Visibility of Technology and Cumulative Innovation: Evidence from Trade Secrets Laws

Bernhard Ganglmair ***(ZEW Mannheim, MaCCI, University of Mannheim)***

Imke Reimers ***(Northeastern University)***

BU TPRI IP Day

Boston University School of Law | July 22, 2019

Is too much trade secrecy bad for welfare?

The Secrets of Cremona

Scientists are trying to uncover what makes Stradivarius violins special – but are they wasting their time?

December 19, 2016 2.59pm EST

Secrets Of Stradivarius' Unique Violin Sound Revealed, Professor Says

Date: January 25, 2009

Source: Texas A&M University

Summary: For centuries, violin makers have tried and failed to reproduce the pristine sound of Stradivarius and Guarneri violins, but after 33 years of work put into the project, one professor is confident the veil of mystery has now been lifted.

UNITED STATES PATENT OFFICE.

MATTHIAS KELLER, OF PHILADELPHIA, PENNSYLVANIA.

MACHINE FOR CUTTING THE FRONTS AND BACKS OF VIOLINS.

Specification of Letters Patent No. 13,878, dated December 4, 1855.

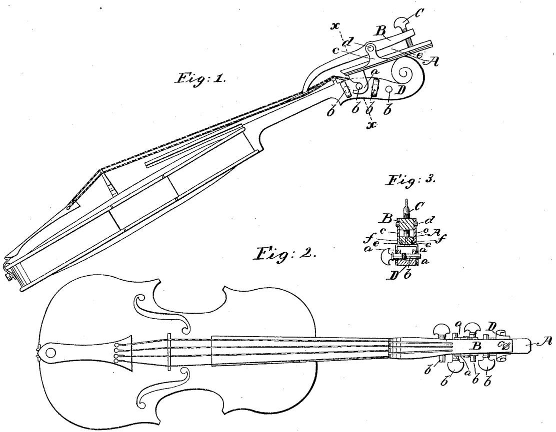
Patented Feb. 12, 1924. 1,483,733

UNITED STATES PATENT OFFICE.

LOUIS KOZELEK, OF SCHENECTADY, NEW YORK.

PROCESS OF TREATING WOOD FOR THE MANUFACTURE OF MUSICAL INSTRUMENTS.

No Drawing. Application filed July 5, 1922. Serial No. 572,799.



How visible (or self-disclosing) is your invention?

Patenting/Trade Secrecy and Follow-On Innovation

Patenting	**Institutions:** strength of patent vs. TS protection	**Visibility:** needed for enforcement but counter secrecy
Follow-on Innovation	**Institutions:** patents' anticommons effect?	**Effective Visibility:** patents make visible what's otherwise hidden

Do you see?

Institutions and *Visibility* Matter for Choice of IP Protection

- Stronger trade secrets protection makes patents less attractive
- This effect is stronger for lower visibility technologies
  - the disclosure-cost of patenting is higher for inventions that are otherwise not visible
  - with stronger protection, trade secrecy becomes a more attractive option especially for these low-visibility technologies
- Visibility difficult to measure, but:

processes on average less visible than products

Research Questions

1. **Does stronger trade secrets protection affect what is disclosed?**
   - Patents tell us what *isn't* kept secret.
   - Less disclosure of inventions (i.e., patenting) with lower visibility (processes)

2. **How does trade secrets protection affect welfare?**
   - Negative for technologies with low R&D costs / high R&D profitability
   - Optimal level of protection increases in R&D costs

Outline

1. Simple model of disclosure
2. Data
   - Exogenous variation of trade secrets protection across states and time
   - Indicators for process and product patents
3. Empirical estimation
   - diff-in-diff estimation utilizing exogenous variation in TS protection
   - Stronger trade secrets protection leads to relatively fewer process patents
4. Welfare simulation (including initial and follow-on innovation)
   - Ambiguous effects of stronger trade secrets protection
   - More positive for high costs of R&D

Theoretical Framework

Visibility Matters: Inventor’s Choice

- A simple model of patent or secrecy for a given invention
- Inherent visibility:
  - value from patent increases in visibility (of use)
  - value from secrecy decreases in visibility (of invention)
- Value from secrecy increases in legal protection of trade secrets

Trade secrets protection:

- patents are less attractive
- effect is stronger for processes (lower visibility)

Patents:

relatively fewer process patents

Visibility Matters: Society's Trade-Off

- Society cares if *processes* are patented (and disclosed):
  - They are otherwise not visible and available for others to use
- Stronger trade secrets protection:
  - Incentivizes innovation, especially of *less visible* technologies
    - ⇒ *more* innovation **ex ante**
  - Prevents disclosure of those technologies
    - ⇒ *less* follow-on innovation **ex post**
      (Furman *et al.* 2018, Gross 2019, Hegde *et al.* 2018)

Is too much trade secrecy bad for welfare?

Data and Institutions

Data Sample

~1.5 million single-state U.S. utility **patents** with priority dates between 1976 and 2008 (granted by 2014)

- *single-state patents:* all U.S. inventors and U.S. assignees are from the same state
- *priority dates:* date closest to the disclosure decision (priority date of parent application to account for divisionals and continuations)
- **process** vs. **product patent** indicator to proxy for visibility
  - patent-claim level text analysis: process claims and product claims
  - process patent if at least one process claim (robust)

Stats

What is a Trade Secret? Legal Protection?

- Any information a firm produces or collects and keeps to itself
  - Your secret BBQ sauce
  - Customer list (for your Horse Yoga book series)
  - Production process (e.g., peanut butter into Peanut Butter M&Ms)
  - Edison's "10,000 ways that won't work"
- In *this paper*: patentable inventions
  - **one third** of patentable inventions kept secret (Mansfield 1986)
- Protection weaker than from patents:
  - Laws protect against misappropriation
  - Do not grant exclusivity (independent discovery, reverse engineering)

Trade Secrets Protection: Uniform Trade Secrets Act

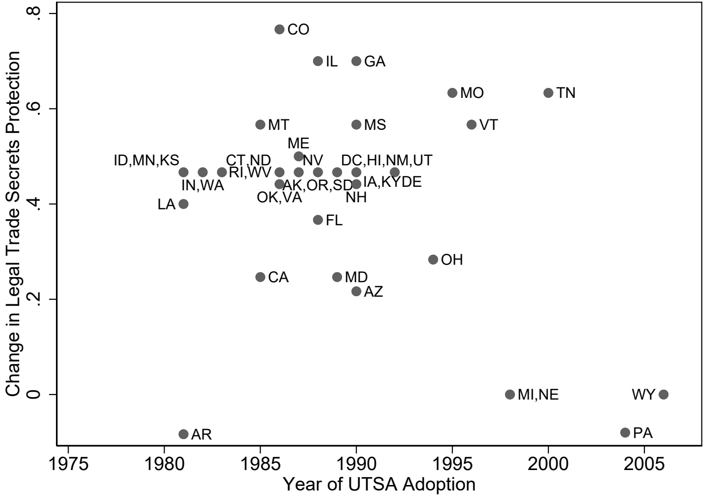
- Exogenous variation in **trade secrets protection** through **Uniform Trade Secrets Act** (1979 amended 1985)
  - Published by Nat'l Conference of Commissions on Uniform State Laws
  - States voluntarily adopt *template* to change from common law to UTSA
  - 1981–2013: 47 states, D.C., P.R., and V.I. have adopted it

- Harmonize and clarify state trade secrets laws:
  - *definition*
  - *misappropriation*
  - *remedies*

- Png (2017) constructs an index that captures the strength of trade secrets protection in a state before and after adoption of the UTSA

▸ List of factors used for index

Trade Secrets Protection Increased in Most States



Time Series

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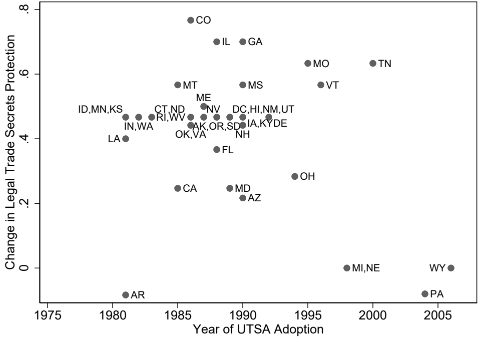
Testing the Theoretical Prediction

The share of process patents is decreasing as trade secrets protection increases

Empirical Strategy

- We exploit the staggered adoption of the UTSA in a diff-in-diff setting
- Dependent variable:
  patent type (process or product)
- Independent variable of interest:
  trade secrets protection index



Empirical Model

The **likelihood of process patents**:

$$process_{jst} = \boxed{\alpha\, protection_{st}} + \beta X_{jst} + \nu_s + \mu_t + \eta_j + \epsilon_{jst}$$

$process_{jst} = 1$	if patent j files in state s in year t is a process patent
$protection_{st}$	trade secrets protection index in state s in year t
X_{jst}	vector of patent complexity and value controls
ν_s, μ_t, η_j	state, year, and UPSC main class fixed effects

OLS; standard errors clustered by USPC main class and state

Baseline Estimation Results

Dep. variable: =1 if process patent	(1)	(2)	(3)	(4)
Trade Secrets Protection	-0.018**	-0.021**	-0.026***	-0.026***
Patent complexity controls	N	Y	N	Y
Patent value controls	N	N	Y	Y
State, year, USPC class FE	Y	Y	Y	Y
Observations	1,475,058	1,465,095	907,867	899,932
R^2	0.300	0.345	0.289	0.337

- UTSA leads to **mean decrease of 2.2%** of the probability that a patent is process patent (mean increase in TS protection of 0.36 and baseline share of process patents of 0.43)
- Driven by individuals/small firms and chemicals, electronics, mechanics

Size Effects Technology Class Effects

Identification and Robustness checks

Instrument for UTSA using other uniform laws	Placebo tests (adoption *t* years earlier)	State-specific time trends
Patent application date as decision timing	First applicant location	No software patents
Patent family head (parent patent)	Single applicant	Alternative process patents (first claim, majority)

IV Robustness

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Structural Estimation and Welfare Results

Protection of trade secrets affects

– ex ante R&D decisions

– **disclosure decisions**

– follow-on innovation

Three-Stage R&D Model

Stage 1: Ex ante R&D decision

- Weigh cost of R&D of *potential invention* against expected payoff

Stage 2: Disclosure or Trade Secret

- Weigh visibility and trade secrets protection

Stage 3: Follow-on Innovation

- Probability of follow-on innovation with trade-off:
  - effective visibility of initial invention (**function of disclosure**)
  - barriers to access (**patents' "anticommons effect"**)

Do you see shoulders to stand on? Can you stand on them?

Estimation Challenges

Stage 1: No data on potential inventions

Step 2: Assuming R&D costs, simulate *ideas* distributions that explain *realized* inventions

Stage 2: We do not observe trade secrets

Step 1: Use MLE to explain the observed share of process patents and obtain distribution of realized inventions

Stage 3: We cannot measure follow-on innovation for trade secrets

We do have:

- strength of trade secrets protection
- share of process patents

Welfare: Function of Trade Secrets Protection

1. Inventor's ex-ante R&D incentives from IP protection (profits from exclusive access)
2. Exclusive access to technology (of various degrees) creates deadweight loss
3. "Market's" ex-post R&D – with tradeoff
   - Disclosure has a positive effect on follow-on innovation
   - Patents on early ideas raise costs of creating future ones – *anticommons*

Estimation Welfare Function

Trade Secrets Protection: The Trade-off

higher ex-ante R&D incentives
with more potential for follow-on innovation

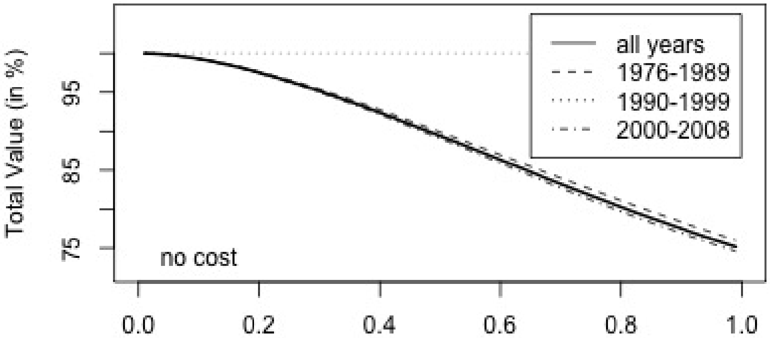
vs.

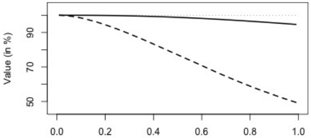
less disclosure of non-self disclosing inventions
and larger deadweight loss (from trade secrets)

Welfare Results

1. What is the effect of trade secrets protection on welfare?
2. What is the average effect of the adoption of the UTSA?

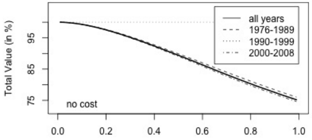
(1) No R&D Costs: Negative Effect

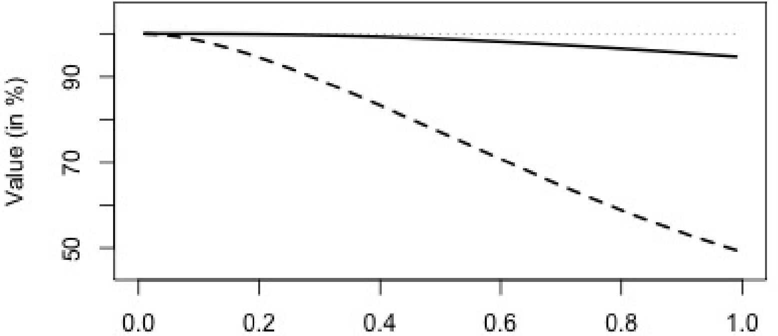




- Stronger TS protection has an unambiguously negative effect on welfare

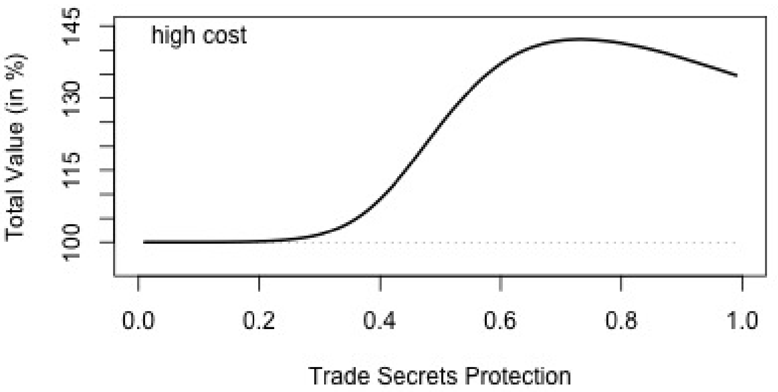
(1) No R&D Costs: Negative Effect

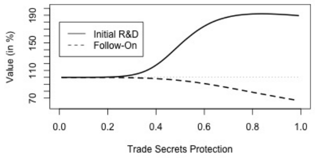




- Less disclosure $\rightarrow$ less follow-on innovation (dashed)
- Ex ante incentives are ineffective – only a negative DWL-effect (solid)

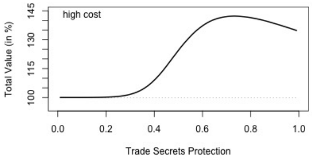
(1) High R&D Costs: Maybe Positive Effect

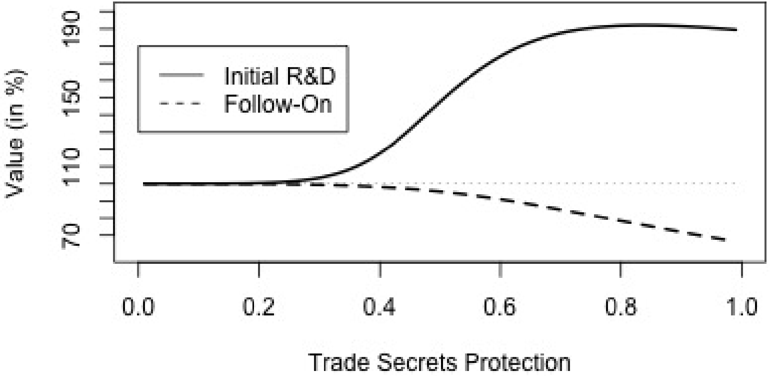




- Stronger TS protection can have a positive overall welfare effect

(1) High R&D Costs: Maybe Positive Effect





- Negative effect on follow-on innovation prevails (dashed)
- Ex ante incentive effect more than offsets the negative DWL-effects (solid)

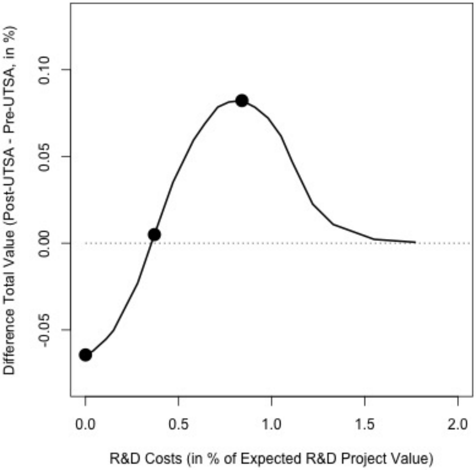
(2) Negative Average Effect for Low R&D Costs

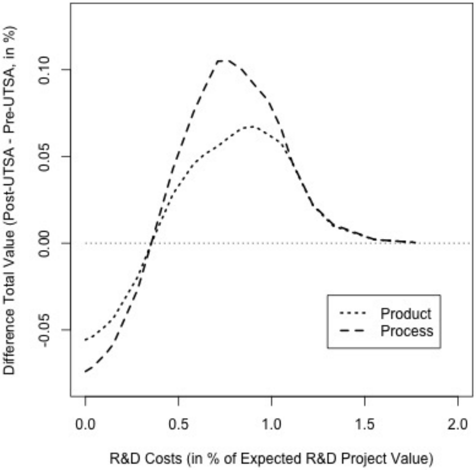
Percentage change in welfare:

$$\%\Delta W = \frac{W(\tau^{\text{post}}) - W(\tau^{\text{pre}})}{W(\tau^{\text{pre}})}$$

τ . . . level of trade secrets protection

(2) Negative Average Effect for low R&D Costs





low cost $\simeq$ high profitability

Summary

- Visibility matters for patenting-vs-secrecy
- Trade secrets matter for patenting-vs-secrecy

  $\Rightarrow$ both matter for disclosure and follow-on innovation
- add costs $\Rightarrow$ non-trivial effect of trade secrets on welfare

Bad for welfare? Depends R&D costs!

Thank you!

b.ganglmair@gmail.com

i.reimers@neu.edu

Construction of the UTSA Index

- Continuous use requirement
- Requirement to take reasonable effort to protect trade secrets
- Mere acquisition as misappropriation
- Limitations on whether the trade secret owner can take legal action
- Availability of punitive damages multiplier
- Limitations on injunctions

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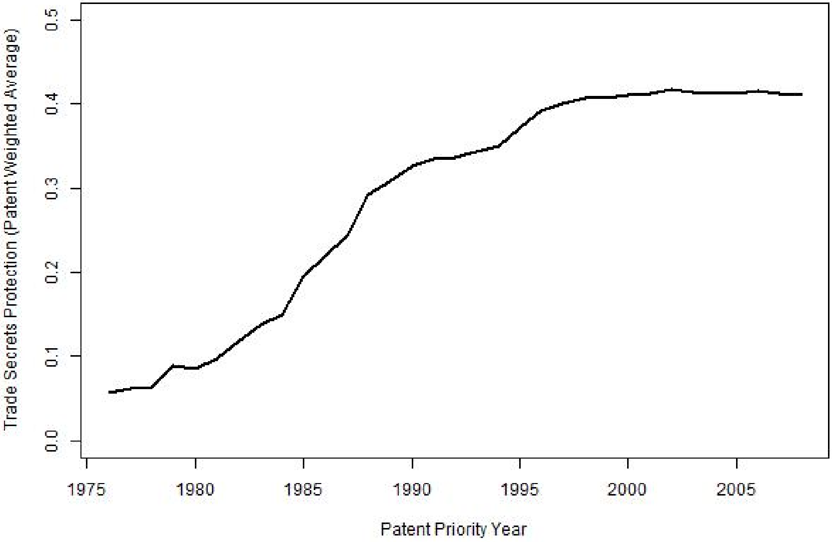
Trade Secrets Protection (Patent Weighted Average)
0.0
0.1
0.2
0.3
0.4
0.5
1975
1980
1985
1990
1995
2000
2005
Patent Priority Year

	Before UTSA		After UTSA	
	Mean	SD	Mean	SD
Process patent	0.428		0.521	
Number of process claims	0.759	1.300	0.964	1.470
Number of product claims	1.812	1.810	1.951	1.920
Observations	680,766		836,139	

- Process patent if at least one claim is a process claim
- “Aggressive" indicator – lower process shares for more conservative indicators – robust

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Heterogeneity: Size Effects

	(1)	(2)	(3)	(4)
Small firm	0.050***	0.027***	0.043***	0.021***
	(0.003)	(0.003)	(0.003)	(0.003)
Large firm	0.062***	0.038***	0.055***	0.035***
	(0.004)	(0.003)	(0.004)	(0.004)
Individual × Trade secrets protection	-0.037***	-0.041***	-0.051***	-0.046***
	(0.009)	(0.008)	(0.009)	(0.009)
Small firm × Trade secrets protection	-0.022**	-0.019**	-0.024**	-0.020**
	(0.009)	(0.009)	(0.010)	(0.009)
Large firm × Trade secrets protection	-0.002	-0.007	-0.008	-0.012
	(0.012)	(0.011)	(0.011)	(0.011)
Control vars: Complexity	N	Y	N	Y
Control vars: Value	N	N	Y	Y
Observations	1460358	1450434	905492	897578
$\overline{R}^2$	0.301	0.345	0.291	0.337

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Heterogeneity: Technology Class Effects

	(1)	(2)	(3)	(4)
Chemicals × Trade secrets protection	-0.064***	-0.060***	-0.059***	-0.053***
	(0.014)	(0.013)	(0.015)	(0.014)
Computers × Trade secrets protection	0.065***	0.061***	0.053***	0.046***
	(0.014)	(0.013)	(0.015)	(0.013)
Drugs × Trade secrets protection	-0.027	-0.020	-0.019	-0.017
	(0.021)	(0.020)	(0.020)	(0.019)
Electronics × Trade secrets protection	-0.010	-0.016	-0.033**	-0.036**
	(0.015)	(0.014)	(0.015)	(0.014)
Mechanics × Trade secrets protection	-0.031**	-0.036***	-0.040***	-0.038***
	(0.015)	(0.014)	(0.014)	(0.014)
Other × Trade secrets protection	-0.033***	-0.039***	-0.038***	-0.037***
	(0.010)	(0.010)	(0.010)	(0.010)
Control vars: Complexity	N	Y	N	Y
Control vars: Value	N	N	Y	Y
Observations	1475035	1465093	907857	899931
Adjusted R^2	0.300	0.345	0.289	0.337

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IV Estimates

- Instrument with state-level adoption of other uniform laws, unrelated to innovation (Png 2017b)
- Determination of death, lien regulation, durable power of attorney, fraudulent transfer

	(1)	(2)	(3)	(4)
Trade secrets protection	-0.101***	-0.077*	-0.118***	-0.110***
	(0.037)	(0.042)	(0.042)	(0.040)
Control vars: Complexity	N	Y	N	Y
Control vars: Value	N	N	Y	Y
Observations	1475058	1465095	907867	899932

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Robustness

	(1) Appl. Date	(2) Family Head	(3) Assignee Loc	(4) Single Assignee
Trade secrets protection	-0.030***	-0.030***	-0.028***	-0.025***
	(0.008)	(0.009)	(0.008)	(0.009)
Observations	881197	799099	1438020	852598
$\overline{R}^2$	0.335	0.342	0.334	0.335

	(1) Process: 1st	(2) Process: Most	(3) No Software	(4) Pre-trends
Trade secrets protection	-0.022***	-0.019***	-0.018**	-0.054***
	(0.007)	(0.007)	(0.008)	(0.017)
Observations	889101	894959	654458	894959
$\overline{R}^2$	0.307	0.261	0.314	0.335

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Estimation Procedure

1. Estimate Stage-2 *conditional distributions* using U.S. patent data and Proposition 2
   - Estimate visibility distribution for processes, G_M
   - Estimate distribution of invention types (θ_t)
   - Hold fixed: G_P and patent premium $\lambda = 0.1$ (Schankerman and Schuett 2017)

2. Via SMM, estimate Stage-1 *unconditional distributions*: Find the unconditional distributions that give rise to the conditional distributions estimated in Step 1, accounting for the inventor's R&D decision given costs C.

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Welfare Simulations

- Welfare from patent (think: Harberger's triangle):

$$W_D(\phi) = 2v - \frac{\phi v}{2}$$

- Welfare from secret:

$$W_S(\phi) = 2v - \frac{\tau\,(1-\phi)\,v}{2}$$

- Expected total welfare:

$$W(\tau) = E_{(\Theta_i,\phi_i,\tilde{\pi}_i,v_i,v_{i_F})}\left[\mathbf{R}_i(\tau)\left(W_{\Theta_i} + \tilde{\beta}_{i_F,\tilde{\pi}_i}\mathbf{R}_{i_F}W_{i_F}\right)\right]$$

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