Industry-University Collaboration and Commercializing Chinese Corporate Innovation

David H. Hsu	University of Pennsylvania
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Kaiguo Zhou	Sun Yat-Sen University
Tong Zhou	ShanghaiTech University

May 2022 @ ABFER

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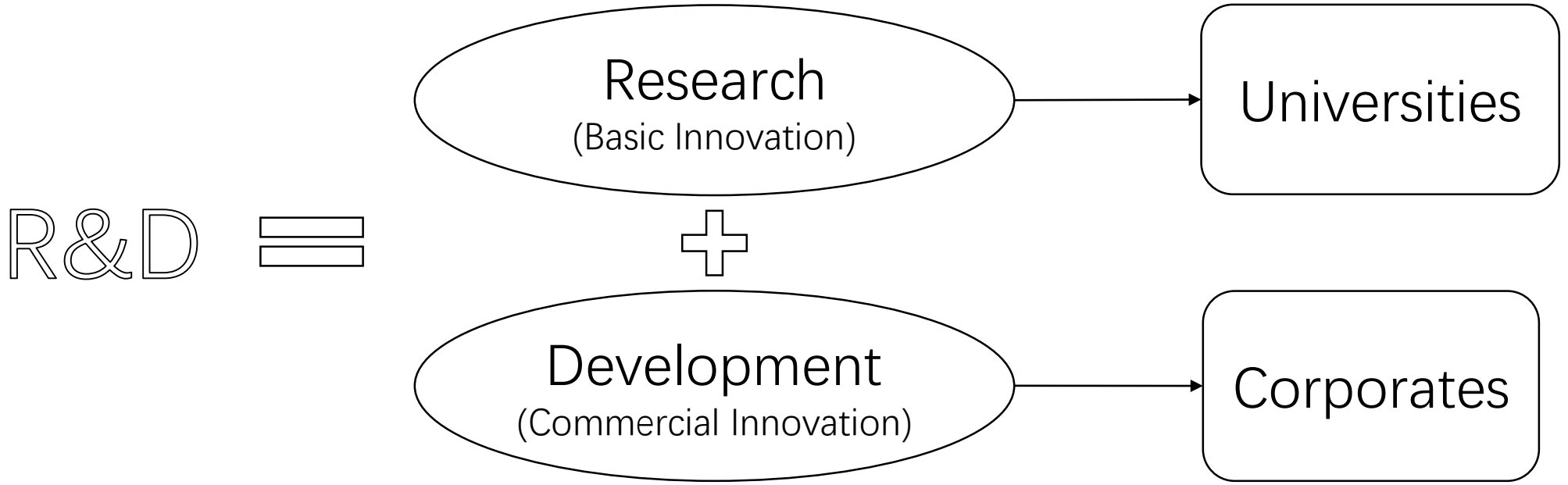
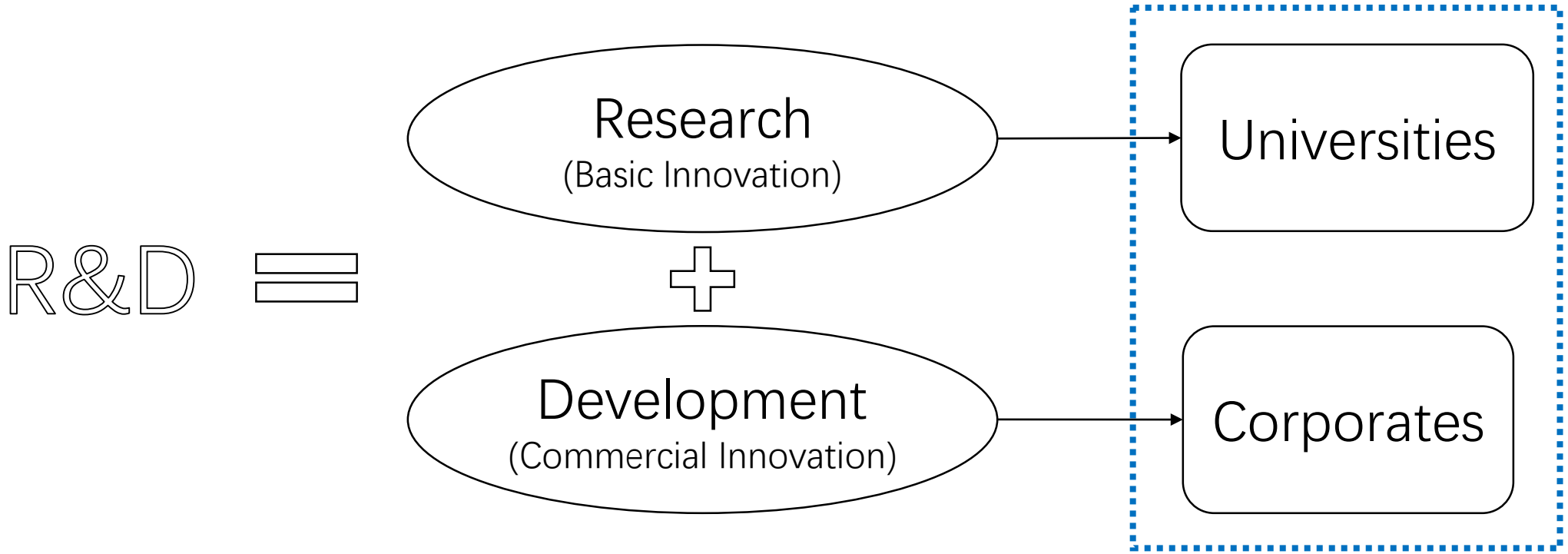
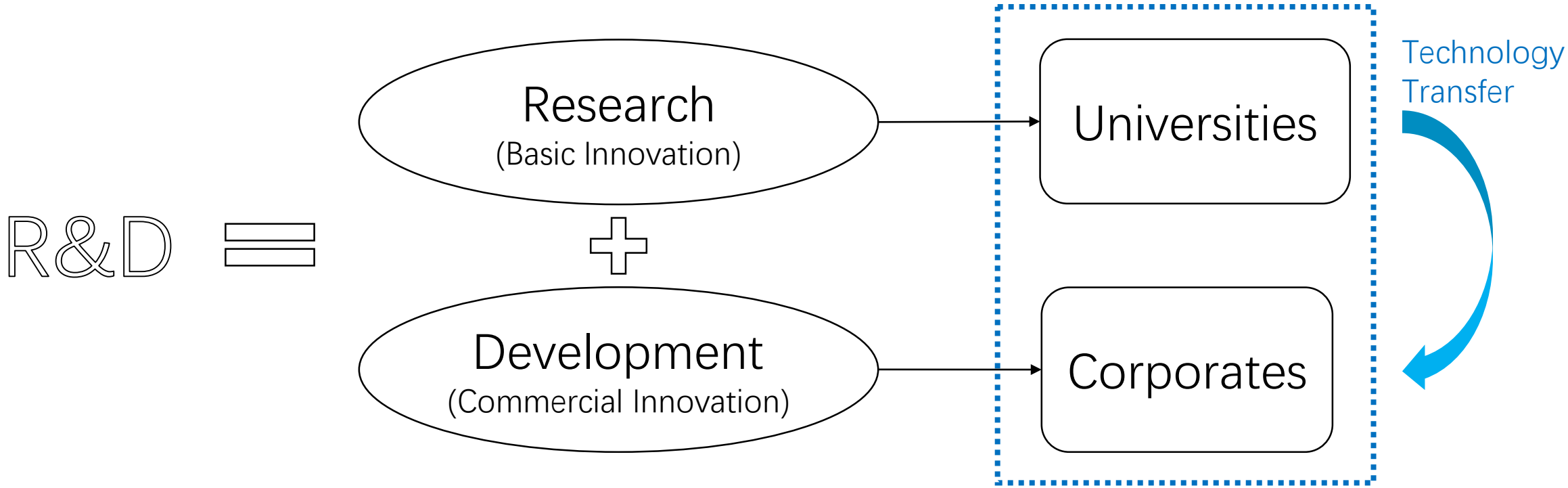
Industry-University Collaboration ("IUC")



Industry-University Collaboration ("IUC")



Industry-University Collaboration ("IUC")



IUC – Firms' Perspective

- **University spillover** and industrial technology
  - Nelson (1986 AER), Levin et al. (1987), Jaffe (1989 AER), Acs, Audretsch, and Feldman (1992 AER, 1994 REStat), and Cohen, Nelson, and Walsh (2002 MS)
- Previous studies test the effects of **industry-university collaboration** on **corporate innovation** are based on **survey data in developed countries**
  - Motohashi (2005 RP): industry survey of 724 firms in Japan
  - Fortana et al. (2006 RP): SME survey of 458 firms in Europe
  - Maietta (2015 RP): manufacturing industry survey of 1,744 firms in Italy
  - Walsh et al. (2016 RP): survey of about 1,900 inventors in the U.S.
- We examine the **underlying mechanisms** of technology transfers through IUC from firms' perspective

IUC and Innovation Commercialization

- **Cornerstone of technology commercialization**
  - Commercialization is a crucial step to convert innovation and invention into **profitability, competitiveness, and long-term performance** (Adams, 1990 JPE; Damanpour, 1991 AMJ; Zahra and Nielsen, 2002 SMJ)

- **Whether IUC enhances technology commercialization?**
  - Although university research is commonly regarded as more basic, it is **not necessarily wholly disconnected from product commercialization** (Roberts and Peters, 1981 RP; Chang et al., 2009 RP; Glenna et al., 2011 RP)
  - Basic research may have **broader applications** across technology fields, which creates **synergies across product lines** (Pavitt, 1991 RP)
  - Basic research may push technological frontier and enable a **first mover strategy** (Rosenberg, 1990 RP)

- **Industry-university collaboration could facilitate technology transfers from universities to corporates, thereby promoting corporate innovation commercialization**
  - **Two channels: knowledge acquisition and talent recruiting**

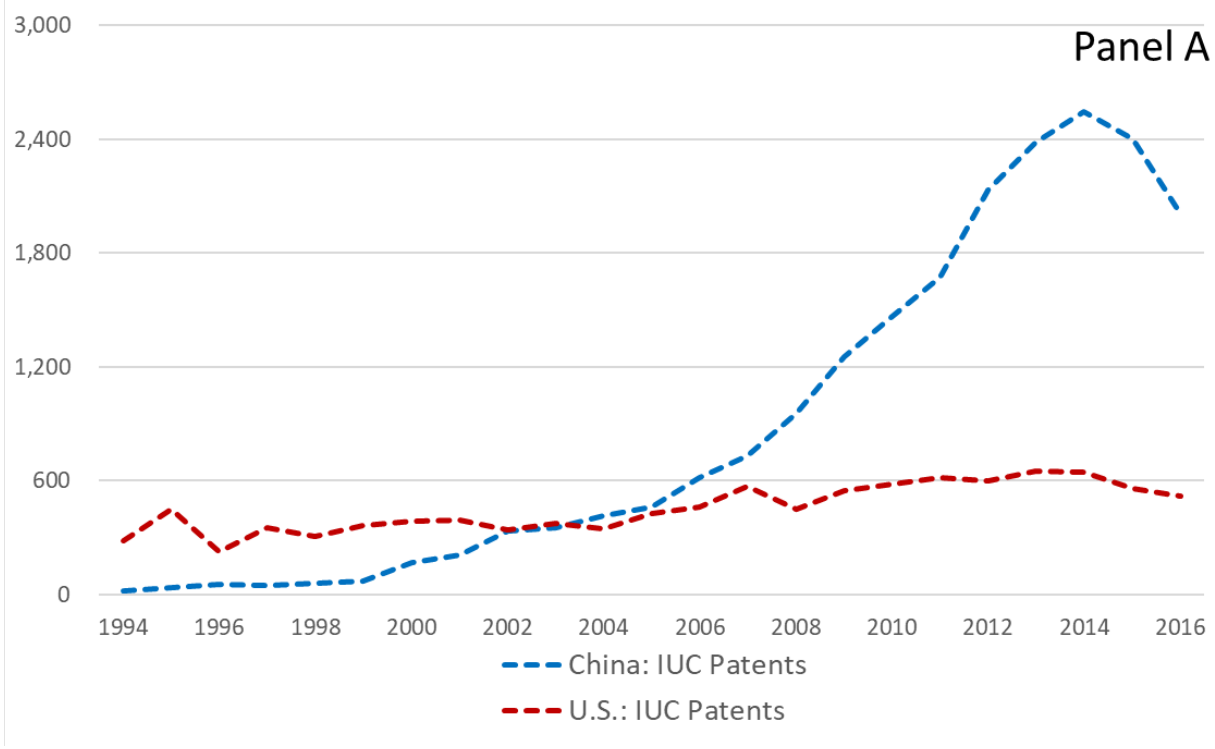
Huawei IUC Laboratories

- Huawei's joint laboratories with Tsinghua, Peking, Shanghai Jiaotong, Huazhong Science and Technology, South East, Nanjing…

- HUST-Huawei Joint Laboratory for Next-Generation Storage Devices
  - Fei XIANG (officer of storage devices R&D):
    - Huawei's product demand and HUST's technology capability are complementary to each other

- Tsinghua-Huawei Joint Research Institute
  - Wenwei XU (director of Huawei):
    - To resolve the bottlenecks and challenges of Information and Communication Technology (ICT), Huawei aims to achieve theoretical breakthroughs and technical inventions that could strengthen their vision and competitive edge in the Innovation 2.0 Era
    - One task of the joint research institute is to synergize technologies and talent resources

Why China?


Panel A
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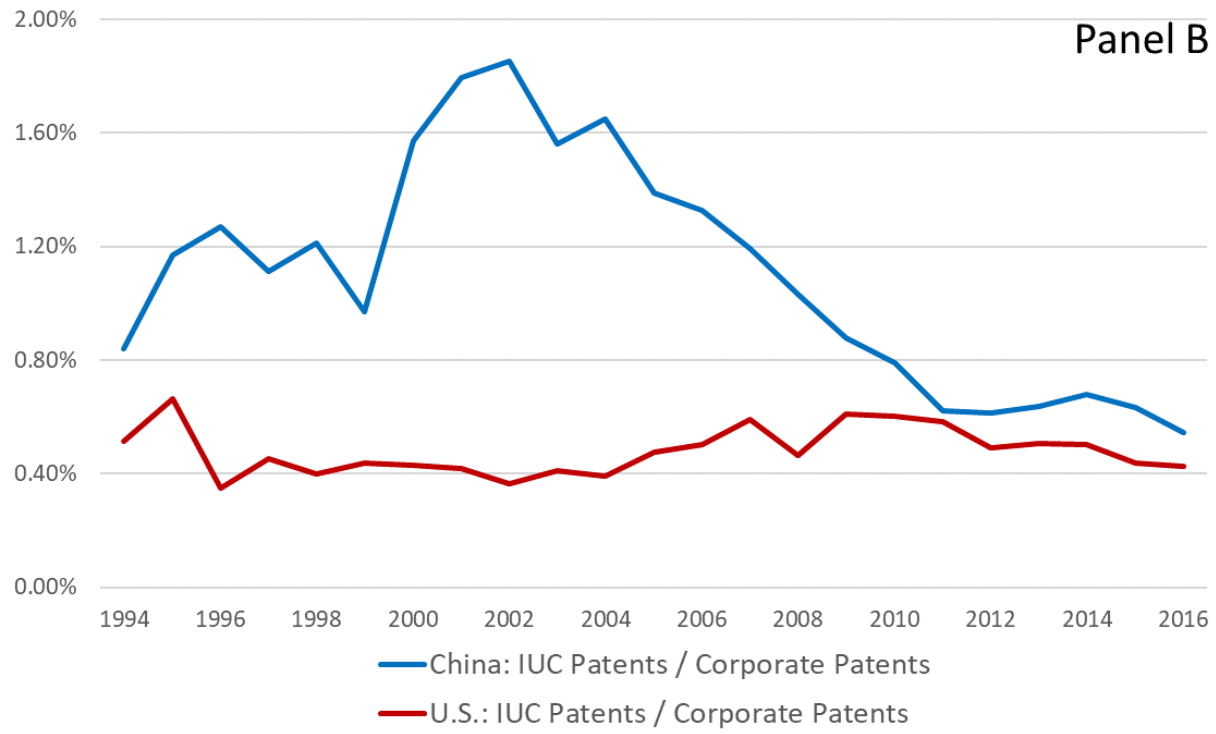
China: IUC Patents
U.S.: IUC Patents


Panel B
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China: IUC Patents / Corporate Patents
U.S.: IUC Patents / Corporate Patents

Data

Data

- We **are among the first to** use a **hand-collected, large-scale innovation dataset** in China

- **540K industrial firms 1998-2013**
  - Full coverage
    - Not limited to specific industries
    - Sufficient variation in firm characteristics
    - Detailed data for causal inference and mechanism analysis
  - Complete accounting information provided by National Bureau of Statistics (国家统计局)
    - No selection and survivorship bias
    - Unique firm codes allowing us to trace firms that change names over time (Brandt, et al., 2014 CER)
    - **Unique data of new product sales**

Data

- **A sample of innovative firms**
  - Manually collect NBS firms' patents granted from China National Intellectual Property Administration (CNIPA, 国家知识产权局)
  - **2.8M patents** that have been applied by (and successfully granted to) **93.3K of industrial firms** 1996-2016
  - For mechanism analysis:
    - 1.4M citing-cited patent pairs
    - 1.3M unique inventors and 13M inventor-patent pairs
  - Further drop firms with IUC patents in the first three sample years
    - To exclude university-run firms and professor-run firms
  - **92.5K unique firms and 784K firm-year observations**

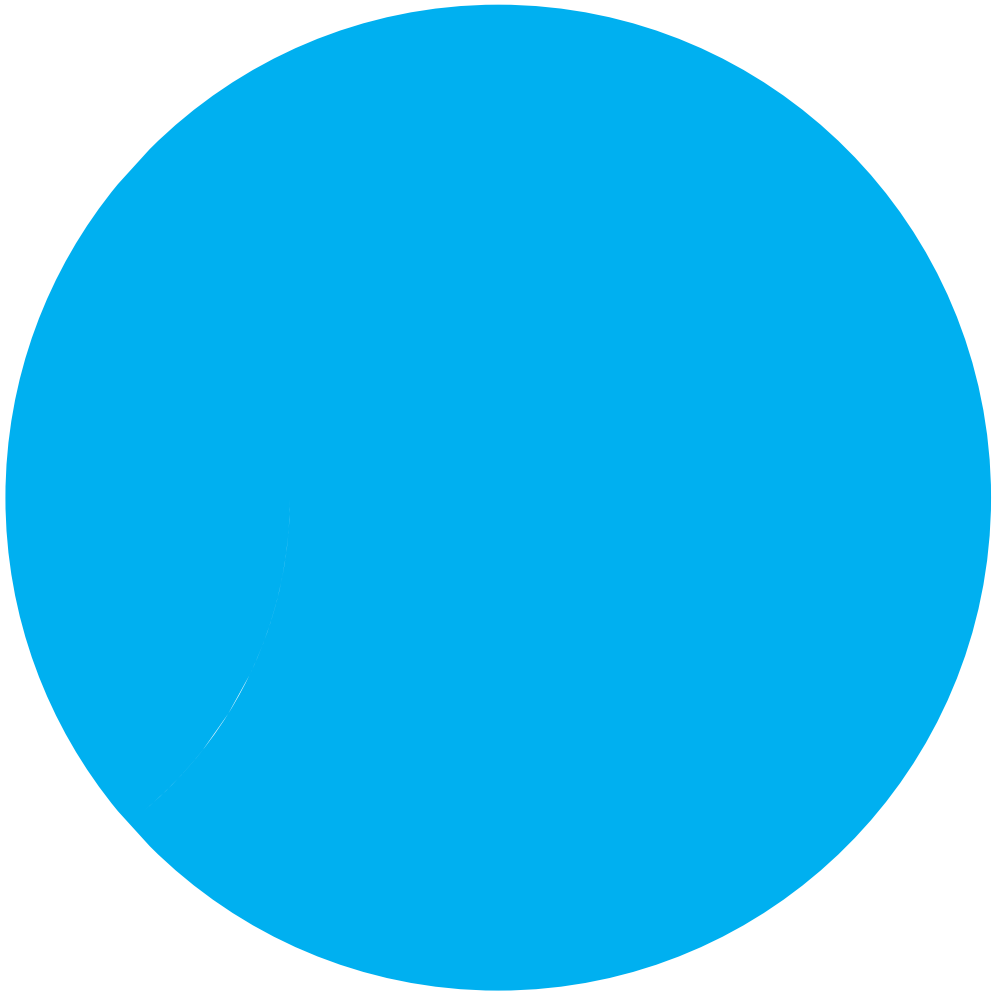
- We focus on invention model patents and utility model patents and skip design patents
  - They are comparable to "basic" utility patents and "improvement" utility patents categorized by USPTO (Huang, 2010 Science)
  - They capture novel technological innovation (Liegsalz and Wagner, 2013 RP; Hu et al., 2017 JDE)
  - We have also collected rich information on International Patent Classifications (IPCs), backward citations, assignees, and inventors

Data

- **University patents 1996-2016**
  - Research resources are concentrated in well-established universities and research institutes
  - First-tier “985”: 39 universities
  - Second-tier “211”: 112 universities
  - Research institutes: Chinese Academy of Sciences 中科院 and Chinese Academy of Social Sciences 社科院
  - **0.6M university patents** – at least one assignee is a university (or research institute)

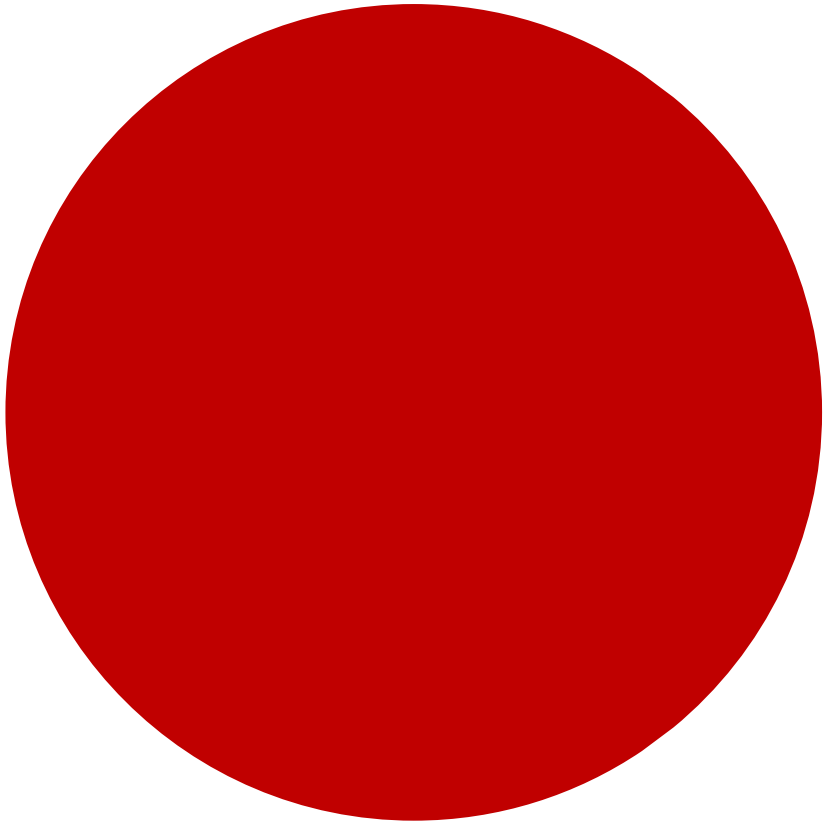
- **IUC patents 1996-2016**
  - Both one firm and one university are listed as the patent assignees
  - **20K IUC patents**
  - Caveat: we only consider “successful” IUC activities (Hong, 2008 RP; Walsh et al., 2016 RP)

Data



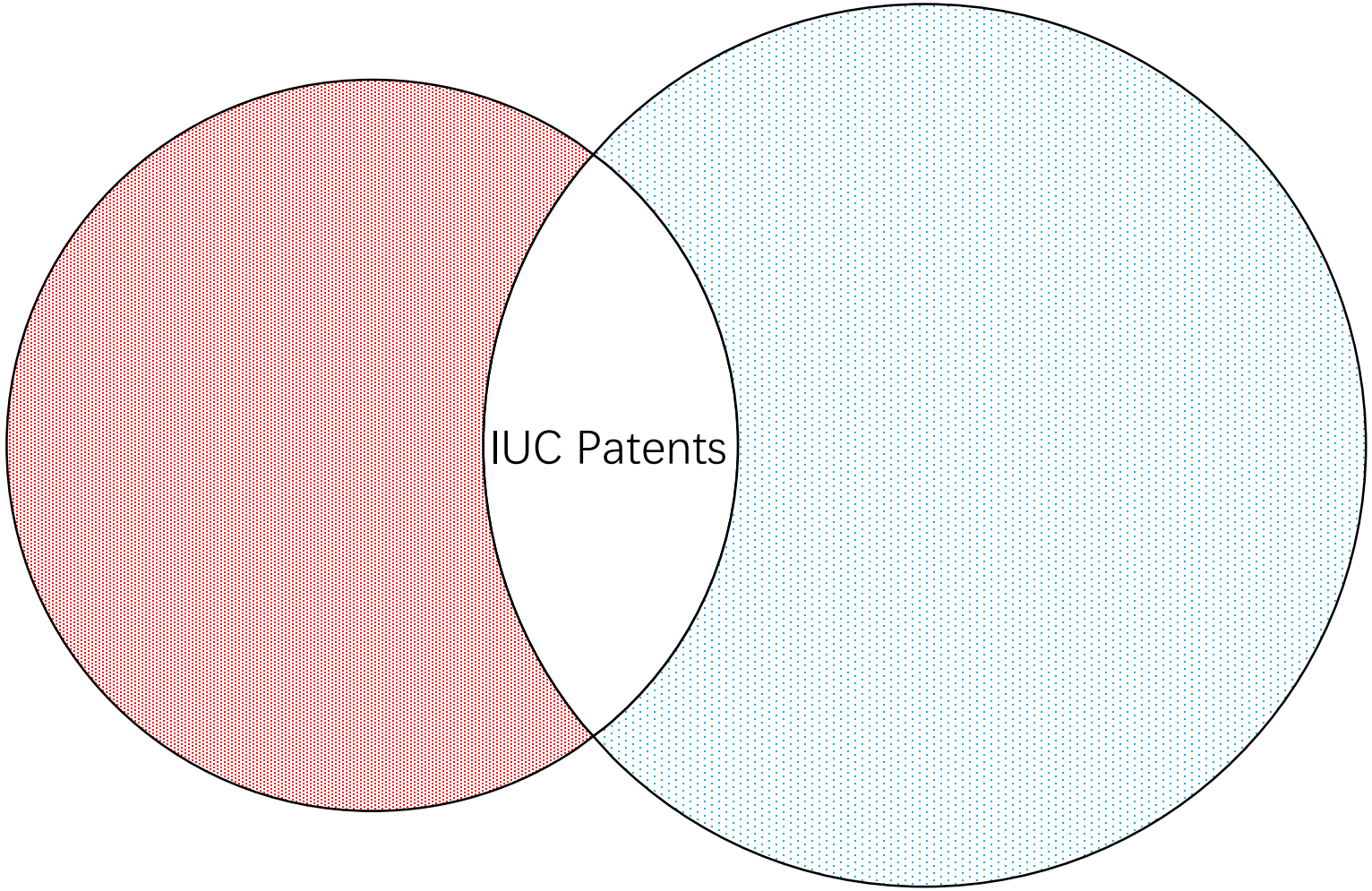
Corporate Patents - 2.8M

Data



University Patents - 0.6M

Data



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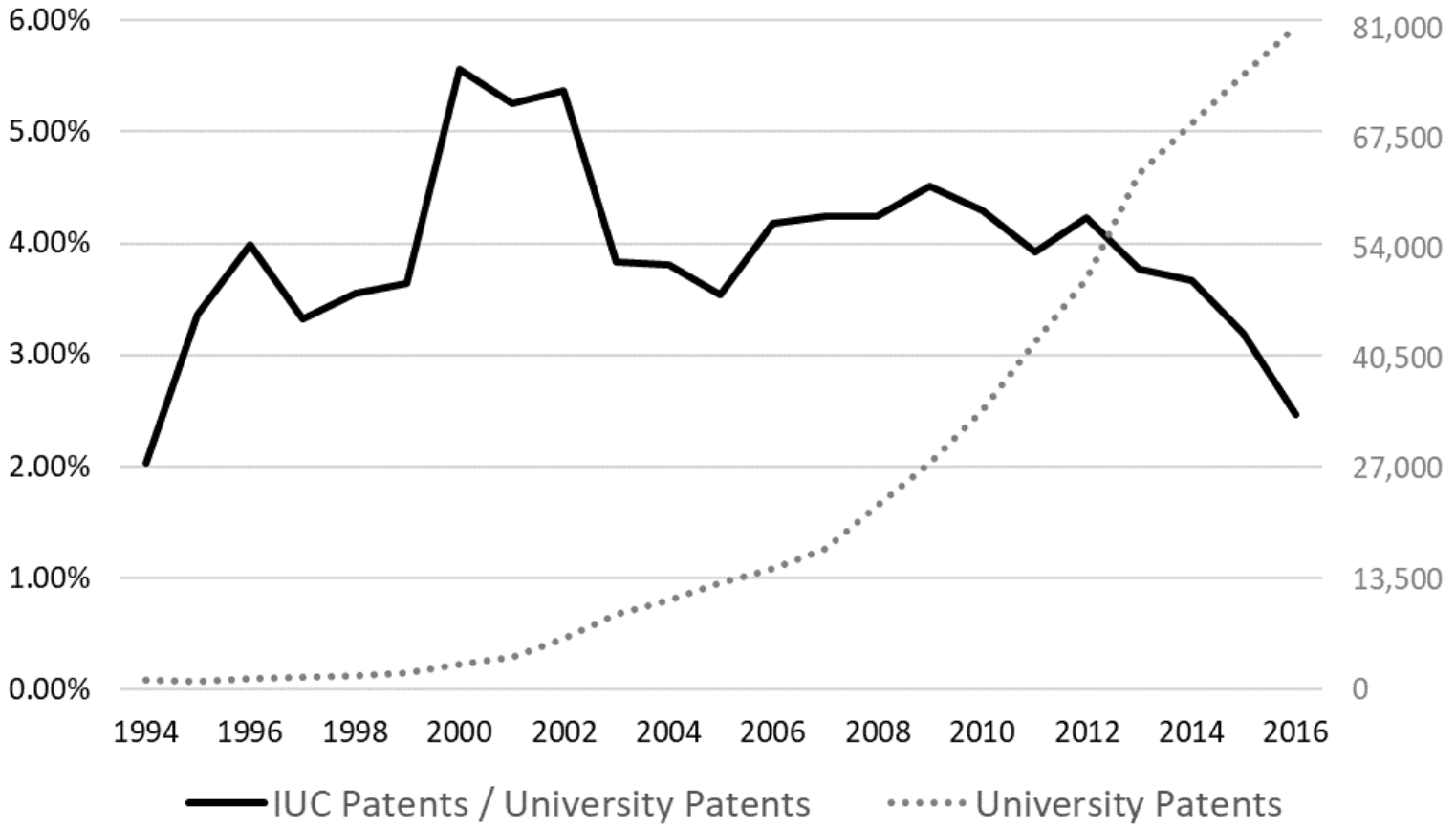
Data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IUC Patents / University Patents
University Patents

Empirical Measures – IUC

- IUC – key independent variable in both extensive and intensive margins
  - **IUC Dummy**: equals one if the focal firm has an IUC patent (assigned to both a university and the focal firm) application
  - **IUC Count**: number of IUC patents applied (and later successfully granted)
  - **IUC Ratio**: ratio of the number of IUC patents over total number of patents assigned to the focal firm
  - A three-year window to measure innovation inputs from year t-2 to t (Bena and Li, 2014 JF; Hsu et al., 2018 REStat)

	Mean	Std	Min	Q1	Median	Q3	Max
IUC Dummy	0.006	0.074	0.000	0.000	0.000	0.000	1.000
--(Conditional on non-zero obs)	1.000	0.000	1.000	1.000	1.000	1.000	1.000
IUC Count	0.009	0.137	0.000	0.000	0.000	0.000	3.000
--(Conditional on non-zero obs)	1.655	0.818	1.000	1.000	1.000	2.000	3.000
IUC Ratio	0.003	0.047	0.000	0.000	0.000	0.000	1.000
--(Conditional on non-zero obs)	0.496	0.394	0.000	0.111	0.400	1.000	1.000

Empirical Measures – Corporate Innovation

- We only focus on future (solely assigned) corporate innovation outputs from year t+1 to t+3
- Technology commercialization
  - **NewProductSales**: output value of new products
- Patent quantity and quality
  - **PatCount**: number of patents solely assigned to the focal firm
  - **PatCite**: average number of forward three-year citations of patents solely assigned to the focal firm
- Patent technology
  - **PatBasic**: ratio of academic papers over total backward citations of patents that are solely assigned to the focal firm
  - **PatExplore**: ratio of exploratory patents over the number of patents that are solely assigned to the focal firm
  - **TechBreadth**: average number of unique primary IPC codes per patent that is solely assigned to the focal firm

Empirical Measures – Corporate Innovation

- **Patent backward citations**
  - Chinese patents
  - Foreign patents
  - Non-patent references

- **International Patent Classification**
  - 8 categories from A to H
  - 135 classes, e.g., C01, E23

Empirical Measures – Corporate Innovation

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C01D 7/02 (2006.01)

(56) 对比文件
CN 106115720 A,2016.11.16
周才金.非受限空间内对撞流微反应器制备高性能纳米颗粒的研究.《中国优秀硕士学位论文全文数据库 工程科技I辑》.2019,

审查员 常伟伟

权利要求书1页 说明书4页 附图2页

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代理人 张润
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CN 104978492 A,2015.10.14
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权利要求书2页 说明书14页 附图5页

Baseline Analysis

Regression Model

$$NewProductSales_{t+1\to t+3} = \beta \cdot IUC_{t-2\to t} + Controls + FEs + \varepsilon_{t+3}$$

- Control variables: (Hsu et al., 2014 JFE; Gao et al., 2018 JFQA)
  - **Production scale**: total sales
  - **Innovation-related**: patent portfolio size, R&D intensity
  - **Basic characteristics**: total assets, age
  - **Operation-related**: cash ratio, capex intensity, profitability ratio, sales growth, export ratio, leverage ratio, subsidy ratio
  - **Labor-related**: labor ratio, wage per employee
- Fixed effects:
  - **Firm fixed effects**: control for corporate culture
  - **Province-by-year fixed effects**: control for regional innovation policies
  - **Industry-by-year fixed effects**: control for industry cycles

Baseline – Innovation Commercialization

Dept Var = New Product Sales						
	Panel A: IUC measured in Dummy		Panel B: IUC measured in Count		Panel C: IUC measured in Ratio	
	(1)	(2)	(1)	(2)	(1)	(2)
Industry-University Collaboration	12.8433**	12.9913**	7.7782**	8.0037**	12.7779**	12.9313**
	(5.6023)	(5.5503)	(3.2632)	(3.2364)	(5.6830)	(5.6786)
#Obs	566,633	566,633	566,633	566,633	566,633	566,633
#Firms	92,521	92,521	92,521	92,521	92,521	92,521
R-squared	0.8862	0.8868	0.8862	0.8869	0.8862	0.8868
Total Sales as a Control	YES	YES	YES	YES	YES	YES
Innovation-Related Controls	YES	YES	NO	YES	NO	YES
Firm Characteristics Controls	NO	YES	NO	YES	NO	YES
Firm FE	YES	YES	YES	YES	YES	YES
Province-Year FE	YES	YES	YES	YES	YES	YES
Industry-Year FE	YES	YES	YES	YES	YES	YES

Robustness checks using PPML

- **Innovation commercialization increases with IUC**
  - Firms engaging in IUC increases its new product sales by 13 million RMB (sample mean=21; sample std=54)
  - When IUC intensity (measured by count or ratio) increases by one standard deviation, its technology commercialization increases by 3-5% relative to the sample mean

Causal Inferences

- Potential endogeneity caused by omitted variables, such as corporate culture, local innovation policies, or industry cycles

- Innovation-friendly culture may promote both IUC and corporate innovation outputs
  - We have controlled for firm fixed effects
- Provinces that implement more supportive policies to innovation may promote both IUC and corporate innovation outputs
  - We have controlled for province-by-year fixed effects
- Industries that are in the phrases of greater demand for innovation may engage in more IUC and result in more innovation outputs
  - We have controlled for industry-by-year fixed effects

- Standard errors are clustered by firm to accommodate all firm-specific variation in estimation errors, such as autocorrelation

Causal Inferences

- Potential endogeneity caused by matching between universities and corporates
  - Some firms that are able to develop and commercialize their own technologies may be less motivated to engage in IUC → baseline coefficient is an underestimate
  - Some firms with better abilities to commercialize technologies may attract more universities to collaborate → baseline coefficient is an overestimate

- **Solutions:**
  - Staggered difference-in-differences
  - Instrumental variable regressions

Causal Inferences – Staggered DiD

- **Establishment of university science parks serves as plausible exogenous shocks to IUC**
- The main purpose of university science parks is to directly promote IUC as well as technology transfers
  - "国家大学科技园认定和管理办法" issued in 2019: university science parks should serve as a platform to facilitate IUC and realize its social services function
- University science parks are initiated by local governments rather than the pull from the demand side, i.e., corporate activities and decisions (Storey and Tether, 1998 RP; Tan, 2006 JBV)
  - Although university science parks are usually constructed in the same city of the managing universities, the **timing** of their establishment is plausibly exogenous
    - Tsinghua University(清华大学) in 1993
    - Shanghai Jiaotong University(上海交通大学) in 2001
  - Some university science parks are established in **locations** far from the managing universities
    - Chinese Academy of Sciences (中科院, located in Beijing北京) established a science park in Hangzhou杭州 in 2002
  - They are less likely to be initiated by specific firms

Causal Inferences – Staggered DiD

	Panel A: Dept Var = IUC						Panel B: Dept Var = New Product Sales	
	Panel A1: IUC measured in Dummy		Panel A2: IUC measured in Count		Panel A3: IUC measured in Ratio			
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
University Science Park (Post)	0.3226** (0.1310)		0.0032** (0.0013)		0.3327*** (0.0753)		6.4688*** (1.4348)	
Event Year = -2		-0.1402 (0.1604)		-0.0014 (0.0016)		-0.0877 (0.0767)		-2.1339 (1.7647)
Event Year = -1		0.0290 (0.1804)		0.0003 (0.0018)		0.0691 (0.0976)		-0.6458 (2.0768)
Event Year = 0		0.0359 (0.1867)		0.0004 (0.0019)		0.1694* (0.1003)		0.0559 (2.1495)
Event Year = +1		0.2992 (0.2127)		0.0030 (0.0021)		0.4063*** (0.1193)		6.0925*** (2.3458)
Event Year = +2		0.3935* (0.2316)		0.0039* (0.0023)		0.4358*** (0.1244)		5.5294** (2.2512)
Event Year >= +3		0.4828** (0.2274)		0.0048** (0.0023)		0.3910*** (0.1231)		10.7785*** (2.5284)
#Obs	80,137	80,137	80,137	80,137	80,137	80,137	80,137	80,137
#Firms	8,467	8,467	8,467	8,467	8,467	8,467	8,467	8,467
R-squared	0.4273	0.4274	0.4273	0.4274	0.4076	0.4077	0.8648	0.8649
Total Sales as a Control	YES	YES	YES	YES	YES	YES	YES	YES
Innovation-Related Controls	YES	YES	YES	YES	YES	YES	YES	YES
Firm Characteristics Controls	YES	YES	YES	YES	YES	YES	YES	YES
Firm FE (& Province FE)	YES	YES	YES	YES	YES	YES	YES	YES
Industry-Year FE	YES	YES	YES	YES	YES	YES	YES	YES

Causal Inferences – Instrumental Regressions

- **IV: Policy guidance**
  - IUC could be promoted by **local governments' policies**
  - Denotes the ratio of the number of articles mentioning "产学研 (industry-university collaboration)" that are published in official newspapers affiliated with provincial governments (省委机关报)
  - When IV is larger, it is possible that the focal firm's IUC activities are initiated by policy guidance of local governments, rather than by specific corporate factors (Ang, Cheng, and Wu, 2014 REStat)

Causal Inferences – Instrumental Regressions

	Dept Var = New Product Sales					
	Panel A: IUC measured in Dummy		Panel B: IUC measured in Count		Panel C: IUC measured in Ratio	
	1st Stage	2nd Stage	1st Stage	2nd Stage	1st Stage	2nd Stage
Industry-University Collaboration		175.8948* (92.9853)		121.9432* (64.9905)		205.1512* (107.8250)
IV: Policy Guidance	65.0591*** (5.7885)		93.8432*** (10.6361)		55.7810*** (3.7396)	
#Obs	566,633	566,633	566,633	566,633	566,633	566,633
#Firms	92,521	92,521	92,521	92,521	92,521	92,521
***F* Statistic**	517.8		589.9		79.86	
Underidentification LM Statistic (*p* Value)		148.1 (0.000)		91.29 (0.000)		260.8 (0.000)
Control Variables	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES
Province FE	YES	YES	YES	YES	YES	YES
Industry-Year FE	YES	YES	YES	YES	YES	YES

- IV estimates are highly comparable to baseline estimates
  - A one-standard-deviation increase in IUC increases New Product Sales by 3%-14% of the sample mean of the dependent variable.

Mechanism Analysis

Technology Transfers – Who Benefit More?

- **As IUC bring new technologies (more basic) to firms, do firms in industries replying more on basic research benefit more from IUC?**
  - Mansfield (1991 RP, 1998 RP), Klevorick et al. (1995 RP), Narin, Hamilton, Olivastro (1997 RP), and Cohen, Nelson, and Walsh (2002 MS)

- **Citations to Academic Papers**: ratio of backward citations to non-patent prior arts over total backward citations of patents applied by (and finally granted to) firms in the industry
- **Citations to University Patents**: ratio of backward citations to university patents over total backward citations of patents applied by (and finally granted to) firms in the industry

Technology Transfers – Who Benefit More?

Panel A: Measuring Reliance on Science with Citations to Basic Science

	Dept Var = New Product Sales					
	Panel A1: IUC measured in Dummy		Panel A2: IUC measured in Count		Panel A3: IUC measured in Ratio	
	High Group	Low Group	High Group	Low Group	High Group	Low Group
	(1)	(2)	(1)	(2)	(1)	(2)
Industry-University Collaboration	19.3208***	-2.8249	11.6726***	-0.8137	13.5537*	-0.3690
	(7.0979)	(8.8523)	(4.1938)	(4.8939)	(6.9892)	(8.9570)
#Obs	283,350	283,283	283,350	283,283	283,350	283,283
#Firms	92,521		92,521		92,521	
R-squared	0.8792	0.8965	0.8792	0.8965	0.8791	0.8965
Controls	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES
Province-Year FE	YES	YES	YES	YES	YES	YES
Industry-Year FE	YES	YES	YES	YES	YES	YES

Panel B: Measuring Reliance on Science with Citations to University Patents

	Dept Var = New Product Sales					
	Panel B1: IUC measured in Dummy		Panel B2: IUC measured in Count		Panel B3: IUC measured in Ratio	
	High Group	Low Group	High Group	Low Group	High Group	Low Group
	(1)	(2)	(1)	(2)	(1)	(2)
Industry-University Collaboration	19.4121***	-4.8452	12.3726***	-3.0843	14.1482*	-2.3122
	(7.4217)	(6.9379)	(4.3077)	(4.1627)	(7.4380)	(6.9193)
#Obs	282,005	284,628	282,005	284,628	282,005	284,628
#Firms	92,521		92,521		92,521	
R-squared	0.8836	0.8915	0.8837	0.8915	0.8836	0.8915
Controls	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES
Province-Year FE	YES	YES	YES	YES	YES	YES
Industry-Year FE	YES	YES	YES	YES	YES	YES

Technology Transfers – Patent Attributes

- **As IUC bring new technologies (more basic, more broadly applicable) to firms, are they reflected in the firms' future (own) patents?**
- Does IUC makes firms more innovation?
  - **PatCount**: the number of new patents filed by a firm in a 3-year window
  - **PatCite**: the number of new citations per patent filed by a firm in a 3-year window
- Does IUC introduce fundamental research to firms?
  - **PatBasic**: ratio of academic papers over total backward citations of patents that are solely assigned to the focal firm
- Does IUC broaden corporate patents' technology base?
  - **PatExplore**: ratio of exploratory patents over the number of patents that are solely assigned to the focal firm
  - **TechBreadth**: average number of unique primary IPC codes per patent that is solely assigned to the focal firm

Technology Transfers – Other Patent Attributes

- **Mechanism of technology transfers is supported**
  - **Higher patent basicness**: IUC strengthens firms' science foundation
  - **Higher patent exploration**: IUC expands firms' technology search areas
  - **Higher technology breadth**: IUC broadens firms' technology application

Panel A: Dept Var = PatBasic			
	Panel A1: IUC measured in Dummy	Panel A2: IUC measured in Count	Panel A3: IUC measured in Ratio
Industry-University Collaboration	0.0071***	0.0028***	0.0053***
	(0.0012)	(0.0006)	(0.0018)
#Obs	784,025	784,025	784,025
#Firms	92,521	92,521	92,521
R-squared	0.4751	0.4751	0.4750
Control Variables	YES	YES	YES
Firm FE	YES	YES	YES
Province-Year FE	YES	YES	YES
Industry-Year FE	YES	YES	YES
Panel B: Dept Var = PatExplore			
	Panel B1: IUC measured in Dummy	Panel B2: IUC measured in Count	Panel B3: IUC measured in Ratio
Industry-University Collaboration	0.0442***	0.0178***	0.0974***
	(0.0119)	(0.0056)	(0.0204)
#Obs	784,025	784,025	784,025
#Firms	92,521	92,521	92,521
R-squared	0.5001	0.5001	0.5001
Control Variables	YES	YES	YES
Firm FE	YES	YES	YES
Province-Year FE	YES	YES	YES
Industry-Year FE	YES	YES	YES
Panel C: Dept Var = TechBreadth			
	Panel B1: IUC measured in Dummy	Panel B2: IUC measured in Count	Panel B3: IUC measured in Ratio
Industry-University Collaboration	0.0909***	0.0406***	0.2055***
	(0.0088)	(0.0042)	(0.0163)
#Obs	784,025	784,025	784,025
#Firms	92,521	92,521	92,521
R-squared	0.4066	0.4066	0.4067
Control Variables	YES	YES	YES
Firm FE	YES	YES	YES
Province-Year FE	YES	YES	YES
Industry-Year FE	YES	YES	YES

Channels of Technology Transfers

- Does IUC facilitate **technology transfers from university to firms**? Yes.
- We also propose **two channels of technology transfers** (Prager and Omenn, 1980 Science)

1. **Channel of knowledge acquisition**
   - Firms could benefit from IUC for "*additional sources of ideas, knowledge, and technology on which to base potential new products and processes*" (Prager and Omenn, 1980 Science)
   - Collaboration facilitates learning (Powell et al., 1996 ASQ; Cassiman and Veugelers, 2002 AER)
   - Learning lows the R&D costs of firms (Belderbos et al., 2004 RP; Scandura, 2016 RP)
2. **Channel of talent recruiting**
   - Firms could benefit from IUC for "*source of potential research employees sympathetic to industry needs*" (Prager and Omenn, 1980 Science)
   - Collaboration enhances the sharing of complementary assets (Rothaermel, 2001 SMJ, 2001 RP; Cowan et al., 2007 MS)
   - Talents from universities strengthen the diversity in innovation teams and decision angles (Østergaard et al., 2011 RP; Qian et al., 2013 SMJ; Che and Zhang, 2018 EJ)

Go to quotations from top Chinese leaders on IUC technology transfers

Channel Tests

- **Through what channels does IUC bring new technologies to firms and promote corporate innovation commericialization?**

$$ChannelVar_{t+1\to t+3} = \beta \cdot IUC_{t-2\to t} + Controls + FEs + \varepsilon_{t+3}$$

- **Knowledge acquisition**
  - **UnivCite**: ratio of university patents cited divided by total patents cited by patents that are solely assigned to the focal firm – knowledge acquired from universities
  - **CorpCite**: ratio of other firms' patents cited divided by total patents cited by patents that are solely assigned to the focal firm – knowledge acquired from other firms
- **Talent recruiting**
  - **UnivInventor**: ratio of former university inventors over total inventors filing patents that are solely assigned to the focal firm – talents recruited from universities
  - **CorpInventor**: ratio of former other firms' inventors over total inventors filing patents that are solely assigned to the focal firm – talents recruited from other firms

Channels – Acquiring Universities' Knowledge

	Dept Var = UnivCite		
	Panel A1: IUC measured in Dummy	**Panel A2: IUC measured in Count**	**Panel A3: IUC measured in Ratio**
Industry-University Collaboration	0.0133*** (0.0030)	0.0058*** (0.0015)	0.0171*** (0.0042)
#Obs	784025	784025	784025
#Firms	92,521	92,521	92,521
R-squared	0.4128	0.4128	0.4128
Control Variables	YES	YES	YES
Firm FE	YES	YES	YES
Province-Year FE	YES	YES	YES
Industry-Year FE	YES	YES	YES

- Firms tend to cite university patents more after engaging in IUC
  - Engaging in IUC is associated with an increase of 1.3% in UnivCite (sample mean = 1%; sample standard deviation = 10%)
  - When IUC intensity (measured by count or ratio) increases by one standard deviation, UnivCite increases by 8% relative to the sample mean

Channels – Acquiring Other Firms' Knowledge (Placebo)

	Dept Var = CorpCite		
	Panel B1: IUC measured in Dummy	**Panel B2: IUC measured in Count**	**Panel B3: IUC measured in Ratio**
Industry-University Collaboration	-0.0022 (0.0063)	-0.0010 (0.0030)	-0.0137 (0.0090)
#Obs	784025	784025	784025
#Firms	92,521	92,521	92,521
R-squared	0.4147	0.4147	0.4147
Control Variables	YES	YES	YES
Firm FE	YES	YES	YES
Province-Year FE	YES	YES	YES
Industry-Year FE	YES	YES	YES

- Firms tend to cite corporate patents indifferently after engaging in IUC

Channels – Recruiting Talents from Universities

	Dept Var = UnivInventor		
	Panel A1: IUC measured in Dummy	**Panel A2: IUC measured in Count**	**Panel A3: IUC measured in Ratio**
Industry-University Collaboration	0.0148*** (0.0017)	0.0066*** (0.0008)	0.0151*** (0.0025)
#Obs	784025	784025	784025
#Firms	92,521	92,521	92,521
R-squared	0.4641	0.4641	0.4639
Control Variables	YES	YES	YES
Firm FE	YES	YES	YES
Province-Year FE	YES	YES	YES
Industry-Year FE	YES	YES	YES

- Firms tend to hire more former university inventors after engaging in IUC
  - Engaging in IUC is associated with an increase of 1.5% in UnivInventor (sample mean = 1%; sample standard deviation = 6%)
  - When IUC intensity (measured by count or ratio) increases by one standard deviation, UnivInventor increases by 1-2% relative to the sample mean

Channels – Recruiting Talents from Other Firms (Placebo)

	Dept Var = CorpInventor		
	Panel B1: IUC measured in Dummy	**Panel B2: IUC measured in Count**	**Panel B3: IUC measured in Ratio**
Industry-University Collaboration	-0.0104*** (0.0035)	-0.0073*** (0.0016)	-0.0126*** (0.0038)
#Obs	784025	784025	784025
#Firms	92,521	92,521	92,521
R-squared	0.4058	0.4058	0.4058
Control Variables	YES	YES	YES
Firm FE	YES	YES	YES
Province-Year FE	YES	YES	YES
Industry-Year FE	YES	YES	YES

- Firms tend to hire fewer inventors from other corporates after engaging in IUC
- This finding suggests that **talent flows from universities act as potential substitutes to talent flows from corporates**

Conclusion

- We examine **to what extent** and **how** industry-university collaboration promotes corporate innovation commercialization
- We use a hand-collected, **large-scaled** innovation dataset that covers **93K industrial firms** and **0.8M firm-year observations** in China
- **Finding #1**: IUC promotes firms' **technology commercialization**
  - Innovation commercialization is measured by new product sales in innovation firms
  - Results are robust when we measure IUC in extensive and intensive margins
  - Causal claims are made based on staggered DiD analysis (the establishment of science park), as well as instrumental regressions (local governments' promotion of IUC)
- **Finding #2**: IUC facilitates **technology transfers** to corporates
  - IUC improves patent number, quality, basicness, exploration, and technology breadth
  - Technologies spill over via **two channels of knowledge acquisition and talent recruiting**
- Policy implication: both **direct technology transfers** through IUC and its **spillover effects that enhance corporate technology commercialization** could be important