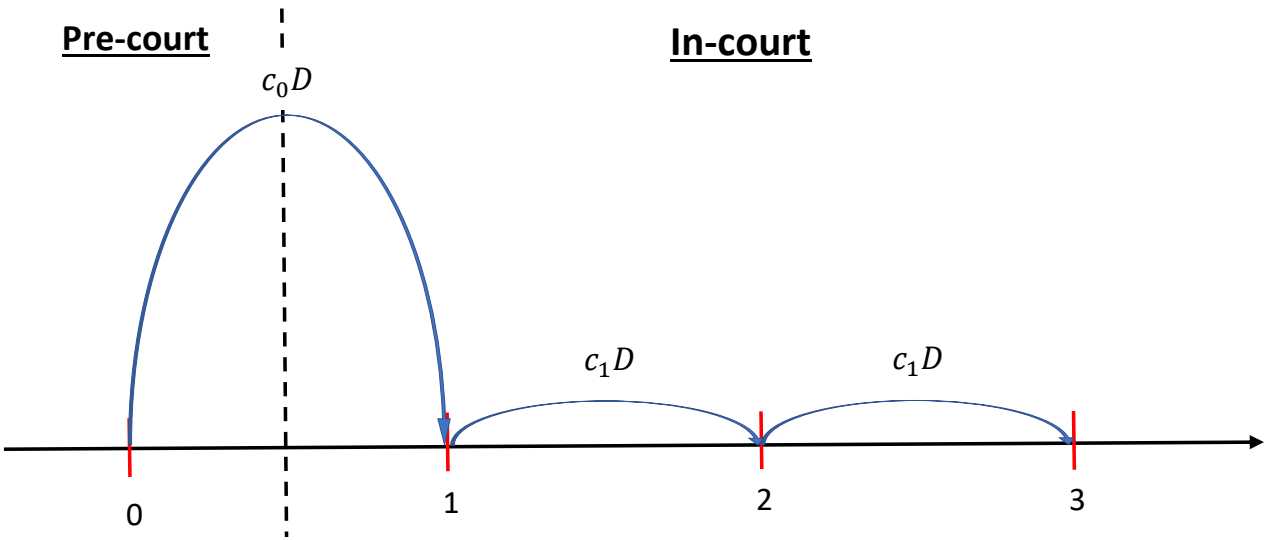
Total duration = 15 months

Assumptions (1/4): Basics

Players

- Insolvent firm
- Senior debt $= D_S$, junior debt $= D_J$, total debt $= D = (D_S + D_J)$
- Each creditor rationally maximizes its expected payout

Periods and costs



Accumulated costs up to period t: $C_t = \mathbf{1}_{\{t>0\}} (c_0 + c_1 t) D$

Assumptions (2/4): Payouts

Liquidation

- Total payout $= L - C_t$
- APR: seniors paid first, then juniors

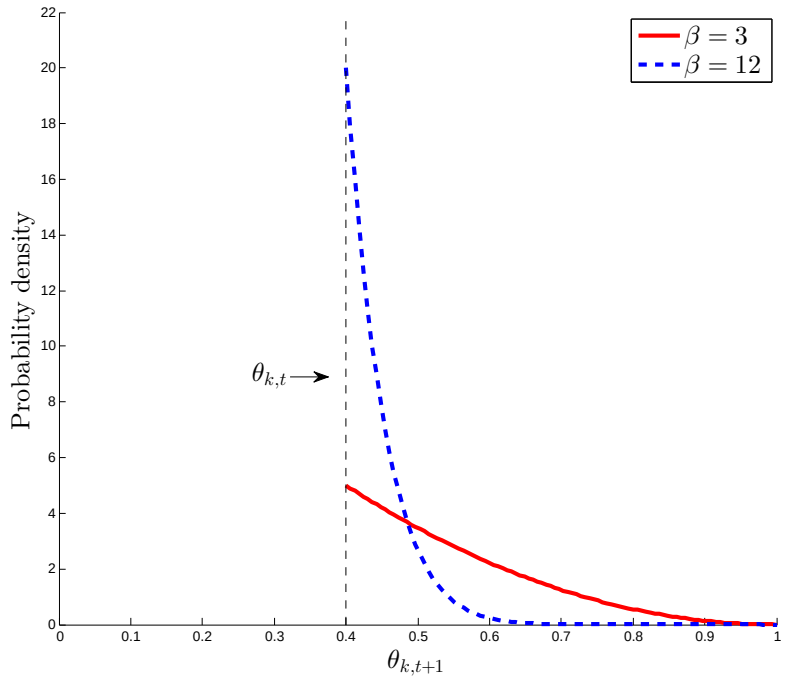
Reorganization

- Total payout $= V_t \theta_{k,t} - C_t$
  - V_t = maximum reorganization value at $t = \rho^{t-1} V_0$
  - $1 - \rho$ = value erosion (a form of indirect bankruptcy costs)
  - $\theta_{k,t}$ = reorganization skill of creditor k (private information)
- Bargain over how to split the total payout

Assumptions (3/4): Reorganization skill

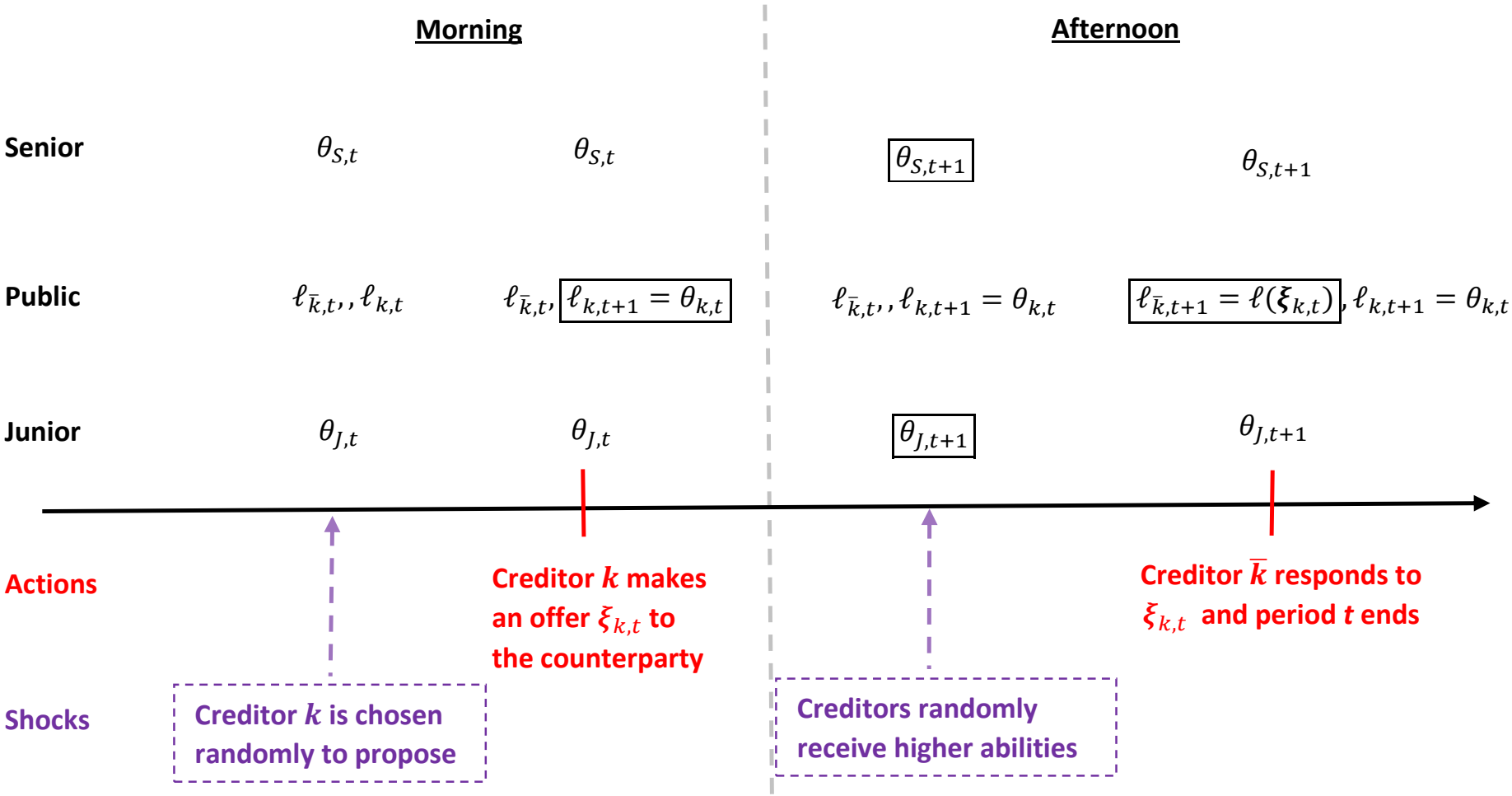
Skill levels increase randomly over time:

$$\theta_{k,t+1}|\theta_{k,t} \sim \text{Generalized Beta } (\theta_{k,t}, \beta) \text{ with } k \in \{S, J\}$$



Interpretation: β^{-1} is "learning" speed (e.g., Kahl, 2002)

Assumptions (4/4): Timeline in period t



Intuition

Tradeoff

Costs of delay: $\uparrow$ direct and indirect costs

Benefits of delay: $\uparrow$ learning, (potentially) $\uparrow$ bargaining power

Intuition

Tradeoff

Costs of delay: $\uparrow$ direct and indirect costs

Benefits of delay: $\uparrow$ learning, (potentially) $\uparrow$ bargaining power

Asymmetric information

$\Rightarrow$ Uncertainty about counterparty's skill $\uparrow$

$\Rightarrow$ Creditors make low-ball offers (precautionary motive)

$\Rightarrow$ Rejection rate $\uparrow \Rightarrow$ delay $\uparrow \Rightarrow$ costs $\uparrow$

$\Rightarrow$ Screening of counterparty's skill $\downarrow \Rightarrow$ Asym. info. $\uparrow$

Intuition

Tradeoff

Costs of delay: $\uparrow$ direct and indirect costs

Benefits of delay: $\uparrow$ learning, (potentially) $\uparrow$ bargaining power

Asymmetric information

$\Rightarrow$ Uncertainty about counterparty's skill $\uparrow$

$\Rightarrow$ Creditors make low-ball offers (precautionary motive)

$\Rightarrow$ Rejection rate $\uparrow \Rightarrow$ delay $\uparrow \Rightarrow$ costs $\uparrow$

$\Rightarrow$ Screening of counterparty's skill $\downarrow \Rightarrow$ Asym. info. $\uparrow$

Conflicts of interest

$\Rightarrow$ Creditors want to grab as much of pie as possible

$\Rightarrow \uparrow$ Incentive to reject offers, in hopes of gaining bargaining power

$\Rightarrow$ Rejection rate $\uparrow \Rightarrow$ delay $\uparrow \Rightarrow$ costs $\uparrow$

Intuition

Tradeoff

Costs of delay: $\uparrow$ direct and indirect costs

Benefits of delay: $\uparrow$ learning, (potentially) $\uparrow$ bargaining power

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$\Rightarrow$ Rejection rate $\uparrow \Rightarrow$ delay $\uparrow \Rightarrow$ costs $\uparrow$

Both frictions

$\Rightarrow$ Creditors play tough with each other $\Rightarrow$ excess delay

Data

Sample: 311 Chapter 11 filings, 1996-2014

Sources:

- UCLA LoPucki Bankruptcy Research Database
- New Generation Research
- Electronic court records (PACER)
- National archives
- Compustat

Filters:

- Public company
- Assets $>$ \$100M (1980 dollars)
- Non-financial firms
- At least 2 debt classes

Observable parameters

- Debt amounts: D_S and D_J
- Liquidation value: L
  - From liquidation analysis report in court documents
  - Analysis typically conducted by independent financial advisor
  - Available for roughly 3/4 of sample
  - Remaining 1/4: Predict L based on firm and creditor characteristics
- Maximum initial reorganization value: V_0
  - Follow Edmans, Goldstein, Jiang (2012)
  - V_0 = Potential Tobin's Q $\times$ book assets
  - Potential Tobin's Q = median Q within industry $\times$ year
- We feed $\{D_J, L, V_0\}$ into model, after scaling by D

SMM estimation and identification

Estimate 7 parameters by matching 9 moments:

Moment	**Helps identify parameter...**
1. Avg. months between plans	Months per period (μ)
2. Fraction resolved in court	Cost of going to court (c_0)
3. S: avg. recovery | pre-court reorg.	Senior's initial skill ($\theta_{S,0}$)
4. J: avg. recovery | pre-court reorg.	Junior's initial skill ($\theta_{J,0}$)
5. Junior's fraction of gain	Junior's prob. of proposing (λ_J)
6. Frac. reorganized | in-court	Inverse speed of learning (β)
7. Avg. log duration in court	Persistence of reorganization value (ρ)
8. Avg. total recovery rate	Multiple parameters
9. Slope(log recovery, duration)	Multiple parameters

Note: Junior's fraction of gain $= \dfrac{\text{Junior payout}}{\text{Total payout}}$

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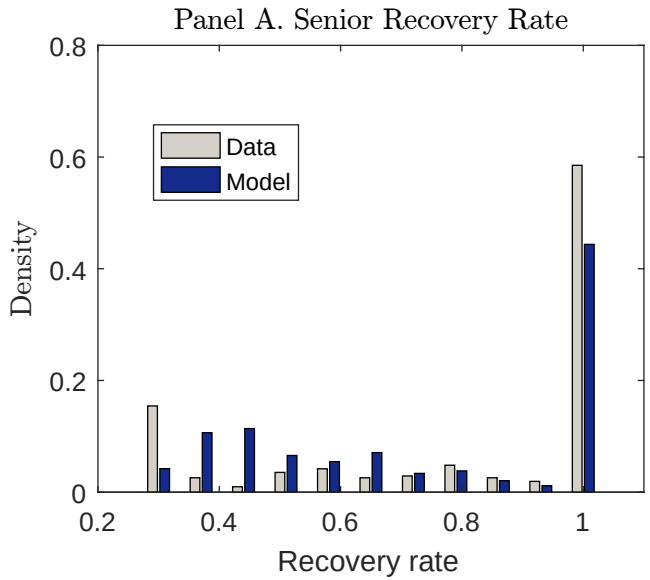
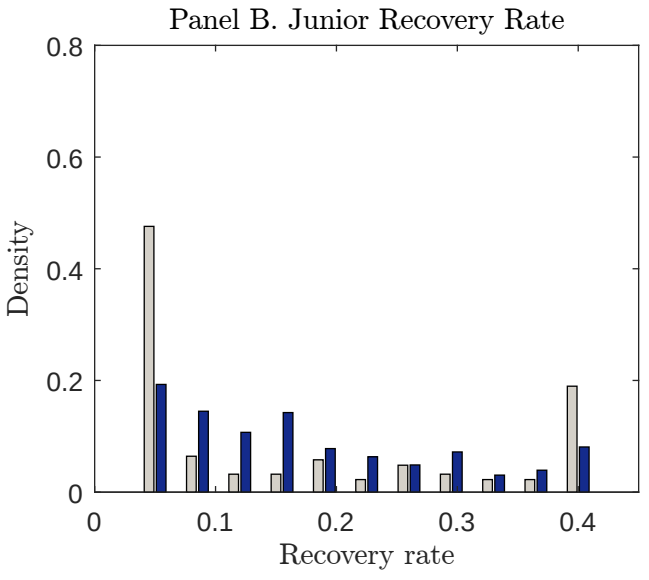
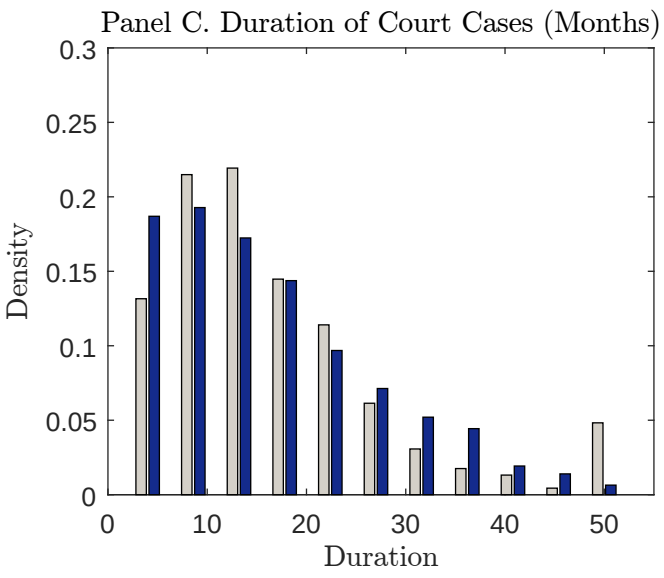
Model fits the data quite well

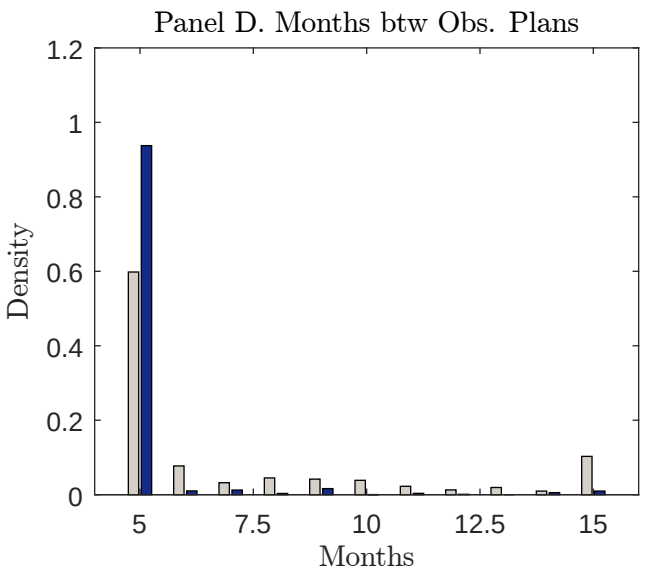
Moment	Model	Data	Std. Err.	t-stat.
Averages Across In-Court Cases:				
Ln Months Between Plans	1.711	1.769	0.060	-0.97
Fraction Reorganized	0.902	0.881	0.021	0.99
Ln Duration (Months)	2.608	2.571	0.058	0.64
Fraction In Court	0.701	0.731	0.025	-1.21
Average Recovery Rates for Pre-Court Reorganizations:				
Junior	0.192	0.221	0.027	-1.06
Senior	0.857	0.878	0.033	-0.63
Averages Across In-Court Reorganizations:				
Junior's Fraction of Gain	0.298	0.270	0.018	1.53
Slope of Ln Recovery on Duration	-0.017	-0.014	0.005	-0.59
Total Recovery Rate	0.375	0.370	0.019	0.25

Model fit – untargeted distributions

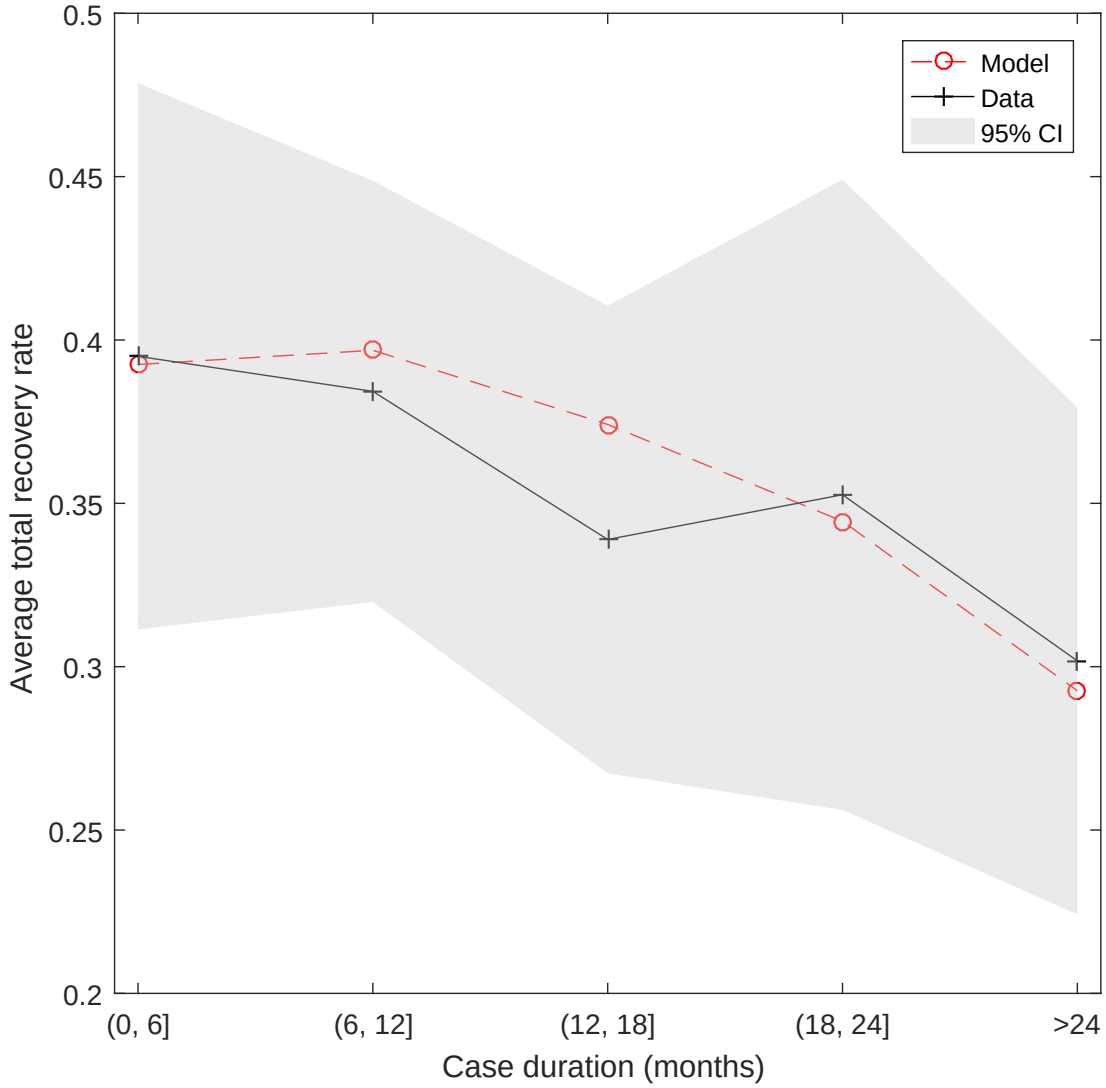








Model fit – total recovery rate vs. duration



Parameter estimates

Parameter	Notation	Estimate	Std. Error
Months Per Period	μ	4.566	0.609
Senior's Initial Reorganization Skill	$\theta_{S,0}$	0.281	0.036
Junior's Initial Reorganiztion Skill	$\theta_{J,0}$	0.364	0.016
(Inverse) Speed of Creditor Learning	β	9.835	1.046
Persistence of Reorganization Value	ρ	0.884	0.006
Fixed Cost of Going to Court (%)	c_0	4.400	0.867
Junior's Probability of Proposing	λ_J	0.346	0.088

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Quantifying inefficiencies and their causes

Next: Compare estimated model to two counterfactual benchmarks

Benchmark #1: Symmetric information

- Creditors perfectly observe each other's skill (complete info.)
- Still uncertainty about future skill (imperfect info.)
- Still conflicts of interest

Benchmark #2: Social planner

- Same as #1 except no conflicts of interest
  - Social planner maximizes expected total payout
  - Choices: wait, liquidate, reorganize (either S or J's plan)
- Still uncertainty about future skill (imperfect info.)
- Remaining frictions: $c_0 > 0$, $c_1 > 0$, $\rho < 1$, slow learning

Quantifying inefficiencies and their causes

Average Total Recovery Rate

	Counterfactual Models	
Estimated Model	Symmetric Information	Social Planner
0.351	0.365	0.429

Quantifying inefficiencies and their causes

Average Total Recovery Rate

	Counterfactual Models	
Estimated Model	Symmetric Information	Social Planner
0.351	0.365	0.429

- Removing asymmetric information $\rightarrow$ 4% increase
- Removing conflicts of interest $\rightarrow$ extra 18% increase
- Avg. value destroyed per year $\approx$ \$11B
- Observed bankruptcy process is quite inefficient

Where is the inefficiency coming from?

Decomposition:

$$\begin{aligned}\text{Average Total Recovery Rate} = & \\ & \text{Frac(Liquidated)} \times \text{Avg. Liquidation Value} \\ + & \text{ Frac(Reorganized)} \times \text{Avg. Reorganization Value} \\ - & \text{ Average Accumulated Costs}\end{aligned}$$

Where is the inefficiency coming from?

Decomposition:

Average Total Recovery Rate =

$$\begin{aligned} &\text{Frac(Liquidated)} \times \text{Avg. Liquidation Value } \mathbf{(5\%)} \\ &+ \text{Frac(Reorganized)} \times \text{Avg. Reorganization Value } \mathbf{(83\%)} \\ &- \text{Average Accumulated Costs } \mathbf{(12\%)} \end{aligned}$$

Where is the inefficiency coming from?

Simulated Statistic	Estimated Model	Counterfactual Models: Symmetric Information	Counterfactual Models: Social Planner
Avg. Reorganization Value	0.411	0.425	0.493
Fraction Resolved Pre-Court	0.299	0.333	0.436
Avg. Duration of Court Cases	16.7	13.4	4.5

Where is the inefficiency NOT coming from?

		Counterfactual Models	
Simulated Statistic	Estimated Model	Symmetric Information	Social Planner
Fraction Reorganized	0.791	0.802	0.819
Avg. Gain from Eliminating Excess Liq. and Reorg.	0.000	0.0048	0.0051
Avg. Loss Due to Low-Skill Reorganization	0.0094	0.0089	0.000

Conclusions

Corporate bankruptcy in the U.S. is quite inefficient

Frictions:

- Asymmetric information between creditors
- Conflicts of interest between creditors

Eliminating these frictions $\rightarrow$ average total payouts $\uparrow$ 22%

- By making cases resolve faster ($\downarrow$ excess delay)
- Surprisingly small: excess liquidation, excess continuation