

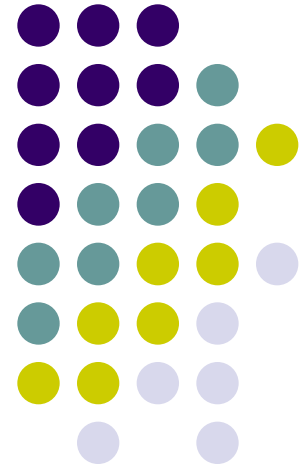
Research Opportunities with Patent Data to Understand Innovation in Emerging Markets

Kenneth Huang

Singapore Management University
Lee Kong Chian School of Business

kennethhuang@smu.edu.sg

August 10, 2013



Two directions where patent related research are going: Recent examples



1. “Deeper”: Analyzing our past practice in using (primarily USPTO) patent data often with novel derived measures or interpretation of basic measures:
 - Patents are useful proxy of innovative output at multiple levels over a significant period of time and citations correlate well with actual knowledge flow (Jaffe & Trajtenberg 2002, Duguet & MacGarvie 2005)
 - But patents represent only a fraction of all inventions constructed within complex institutional framework by strategic actors who use patents to strengthen their competitive positions (Hall & Ziedonis 2001, Ziedonis 2004, Von Graevenitz, Wagner & Harhoff 2011)
 - Patent examination, granting and citation process (Alcacer & Gittelman 2006, Lampe 2011, Roach & Cohen 2011)

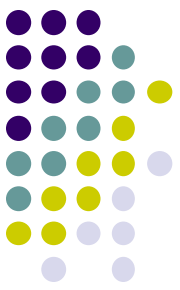
Two directions where patent related research are going: Recent examples



2. “Wider”: Extending, linking, comparing USPTO patent data with other data sources often with novel empirical designs/ identification methods to generate important insights on:

- Institutions (Furman & Stern 2011, Zhao 2006); firms e.g., acquisitions (Kapoor & Lim 2007), financing (Hsu and Ziedonis 2013), licensing (Gans, Hsu & Stern 2008); standard setting organizations (Rysman & Simcoe 2008, Simcoe, Graham & Feldman 2009); inventors e.g., networks and mobility (Fleming 2007, Fleming et al. 2007, Singh & Agrawal 2011); scientific knowledge & processes e.g., patent-paper pairs (Murray & Stern 2007, Huang & Murray 2009 *AMJ*, 2010 *RP*)
- **Innovation, science and technology in emerging markets like China** (Huang 2010 *Science*, Huang et al. 2013, Hu & Jefferson 2009)

Focus on research opportunities by carefully using/combining patent data from emerging economies



Two examples from my own research:

1. Using patent data from China (SIPO)
2. Combining USPTO and SIPO patent data and take advantage of natural experiments

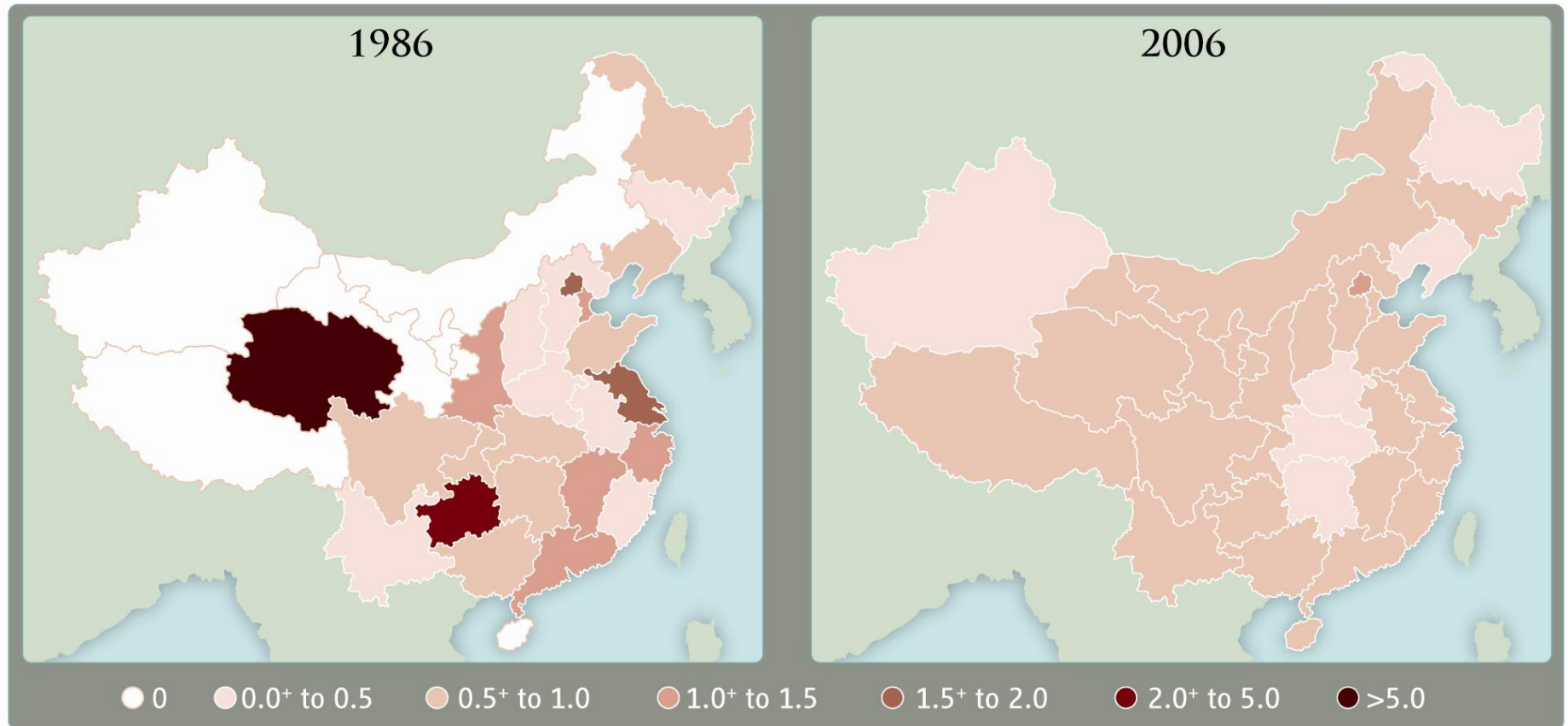


Example 1: Science, technology & innovation in emerging market of China (Huang 2010 *Science*)



- Large-scale patent data can shed light on innovation landscape/ innovative capacity at the national level, particularly scientific & technological trajectories & geographic diffusion
- Extending (beyond USPTO) to SIPO patent data can mitigate:
 - **Selection bias**, as the sample of Chinese firms willing and able to file a patent with the USPTO is severely restricted compared with the entire population of Chinese firms, particularly start-ups
 - **Under-representation** of government-related organizations, regulatory agencies, universities, or research institutes, because these organizations largely file patents within China
- *Key findings:* China's patent system (1985 to 2006) is marked by a growing, domestic private sector scientific and technological capabilities, and systematic geographic diffusion of innovative capacity

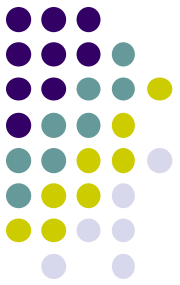
Systematic geographic diffusion of S&T capabilities from coastal areas to central and interior regions => evening-out of relative S&T advantages across China



Source: Huang (2010) Science, 329 (5992): 632-633

Example 2: Institutional regime shift in IPR and patenting strategies of firms in China

(Huang, Geng & Wang 2013)



- Emerging economies often face major regulatory changes during institutional reform and globalization of markets
 - Cause radical change in institutions for emerging market firms
- Institutions that facilitate innovations are critical for competitiveness
 - IPR is one of the most important regulative institutions (North 1991, Acemoglu et al. 2001, Besley & Ghatak 2009, **Huang & Murray 2009**)
 - Firms increasingly operate & conduct R&D in emerging markets (e.g., China) (Barrett et al. 2011, Zhao 2006)
- Conventional view: improve IPR institution enhances firm innovations
 - Emerging economies like China may implement (sudden) regulatory changes to align their IPR standards to international standard
- However, we lack understanding of the reactions – i.e., behaviors and strategies – of firms from different home institutions to such major change in regulative institutions



Research questions

How do Chinese firms react to changes in formal institutions/rules differently from Western firms (in China)?

- Whether & how major shift in China's formal institutional regime in IPR has an impact on firms' patenting strategies in China
- How do changes in firms' patenting behavior in response to IPR regime shift depend on firms' operational age in China and variation in *de facto* quality of IPR system across regions?

IPR institution in China and patenting strategies



- IPR institution/protection mitigates expropriation problems
 - Emerging markets like China have weak IPR regime but regulatory reform/strengthening should encourage innovation
- Firms (especially Western ones) increasingly conduct R&D and innovative activities in such emerging markets as China
 - Internalize innovation or obtain long-term, strong patent protection
 - Firms face alternative strategic choice: SIPO invention vs. utility model patents
 - Invention patents have longer/clearer protection
 - Utility model patents less clear, weaker but easier to obtain
 - Although there are differences, substantial overlaps exist between technologies filed for both types
 - An innovation qualified for invention patents typically also qualifies for and can be filed for utility model patents instead

Natural experiment – major exogenous “shock” to strengthen IPR regime



2001 China Patent Law Amendment

Adopted and announced at the 17th Session of the Standing Committee of the 9th National People's Congress on 25 August 2000 and effective on 1 July 2001. Top-down reform.

Objective: To promote the development and innovation of science and technology

Motivation: Membership into World Trade Organization (WTO)
Patent law fully in line with TRIPS agreement
Enhances innovations from Chinese/domestic technology firms

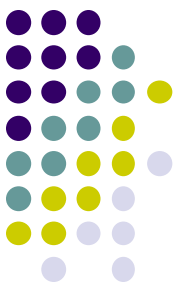
Changes implemented:

Examination/ Review	More efficient examination and approval procedures Patentability of a utility model patent subject to judicial review Search report for utility model that can be obtained after substantive examination may be required
Patent scope	Right to patent goes to employer if employee uses materials and resources of the employer to make invention
Assignee right	Exclusive right of "offering for sale" extended to assignee More severe punishment for violation of existing patent right Stricter licensing procedures Use or sale of patented product without knowing that it was patented now considered infringement

Hypothesis 1: Differential responses of Chinese & Western firms in China to IPR institutional change



- Chinese firms and their strategies are embedded in informal institutional norms & practices deeply rooted in the traditional Chinese philosophies/culture of Taoism & Confucianism
 - Taoism: No objective written rule about what the right conduct is; *wuwei* (action through non-action), naturalness, & spontaneity e.g., *Art of War* by Sun Tzu: “*The supreme art of war is to subdue the enemy without fighting*”
 - Confucianism: Less emphasis on formal rules and regulations but more on social norms and code of conduct as the basis of civil society
 - “Rule by man” (*renzhi* 人治) is preferred to “rule by law” (*fazhi* 法治) *Renzhi* establishes the role of authority and *guanxi* networks in governing the relationship between society members. Respect for authority & relationship are important in implementing *renzhi* in China
- Chinese market: complex interdependence among weak institutional forces – enhances feasibility of conflict resolution through informal intervention by authorities and other informal norms & practices by Chinese firms



Hypothesis 1 (continued)

- **Chinese firms** embed their strategies in such institutional environment for optimal effectiveness and performance
- Chinese firms are less responsive to sudden change/reform in IPR regulations (because of embeddedness of firms and strategies in existing/old institutions)
=> perceive utility model patents as less viable & less increase in adoption (though still increase due to better protection)
- **Western firms** experience different institutional environment when entering China (i.e., embeddedness in home institution)
- When IPR regime improves in China, it reduces difficulty (& need) to adapt to host institutional environment
=> more responsive to new IPR regulation & adopt more

H1. *Upon the strengthening of a previously weak form of IPR protection (utility model patent), the increase in its adoption is smaller for Chinese firms than for Western firms*

Hypothesis 2: Variation in Western firms' operational age in China



- Difference in Western MNCs' operational age and experiences in China may influence their understanding of & adaptation to China's informal institutions, norms & practices
 - Earlier entrants have more opportunity to learn from & understand their Chinese counterparts, markets, governments & business community
 - Western firms learn, imitate and assimilate informal norms and practices of their Chinese counterparts through exposure to local informal norms and practices; Earlier Western entrants also have more time to cultivate relationships and *guanxi* with their key stakeholders
 - Transition from “foreign investors” to “strategic insiders”
 - With longer operation in China, Western firms can better adapt to local informal institution & behave more like Chinese firms in IPR strategies

H2. *Upon the strengthening of a previously weak form of IPR protection (utility model patent), the difference in its adoption by Chinese and Western firms is less salient for Western firms with longer operational experience in China*

Hypothesis 3: Variation in the quality of IPR institutions across regions



- *De facto* quality of IPR system vary across different regions even though IPR law reform in China improves overall patent protection
 - Local protection is stronger in more developed regions e.g., major municipalities: Beijing & Shanghai, & advanced coastal provinces: Guangdong & Shandong
 - More robust IPR system e.g., local IP courts more responsive and effective in litigation and enforcement of IPR dispute and infringement
- Firms and their strategies are (long) embedded in these regions with more robust IPR institutions
 - Less reliance on norm-based approaches using informal institutions
 - Chinese firms more responsive to change

H3. *Upon the strengthening of a previously weak form of IPR protection (utility model patent), the difference in its adoption by Chinese and Western firms is less salient for technologies developed in regions with higher de facto IPR quality*



Context: China-U.S. patent dyads

- China is largest emerging market in the world but formal IPR institution is still relatively weak (IMF 2010)
- China has undertaken one of the most significant IPR law reform in 2001 to better align it with the IPR legal framework of the World Intellectual Property Organization (WIPO)
- Focus on technologies developed/originating in China (e.g., Huang 2010 *Science*)
- Ensure quality of each technology: inventions must pass the bar of novelty, usefulness and non-obviousness in both SIPO & USPTO (U.S.: largest & most important technology market) => “transnational” China-U.S. patent dyads (Huang & Li 2013)
- Strategic choice of invention or utility model patents by firms in China: technologies *a/so* obtained U.S. invention patent



Data construction procedure

- Collect entire population of granted USPTO invention patents with China priority until end of 2008
- Ensure the nature/consistency in originating country of patent application: Include patents first filed in China (SIPO) & subsequently in the U.S., matched by priority information
- Compare between Chinese vs. western firms: analyze patents applied by and granted to mainland Chinese firms or western (predominantly U.S. and European) firms
- => 1,070 China-U.S. matching patent dyads applied between 1985 to 2008, covering 430 unique firms
- Firm and organization assignee characteristics from Compustat, USPTO & SIPO, supplemented by various industry publications, news articles & firm websites
- Level of IPR enforcement and legal protection in Chinese provinces from SIPO Annual Reports & NERI Index



Fixed effects logit estimation:

Impact of strengthening of formal IPR regime through patent law reform



Utility model patent_{i,t} = f ($\varepsilon_{i,t}$; α window_year_2000_{i,t}
+ β IPR_change_in_force_{i,t} + λ number_of_claims_i
+ ψ number_of_classes_i + δ cumulative_citation_i
+ ω private_firm_i + ς years_since_founding_i
+ ξ Lifetime_patents + γ Chinese_firm_i
+ ρ IPR_inforce_Chinese_Firm_interactions_{i,t}
+ χ technology_sector_controls_i)

Dependent variable:

Utility model patent (choice of)

Explanatory variables:

IPR change in force; Chinese firm

Control variables:

Window year 2000; number of claims/classes; cumulative citation; tech sectors; (private firm, years since founding; lifetime patents); *firm FEs*

Interaction variables:

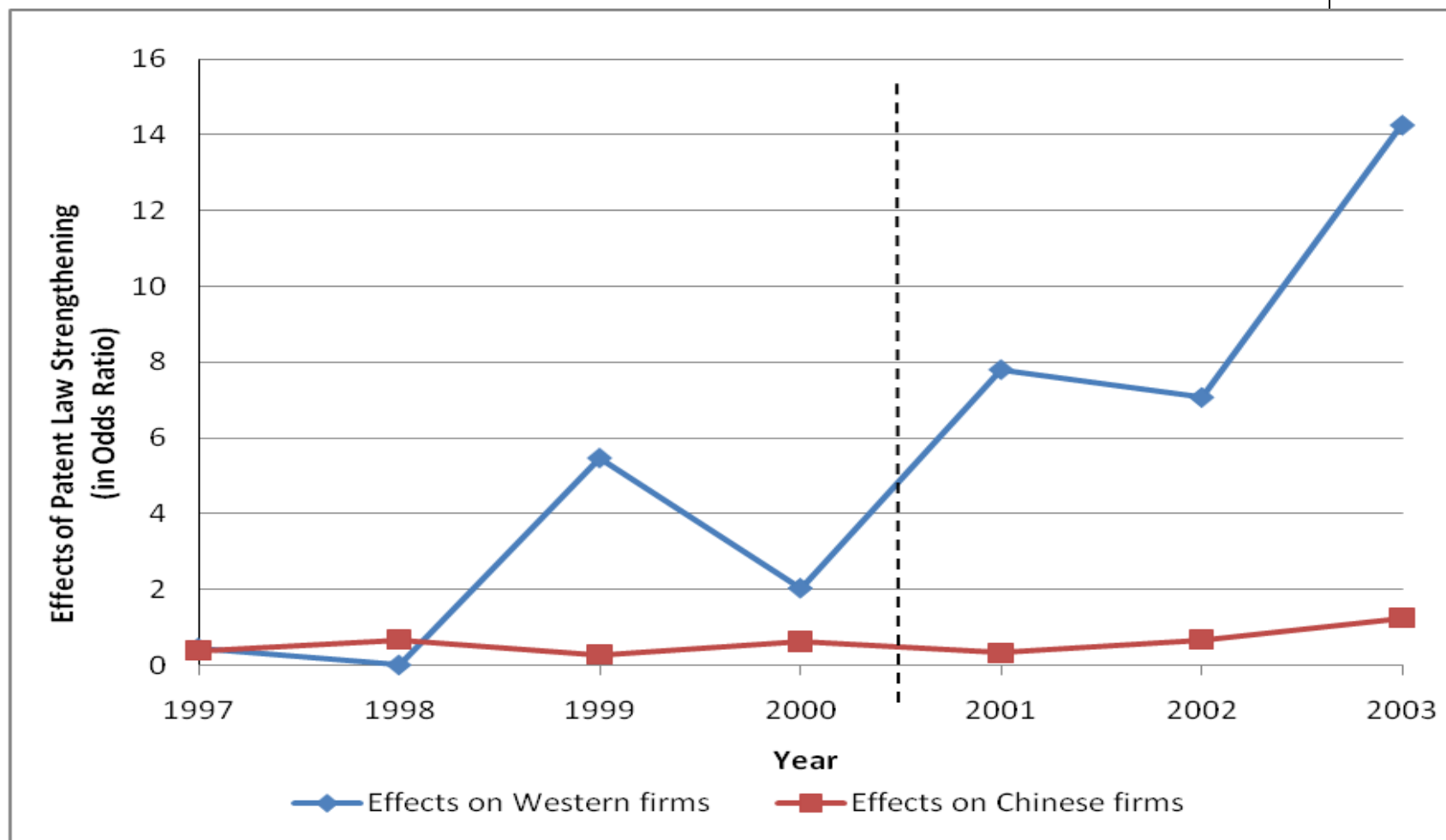
Chinese firm x IPR change in force



Findings I

- Strengthening of IPR regime in China generally increases utility model patenting by both Chinese and Western firms (by about 7.2 to 7.8 times)
- However, such IPR regime shift leads to greater increase in utility model patenting for Western firms than for Chinese firms (by 2.2 to 11 times)
=> H1 supported

Impact of patent law strengthening (announced in August 2000 and implemented in July 2001) on the choice of utility model patenting by Chinese and Western firms





Findings II

- Difference between Chinese and Western firms will decrease as the operational age of Western firms increases
=> H2 supported
- Difference between Chinese and Western firms will decrease if quality of regional IPR system increases
=> H3 supported



Contributions

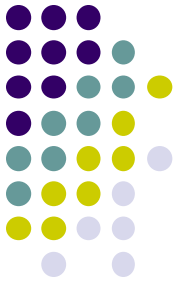
- A new conceptual framework integrating institutional embeddedness of firms/strategies in substitutive relationship of formal/informal institutions
 - Provides a dynamic/temporal view instead of a static view
 - Theoretically identify and predict the underlying rationales for Chinese firms' lower responsiveness (vs. Western firms) to sudden formal institutional changes
- Understand how Chinese firms and strategies are embedded in existing institutions (in the emerging market of China) to improve performance
 - They seek alternative protection against expropriation in innovation through informal institutional approaches and norms that deeply characterize the Chinese society and its economy



Summary

- Creatively and carefully using/combining patent data from emerging markets (e.g., China) can yield valuable insights & move us one step closer to:
 - Untangling the complex relationship between spatial and temporal patterns of S&T developments and their linkage to public policies and investment environments
 - Investigating the strategic role of IPR/institutions in shaping knowledge, innovation & entrepreneurship across different markets
- Fertile ground for potential future research!

While patent data can aid in measurement, it is no substitute for interesting research question, important context, strong theoretical framework, careful empirical design, and deep understanding of patenting/ enforcement processes, surrounding institutions, and incentives



Thank You.

Questions/comments?

kennethhuang@smu.edu.sg