Tickets to the Global Market: First US Patent Awards and Chinese Firm Exports

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China Economics Summer Institute (CESI)
23rd August, 2023

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Patent Globalization

- Global patent activity has increased steadily in recent decades
  - Remarkable rise in # patents taken out by foreign firms, especially from emerging economies, in a select few patent jurisdictions
  - Example: share of foreign applicants to United States Patent and Trademark Office (USPTO) went up from 44% in 2000 to 51% in 2015

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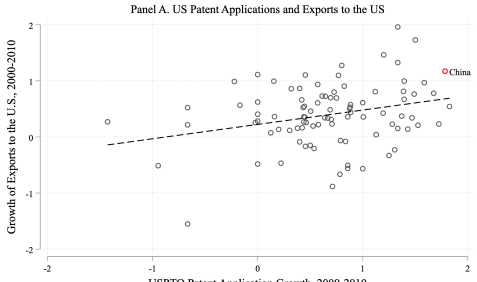
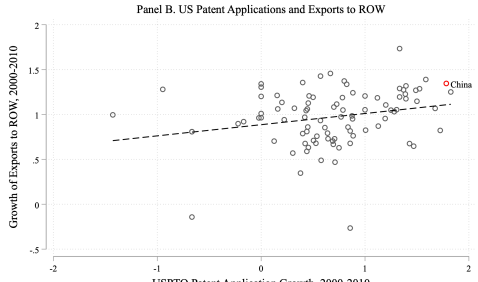
  - Example: share of foreign applicants to United States Patent and Trademark Office (USPTO) went up from 44% in 2000 to 51% in 2015
- First-order questions:
  - Why do firms patent their innovations abroad?
  - Can established patent authorities in developed countries act as global hubs for alleviating challenges faced by firms from emerging economies when they participate in the global marketplace?

USPTO Patent Applications and Exports Across Countries



Fitted line slope (standard error): 0.256 (0.105)



Fitted line slope (standard error): 0.124 (0.059)

Note: These figures plot the growth in exports respectively to the U.S. and to the rest of the world across countries against the growth in USPTO patent applications over the 2000-2010 period. The slope of the corresponding fitted line and its robust standard error are reported below each figure.

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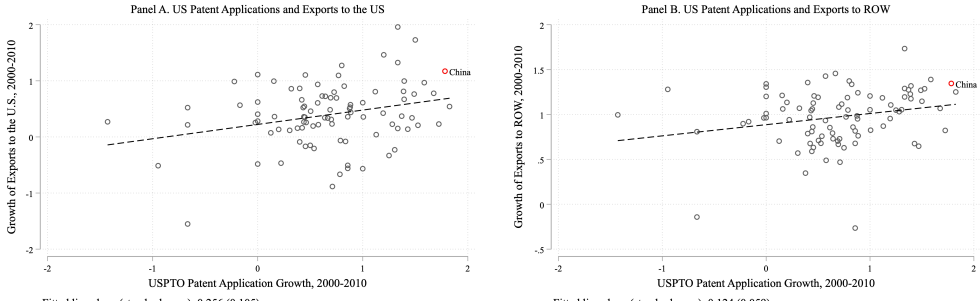

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- U.S. patents may confer advantages to the foreign patent holders that extent beyond market protection in the U.S.

This Paper: U.S. Patents and Chinese Exports

- Ideal institutional context: U.S. and China
  - Both are top-3 trading economies; U.S.: advanced with strong institutions vs. China: emerging with rapid structural transformation
  - Stigma about quality of Chinese products and Chinese patent system
  - U.S. is both important market and top patent office for Chinese firms

◂ Anecdotal Evidence

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◂ Anecdotal Evidence

- How does first U.S. patent approval affect the export performance of Chinese firms?
  - Match rich data on USPTO patent applications, Chinese customs transactions, and Chinese industrial survey
  - Compare successful to unsuccessful first-time applicants
  - Instrument patent approval with leniency of quasi-randomly assigned USPTO examiner (Sampat and Williams, 2019; Farre-Mensa et al., 2020)
  - Identify causal effect of U.S. patent and explore possible mechanisms

Results

1. Successful first USPTO application improves Chinese firms' export growth
   - **17.5%** higher annualized export growth for successful than that unsuccessful applicants
   - Driven by survival and expansion in incumbent destination-product markets (88%)
   - Battery of specification checks: balance tests, event study, placebo, robustness

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   - **Quality capacity**: bigger effect on exports of differentiated products to high-income countries
   - **Contract credibility**: bigger effect on exports of high contract reliance industries to high rule-of-law countries

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4. No Mechanisms III: financial constraints, follow-on innovation

Contribution

- **Effects of patenting on firm operations**: we study how cross-border patent activity is related to firms' export performance
  - Williams (2013, 2017); Galasso and Schankerman (2015); Cockburn et al. (2016); Palangkaraya et al. (2017); Galasso and Schankerman (2018); Kline et al. (2019); Sampat and Williams (2019); Farre-Mensa et al. (2020); Rassenfosse et al. (2022)
- **Firm productivity, innovation, and trade**: we identify the causal effect of patenting conditional on firms' innovation prowess
  - Lileeva and Trefler (2010); Aw et al. (2011); Bustos (2011); Bøler et al. (2015); Aghion et al. (2018); Liu and Ma (2020); Maican et al. (2020); Coelli et al. (2022)
- **Information asymmetry in international trade**: we provide novel evidence that obtaining patent recognition from a global patent hub can signal quality capacity and contractual credibility for firms in developing countries
  - Rauch (1999, 2001); Banerjee and Duflo (2000); Casella and Rauch (2002); Rauch and Trindade (2003); Feenstra and Hanson (2004); Ahn et al. (2011); Chaney (2014); Macchiavello and Morjaria (2015); Monarch and Schmidt-Eisenlohr (2017); Steinwender (2018); Akerman et al. (2022); Rauch and Trindade (2022)

Data

Data Sources

- USPTO Patent Examination Research Dataset (PatEx, 2001-2016)
  - Rich information about universe of patent applications
    - basic information about patent applicants
    - identity of patent examiners
    - outcome at each examination step
- Chinese Customs Trade Statistics (CCTS, 2000-2016)
  - universe of export and import transactions
  - transaction-level product code, country, value, quantity, etc.
- Chinese Annual Survey of Industrial Enterprises (ASIE, 1998-2013)
  - operational and financial information of above-scale industrial firms

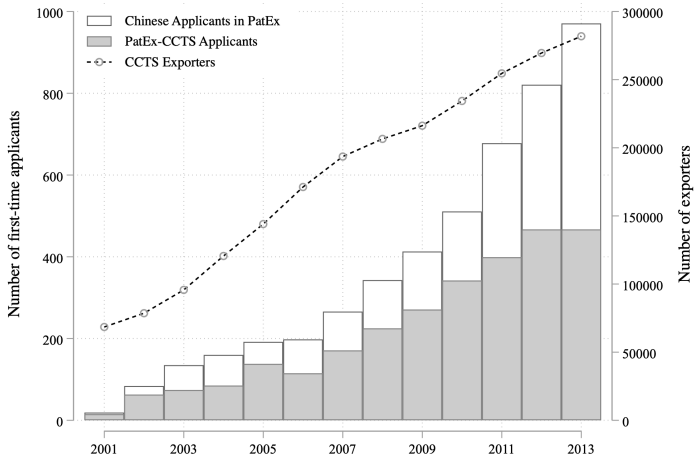
First-time Chinese Applicants in the USPTO

1. We identify Chinese applicants in PatEx based on their location information.
   - Applicant sample starts in 2001 (only approved applicants before 2001)
   - Restrict sample to incorporated applicants
   - Drop applicants from Hong Kong and Macau
   - Standardize applicants' English names

2. We manually match Chinese PatEx patent applicants to CCTS exporters based on name and location (from English to Chinese)
   - Cross-checks based on patent and business registration records
   - Secondary match from CCTS to ASIE standard in the literature

⏩ Illustrative Example

Chinese Trade and USPTO Patent Activity Over Time

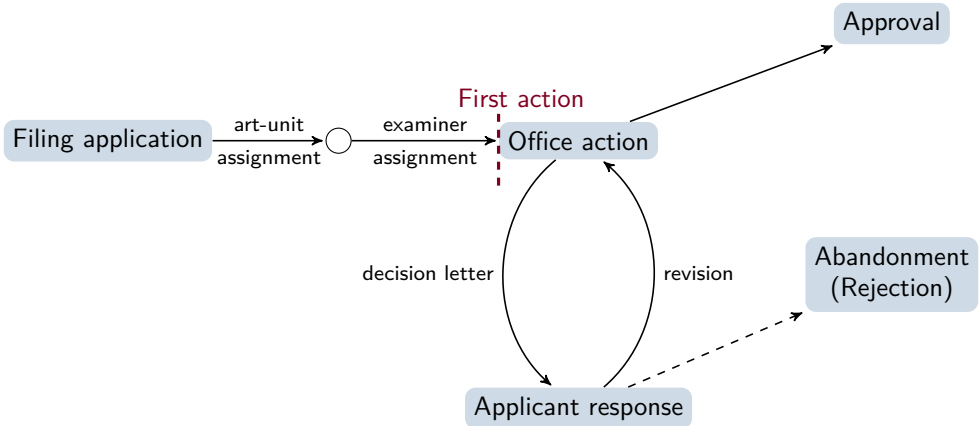


Note: This figure traces the evolution of Chinese trade and USPTO patent activity over time. The white bars display the number of Chinese firms that file a USPTO patent application for the first time in a given first-action year. The grey bars display the subset of these firms that can be matched to exporters in the CCTS-PatEx data. The dashed line displays the total number of CCTS exporters.

Technology Classes Comparison of U.S. Patent Applicants and Other Exporters

Empirical Strategy

The Patent Examination Process



Illustrative Example

Empirical Setup

We adopt the following generalized specification to estimate the effect of a successful first U.S. patent application on Chinese firms' export growth:

$$\begin{aligned}\Delta_k Export_{it+k} &\equiv \frac{Export_{it+k} - Export_{it}}{0.5(Export_{it+k} + Export_{it})} \\ &= \beta \cdot \mathbb{1}(\text{Success First App} = 1)_{iajt} + \Gamma Z_{it} + \lambda_{s\tau} + \epsilon_{it+k}\end{aligned}$$

- i = exporter, a = art unit, j = examiner, t = first-action year, $k \equiv 3$ in baseline
- Z_{it} controls: log initial exports, export tenure
- $\lambda_{s\tau}$: HS2 sector by application year pair fixed effects
- Coefficient of interest: β
  - OVB: patent application outcome might be correlated with unobserved firm characteristics such as inherent innovation capacity or realized innovation quality

⏭ Export Growth since First-Action Year

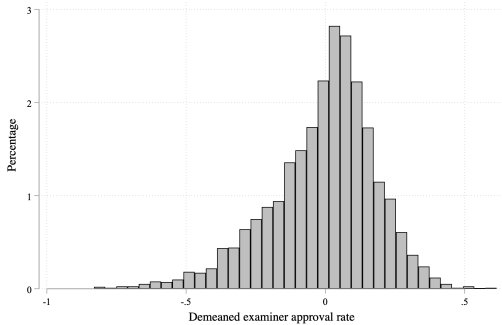
IV Strategy

Identification exploits USPTO idiosyncrasy

- Patent examiners assigned quasi-randomly within technology-determined art units
- Examiners differ in their ex-ante approval propensity

$$Approval\ Rate_{iajt} = \frac{\#Granted_{iajt}}{\#Examined_{iajt}}$$

- $\#Granted_{iajt}$ ($\#Examined_{iajt}$) = patents that examiner j has granted (examined) in art unit a prior to her decision on i's application at time t
- We demean approval rates within at to exclude the potential bias due to non-random assignment of art unit



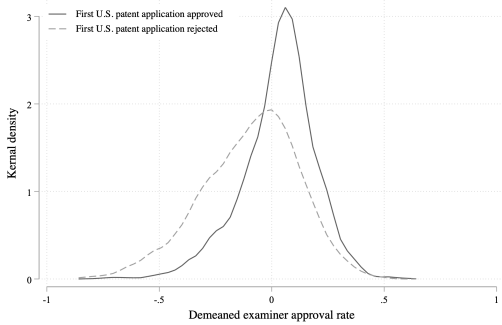
Note: This figure shows the distribution of the demeaned approval rate of USPTO patent examiners assigned to first-time patent applications by CCTS-PatEx Chinese exporters. Examiner approval rates are demeaned by art unit and first-action year.

First-Stage IV Validity

We instrument $\mathbb{1}(\text{Success First App} = 1)_{iajt}$ by the demeaned $\textit{Approval Rate}_{iajt}$.

Dependent variable	*Successful USPTO application*			
	(1)	(2)	(3)	(4)
Examiner approval rate	0.970***	0.968***	0.950***	0.955***
	(0.0689)	(0.0693)	(0.0783)	(0.0787)
Log exports		0.00227		0.0146*
		(0.00567)		(0.00750)
Export tenure		-0.00789*		-0.00181
		(0.00436)		(0.00508)
Log employment				-0.0105
				(0.0107)
HS2-year fixed effects	Yes	Yes		
Industry-year fixed effects			Yes	Yes
Ownership-year fixed effects			Yes	Yes
Sample	CCTS		CCTS-ASIE	
F-test: IV = 0	198.07***	195.26***	147.05***	147.44***
# Observations	1,156	1,156	940	940

Note: This table reports first-stage regression results for the predictive power of an examiner's *ex-ante* demeaned approval rate for the success of an exporter's first USPTO patent application. The sample covers all CCTS-PatEx matched exporters in Columns 1-2 and all CCTS-ASIE-PatEx matched exporters in Columns 3-4. Column 2 controls for initial log exports and export tenure. Column 4 further controls for log employment. Columns 1-2 include HS2 sector by year pair fixed effects, while Columns 3-4 include CIC2 industry by year and ownership type by year pair fixed effects. Heteroskedasticity-consistent standard errors are clustered by examiner art unit. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

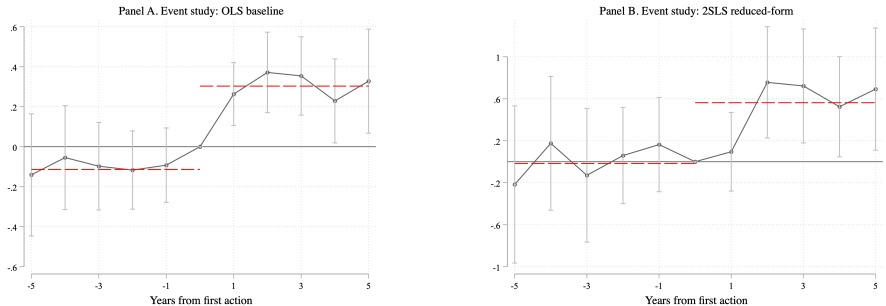


Note: This figure shows the kernel density of demeaned examiner approval rates separately for successful and unsuccessful patent applications. The sample covers all first-time USPTO applications by CCTS-PatEx Chinese exporters. Examiner approval rates are demeaned by art unit and first-action year.

⏩ Balance Tests ⏩ Testing for Examiner Specialization

Effect of First U.S. Patent on Chinese Firm Exports

Event Study



Note: This figure plots event-study estimates for the effects of a successful first US patent application and a more lenient USPTO patent examiner on the exports of first-time Chinese applicants. The sample covers all CCTS-PatEx matched exporters. The dependent variable is log exports. The regressors comprise interactions of time dummies with an indicator for a successful patent application in Panel A and with the patent examiner's demeaned approval rate in Panel B. Both regressions include firm fixed effects and HS2 sector by year pair fixed effects. Heteroskedasticity-consistent standard errors are clustered by examiner art unit.

First US Patent Promotes Chinese Firms' Export Growth

Dependent variable	*Annualized 3-year export growth*					
	(1)	(2)	(3)	(4)	(5)	(6)
Successful USPTO application	0.0667***	0.172***	0.175***	0.0599**	0.217***	0.201***
	(0.0214)	(0.0564)	(0.0522)	(0.0253)	(0.0691)	(0.0621)
Log exports			-0.0367***			-0.0457***
			(0.00492)			(0.00593)
Export tenure			-0.00299			-0.0141***
			(0.00366)			(0.00371)
Log employment						0.0294***
						(0.00856)
HS2-year fixed effects	Yes	Yes	Yes			
Industry-year fixed effects				Yes	Yes	Yes
Ownership-year fixed effects				Yes	Yes	Yes
Model	OLS	2SLS	2SLS	OLS	2SLS	2SLS
Sample		CCTS			CCTS-ASIE	
F-stat		198.07	195.26		147.05	147.44
# Observations	1,156	1,156	1,156	940	940	940

Note: This table reports the estimated effect of a successful first U.S. patent application on the subsequent export growth of Chinese applicants. The dependent variable is the annualized 3-year export growth rate. The sample covers all CCTS-PatEx matched exporters in Columns 1-3 and all CCTS-ASIE-PatEx matched exporters in Columns 4-6. Columns 1 and 4 are estimated with OLS, while Columns 2, 3, 5, and 6 are estimated with 2SLS, using the demeaned examiner approval rate as an instrument. Column 3 controls for initial log exports and export tenure. Column 6 further controls for log employment. Columns 1-3 include HS2 sector by year pair fixed effects, while Columns 4-6 include CIC2 industry by year and ownership type by year pair fixed effects. Heteroskedasticity-consistent standard errors are clustered by examiner art unit. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

⏩ Placebo Test ⏩ Alternative Specifications ⏩ Controlling for Global Patenting

⏩ The Effect of Second Application

Firm Export Growth Decomposition

The export growth rate can be decomposed into two components.

$$\begin{aligned}\Delta_k Export &\equiv \frac{Export_k - Export_0}{0.5(Export_k + Export_0)} \\ &= \underbrace{\frac{\sum_{\omega\in\Omega_0}(x_{\omega k} - x_{\omega 0})}{0.5(Export_k + Export_0)}}_{Incumbent\ Component} + \underbrace{\frac{\sum_{\omega\in\Omega_k\setminus\Omega_0} x_{\omega k}}{0.5(Export_k + Export_0)}}_{New\ Component}\end{aligned}$$

- **The "incumbent" component**: contribution of incumbent destination-product pairs
  - **The "continuing" component**: Value change of continuing destination-product pairs
  - **The "drop" component**: Value destruction from dropped destination-product pairs
- **The "new" component**: contribution of value creation from newly added destination-product pairs

Firm Export Growth Decomposition

Main driver (88%): survival and expansion in incumbent destination-product markets

Dependent variable	*Component of annualized 3-year export growth*			
	Incumbent dest-prod markets		New dest-prod markets	
	(1)	(2)	(3)	(4)
Successful USPTO application	0.153***	0.153***	0.0195	0.0217
	(0.0486)	(0.0487)	(0.0309)	(0.0260)
Log exports		-0.00562		-0.0311***
		(0.00407)		(0.00232)
Export tenure		-0.0000904		-0.00290*
		(0.00314)		(0.00149)
HS2-year fixed effects	Yes	Yes	Yes	Yes
F-stat	198.07	195.26	198.07	195.26
# Observations	1,156	1,156	1,156	1,156

Note: This table reports the estimated effect of a successful first U.S. patent application on constituent components of the subsequent export growth of Chinese applicants. The dependent variable in Columns 1-2 and 3-4 is the contribution of expansion in a firm's incumbent and new destination-product markets respectively to its total export growth. The sample covers all CCTS-PatEx matched exporters. All columns are estimated with 2SLS, using the demeaned examiner approval rate as an instrument. Columns 2 and 4 control for initial log exports and export tenure. All columns include HS2 sector by year pair fixed effects. Heteroskedasticity-consistent standard errors are clustered by examiner art unit. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Three-part Decomposition CCTS-ASIE Sample Export Margins Exports by Firm-Destination-Product

Why Does First U.S. Patent Boost Chinese Firm Exports?

Mechanism Test I: Firm Export Growth Decomposition

We decompose each firm's export growth by product/destination groups:

$$\begin{aligned}\Delta_k EX_i &\equiv \frac{EX_{ik} - EX_{i0}}{0.5(EX_{ik} + EX_{i0})} \\ &= \sum_{p \in P} \sum_{d \in D} \frac{EX_{ipdk} - EX_{ipd0}}{0.5(EX_{ik} + EX_{i0})},\end{aligned}$$

- p: product category
  - Technologically related versus technologically unrelated
  - High quality differentiation versus Low quality differentiation
  - High contract reliance versus low contract reliance
- d: destination category
  - U.S. versus non-U.S.
  - high GDP per capita versus low GDP per capita
  - high rule-of-law index versus low rule-of-law index
- We regress each of the components on first U.S. patent application outcome to identify the "main driver" of patent-induced export growth

Mechanism Test II: Export Growth Across Markets Within Firms

We apply a specification similar to Eckel et. al (2015):

$$y_{ipdt+k} = \beta_w \cdot \mathbb{1}(\text{Successful First Application} = 1)_{it} \cdot C(d) + \Gamma_w Z_{ipdt} + \eta_{i\tau} + \lambda_{p\tau} + \lambda_{d\tau} + \epsilon_{ipdt+k}$$

- p denotes HS6 products, d denotes destination countries.
- y_{ipdt+k} is the outcome variable
  - Extensive margin: survival dummy of incumbent pairs
  - Intensive margin: value/price growth of continuing pairs
- $C(d)$: destination characteristics (U.S. indicator, GDP per capita, rule-of-law index)
- Z_{ipdt}: log initial destination-product pair export and relative export tenure
- $\lambda_{p\tau}$ ($\lambda_{d\tau}$): product (destination) by application year fixed effects
- $\eta_{i\tau}$: firm fixed effects to control for heterogeneity across firms
- Coefficient of interest: β_w (within-firm heterogeneous responses across destinations)

Mechanism I: Monopoly Power

Hypothesis 1: U.S. patent rights strengthen exporters' monopoly power and sales of protected products in the U.S. market, but not of other destination-product markets

To test Hypothesis 1, we examine:

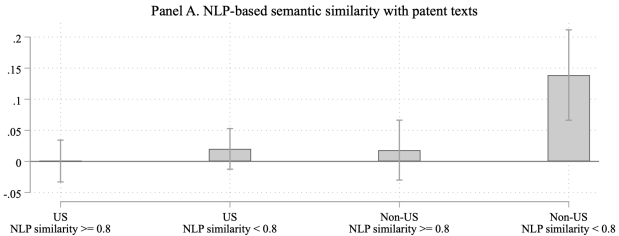
- whether the patent effect is driven by technologically related products sold in the U.S.
- whether the values and prices of those export flows are improved

We identify products that are technologically related to a given patent based on two alternative semantic similarity analyses

- Apply NLP techniques to compute the semantic similarity between textual descriptions of individual patents and HS-6 products (similar to Argente et al. 2023)
  ◂ The NLP-based semantic similarity
- Apply Algorithmic Links with Probabilities (ALP) weighting methods by Goldschlag, et al. (2020) to the descriptions of USPC technology classes and HS-6 products
  ◂ The ALP weighting algorithm

Weak Evidence for Monopoly Power Mechanism

Evidence 1a: Firm export growth decomposition



◂ Regression results ◂ Growth rate by types

Weak Evidence for Monopoly Power Mechanism

Evidence 1b: Export Growth Across Markets Within Firms

Panel A. NLP-based semantic similarity with patent texts

Dependent variable	*Export value growth*			*Export price growth*		
Technologically related products	All	Yes	No	All	Yes	No
	(1)	(2)	(3)	(4)	(5)	(6)
Successful USPTO application × U.S.	0.112	-0.120	0.295	0.0497	0.0186	0.0322
	(0.115)	(0.119)	(0.194)	(0.0647)	(0.0995)	(0.103)
F-stat	6.96	20.06	3.89	6.33	25.19	3.43
# Observations	38,824	14,601	23,517	31,226	12,129	18,524

Panel B. Lybbert and Zolas (2014) ALP similarity with patent classes

Dependent variable	*Export value growth*			*Export price growth*		
Technologically related products	All	Yes	No	All	Yes	No
	(1)	(2)	(3)	(4)	(5)	(6)
Successful USPTO application × U.S.	0.112	-0.133	0.139	0.0497	0.0432	0.0149
	(0.115)	(0.243)	(0.121)	(0.0647)	(0.165)	(0.0738)
F-stat	6.96	7.83	5.93	6.33	8.82	5.23
# Observations	38,824	7,774	30,411	31,226	6,634	24,061

Controls	Firm-dest-prod level log exports and relative export tenure
Fixed effects	Firm-year, HS6-year, and destination-year fixed effects

Note: This table reports the heterogeneous effect of a successful first U.S. patent application on the growth in export values and prices across destinations and products within firms, for the sample of continuing firm-destination-product triplets of CCTS-PatEx matched exporters. The variable U.S. is an indicator equal to 1 if the export destination is the U.S. The standalone term of Successful USPTO application is absorbed by the firm by year pair fixed effects. Columns 1 and 4 cover all products, while Columns 2 and 5 (Columns 3 and 6) restrict the sample to products that are technologically related (unrelated) to a firm's patent. Products are technologically related to a patent or patent technology class if their descriptions have semantic similarity above 80% based on the NLP method in Panel A (see Appendix ?? for details) and ALP weights above 5% based on Lybbert and Zolas (2014) approach in Panel B. All columns are estimated with 2SLS, using the demeaned examiner approval rate as an instrument. All columns include HS6 by year, destination by year, and firm by year pair fixed effects, and control for firm-destination-product level initial log exports and relative tenure. Heteroskedasticity-consistent standard errors are clustered by examiner art unit. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Mechanism II: Asymmetric Information

Hypothesis 2: U.S. patent grant constitutes a signal that alleviates information frictions in international trade

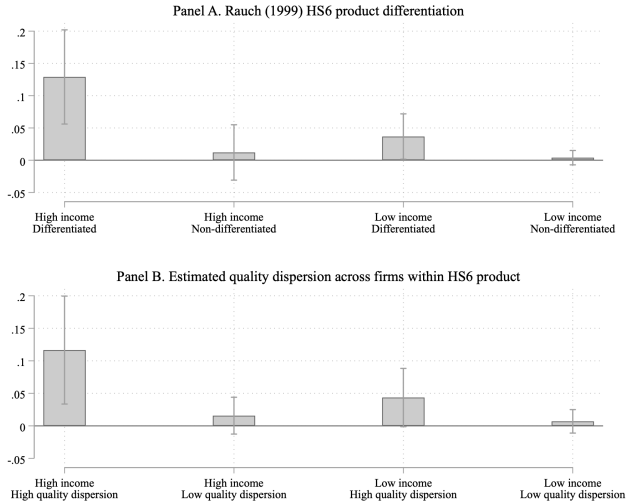
- Quality capacity signal: firms' output quality capacity under quality differentiation
- Contract credibility signal: firms' trustworthiness under contractual frictions

To test Hypothesis 2, we examine:

- (*quality capacity*) whether U.S. patents increase firm exports disproportionately more for products with greater scope for quality differentiation, in richer destinations
- (*contract credibility*) whether U.S. patents increase firm exports disproportionately more for products with greater contract reliance, to destinations with stronger contract enforcement

Strong Evidence for Quality Capacity Signal

Evidence 2a: Firm export growth decomposition



◂ Regression results ◂ Growth rate by types

Strong Evidence for Quality Capacity Signal

Evidence 2b: Export Growth Across Markets Within Firms

Panel A. Rauch (1999) HS6 product differentiation

Dependent variable	*Survival Indicator*			*Export value growth*		
Differentiated products	All	Yes	No	All	Yes	No
	(1)	(2)	(3)	(4)	(5)	(6)
Successful USPTO application × ln(GDP per capita)	0.0207*	0.0302**	0.00159	0.00255	-0.00423	0.0330
	(0.0119)	(0.0130)	(0.0248)	(0.0194)	(0.0220)	(0.0407)
F-stat	32.59	26.78	49.92	21.14	18.35	16.92
# Observations	85,955	70,123	10,555	38,665	32,251	4,112

Panel B. Estimated quality dispersion across firms within HS6 product

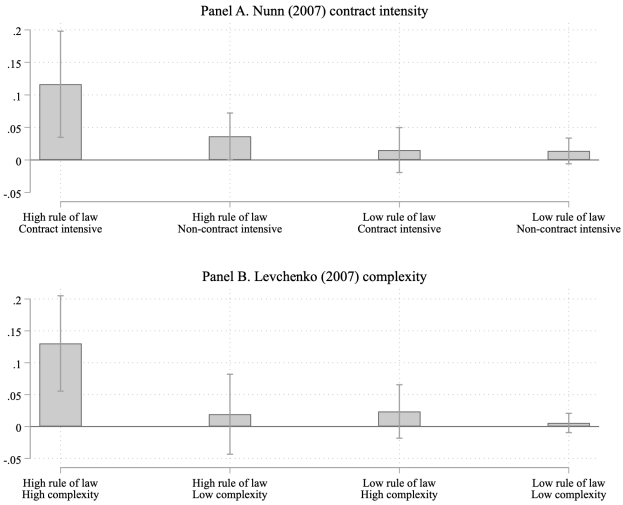
Dependent variable	*Survival Indicator*			*Export value growth*		
High quality-dispersion products	All	Yes	No	All	Yes	No
	(1)	(2)	(3)	(4)	(5)	(6)
Successful USPTO application × ln(GDP per capita)	0.0207*	0.0285**	-0.0107	0.00255	0.000385	0.0142
	(0.0119)	(0.0134)	(0.0228)	(0.0194)	(0.0236)	(0.0217)
F-stat	32.59	25.99	56.73	21.13	15.27	37.11
# Observations	85,955	71,677	13,557	38,665	31,753	6,430

Controls	Firm-dest-prod level log exports and relative export tenure
Fixed effects	Firm-year, HS6-year, and destination-year fixed effects

Note: This table reports the heterogeneous effect of a successful first U.S. patent application on the survival probability and export growth across destinations and products within firms. The variable ln(GDP per capita) is the log GDP per capita of the destination country. The standalone term of Successful USPTO application is absorbed by the firm by year pair fixed effects. The sample in Columns 1-3 (Columns 4-6) covers all incumbent (all continuing) firm-destination-product triplets for CCTS-PatEx matched exporters. Columns 1 and 4 cover all products, while Columns 2 and 5 (Columns 3 and 6) restrict the sample to products with high (low) scope for quality differentiation. Products have high scope for quality differentiation if they are differentiated according to the Rauch (1999) classification in Panel A and if the coefficient of variation of estimated quality across firms within a product is above the median in Panel B. All columns are estimated with 2SLS, using the demeaned examiner approval rate as an instrument. All columns include HS6 by year, destination by year, and firm by year pair fixed effects, and control for firm-destination-product level initial log exports and relative tenure. Heteroskedasticity-consistent standard errors are clustered by examiner art unit. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Strong Evidence for Contract Credibility Signal

Evidence 3a: Firm export growth decomposition



◂ Regression results ◂ Growth rate by types

Strong Evidence for Contract Credibility Signal

Evidence 3b: Export Growth Across Markets Within Firms

Panel A. Nunn (2007) contract intensity

Dependent variable	*Survival Indicator*			*Export value growth*		
High-contract-intensity industries	All	Yes	No	All	Yes	No
	(1)	(2)	(3)	(4)	(5)	(6)
Successful USPTO application × rule of law	0.0308**	0.0358**	0.0253	0.00472	0.00269	0.0261
	(0.0149)	(0.0147)	(0.0304)	(0.0242)	(0.0233)	(0.0534)
F-stat	25.96	23.85	21.73	17.49	14.31	13.43
# Observations	86,319	56,481	29,237	38,752	26,283	12,009

Panel B. Levchenko (2007) complexity

Dependent variable	*Survival Indicator*			*Export value growth*		
High-complexity industries	All	Yes	No	All	Yes	No
	(1)	(2)	(3)	(4)	(5)	(6)
Successful USPTO application × rule of law	0.0308**	0.0374**	0.0152	0.00472	-0.00686	0.0523
	(0.0149)	(0.0148)	(0.0252)	(0.0242)	(0.0253)	(0.0437)
F-stat	25.96	20.37	26.27	17.49	15.65	10.41
# Observations	86,319	54,390	31,388	38,752	25,162	13,106
Controls	Firm-dest-prod level log exports and relative export tenure					
Fixed effects	Firm-year, HS6-year, and destination-year fixed effects					

Note: This table reports the heterogeneous effect of a successful first U.S. patent application on the survival probability and export growth across destinations and products within firms. The variable rule of law is the index value of rule of law of the destination country. The standalone term of Successful USPTO application is absorbed by the firm by year pair fixed effects. The sample in Columns 1-3 (Columns 4-6) covers all incumbent (all continuing) firm-destination-product triplets for CCTS-PatEx matched exporters. Columns 1 and 4 cover all products, while Columns 2 and 5 (Columns 3 and 6) restrict the sample to products that belong to industries with high (low) contract reliance above (below) the median. Industries' contract reliance is proxied with the Nunn (2007) measure of contract intensity in Panel A and with the Levchenko (2007) measure of complexity in Panel B. All columns are estimated with 2SLS, using the demeaned examiner approval rate as an instrument. All columns include HS6 by year, destination by year, and firm by year pair fixed effects, and control for firm-destination-product level initial log exports and relative tenure. Heteroskedasticity-consistent standard errors are clustered by examiner art unit. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

◂ Additional evidence of the signaling mechanism ▸▸ Export Tenure

Ruling Out Other Mechanisms

- Financial constraints
  - U.S. patents may signal higher expected future profits and thereby attract external investors and ease financial frictions faced by exporters
  - However, effect of U.S. patent on exports is not systematically higher for exporters more active in financially vulnerable sectors ◂ Testing the financial constraint mechanism
- Follow-on innovation
  - First U.S. patent may improve exporters' expectations about their future innovation or patenting success, and hence induce them to conduct more R&D, upgrade product quality, and climb up the value chain
  - However, we find little evidence that the first U.S. patent stimulates patenting in China ◂ Patent filing in China

Conclusions

Conclusions

- We identify a large causal effect of a successful first U.S. patent application on a Chinese firm's subsequent export growth
- Unpacking potential mechanisms, we find evidence consistent with U.S. patents signaling product quality and contractual credibility under asymmetric information
  - Limited evidence for monopoly power mechanism
  - No evidence for financial frictions and follow-on innovation mechanisms
- Open questions
  - Global patent policy
  - Welfare effects of patent hubs
  - Trade and patents with GVCs and MNCs

Thanks!

Appendix

Anecdotal Evidence

- **GRG Banking Equipment**: the company filed its first U.S. patent in 2011. *People.com*, the online version of the largest state-owned newspaper *People Daily*, described the event as "another breakthrough for Chinese ATM companies in overseas, especially in Europe and America."
- **Founder Microelectronics**: the company filed its first U.S. patent in 2012. On its official website, the company described the patent as "another important milestone of Founder Microelectronics' IP work."

中国ATM企业首获美国专利授权

随着我国企业“走出去”的步伐加快，知识产权日益成为参与国际竞争的核心要素，越来越多的企业开始通过提升知识产权能力在激烈的全球市场竞争中掌握主动权。日前，从中国ATM厂商广电运通获悉，其发明专利“读卡器异物检测装置及读卡器插口”，于2013年1月8日正式获得美国国家专利局授权，授权公告号US8,348,162B2。同时，该专利也在欧盟、澳大利亚、越南、伊朗等国家进入公示阶段，此前广电运通已在海外市场获得多项专利授权，此次首获美国专利授权，将是中国ATM企业在海外无其欧美国家专利授权取得的又一突破。

方正微电子第一个海外专利授权

发布时间2014-06-16

6月上旬获悉，由方正集团和深圳方正微电子有限公司共同申报的发明专利《METHOD FOR MANUFACTURING DOUBLE-LAYER POLYSILICON GATE》于5月13日在美国授权；这项专利的应用，可解决某研发项目长期以来遗留的一个重大技术难题，提高产品的附加值。方正微电子从2007年开始自主知识产权的布局工作。于2008年4月向国家专利局递交第一篇专利稿，2009年4月第一个实用新型专利在国内授权，2010年3月第一个发明专利在国内授权，2012年12月第一次向美国专利局递交专利申报稿，此次的美国专利授权，是方正微电子在海外授权的第一个专利，是方正微电子知识产权工作的又一个重要里程碑。半导体行业是全球范围内竞争的技术密集型产业，企业的竞争某种程度上是技术创新和知识产权的竞争。近年来，国内企业逐步重视海外专利的申请和保护。

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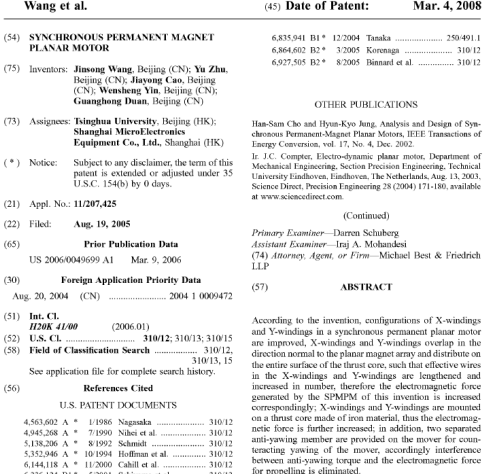
An Illustrative Example of the Matching Procedures

Take **Shanghai Microelectronics Equipment Co.** as an example.

1. The company filed its first U.S. patent application on Aug. 19, 2005.
   - It was about an electronic component.
   - The patent was granted on Mar. 4, 2008 (it normally takes 2.5-3 years).
2. We search the keywords "Microelectronics Equipment" and "Shanghai" in search engines.
   - The company's registered Chinese name is: 上海微电子装备有限公司
   - We cross-check the names with a database of company registrations (*Tianyancha*).



(12) **United States Patent**
Wang et al.

(10) **Patent No.: US 7,339,289 B2**
(45) **Date of Patent: Mar. 4, 2008**

(54) **SYNCHRONOUS PERMANENT MAGNET PLANAR MOTOR**

(75) Inventors: **Jinsong Wang**, Beijing (CN); **Yu Zhu**, Beijing (CN); **Jiayong Cao**, Beijing (CN); **Wensheng Yin**, Beijing (CN); **Guanghong Duan**, Beijing (CN)

(73) Assignees: **Tsinghua University**, Beijing (HK); **Shanghai MicroElectronics Equipment Co., Ltd.**, Shanghai (HK)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **11/207,425**

(22) Filed: **Aug. 19, 2005**

(65) **Prior Publication Data**

US 2006/0049699 A1 Mar. 9, 2006

(30) **Foreign Application Priority Data**

Aug. 20, 2004 (CN) 2004 1 0069472

(51) **Int. Cl.**
H20K 41/00 (2006.01)

(52) **U.S. Cl.** **310/12**; 310/13; 310/15

(58) **Field of Classification Search** 310/12, 310/13, 15
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,563,602	A *	1/1986	Nagasaka	310/12
4,945,268	A *	7/1990	Nihei et al.	310/12
5,138,206	A *	8/1992	Schmidt	310/12
5,352,946	A *	10/1994	Hoffman et al.	310/12
6,144,118	A *	11/2000	Cahill et al.	310/12
6,236,124	B1 *	5/2001	Sekiyama et al.	310/12
6,339,266	B1 *	1/2002	Tanaka	310/12
6,703,726	B2 *	3/2004	Itoh et al.	310/12
6,835,941	B1 *	12/2004	Tanaka	250/491.1
6,864,602	B2 *	3/2005	Korenaga	310/12
6,927,505	B2 *	8/2005	Binnard et al.	310/12

OTHER PUBLICATIONS

Han-Sam Cho and Hyun-Kyo Jung, Analysis and Design of Synchronous Permanent-Magnet Planar Motors, IEEE Transactions of Energy Conversion, vol. 17, No. 4, Dec. 2002.

Ir. J.C. Compter, Electro-dynamic planar motor, Department of Mechanical Engineering, Section Precision Engineering, Technical University Eindhoven, Eindhoven, The Netherlands, Aug. 13, 2003, Science Direct, Precision Engineering 28 (2004) 171-180, available at www.sciencedirect.com.

(Continued)

Primary Examiner—Darren Schuberg
Assistant Examiner—Iraj A. Mohandesi
(74) *Attorney, Agent, or Firm*—Michael Best & Friedrich LLP

(57) **ABSTRACT**

According to the invention, configurations of X-windings and Y-windings in a synchronous permanent planar motor are improved, X-windings and Y-windings overlap in the direction normal to the planar magnet array and distribute on the entire surface of the thrust core, such that effective wires in the X-windings and Y-windings are lengthened and increased in number, therefore the electromagnetic force generated by the SPMPM of this invention is increased correspondingly; X-windings and Y-windings are mounted on a thrust core made of iron material, thus the electromagnetic force is further increased; in addition, two separated anti-yawing member are provided on the mover for counteracting yawing of the mover, accordingly interference between anti-yawing torque and the electromagnetic force for propelling is eliminated.

8 Claims, 6 Drawing Sheets

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Technology Classes of First Patent Applications

Sample: all first-time USPTO patent applicants from China				
Rank	USPC class	USPC title	Number	Percentage (%)
1	514	Drug, bio-affecting and body treating compositions	266	5.55
2	424	Drug, bio-affecting and body treating compositions	196	4.09
3	435	Chemistry: molecular biology and microbiology	144	3.01
4	362	Illumination	112	2.34
5	439	Electrical connectors	84	1.75
6	257	Active solid-state devices	77	1.61
7	455	Telecommunications	71	1.48
8	361	Electricity: electrical systems and devices	69	1.44
9	428	Stock material or miscellaneous articles	68	1.42
10	345	Computer graphics processing and selective visual display systems	67	1.40
		Other	3637	75.91
Sample: first-time USPTO patent applicants matched to CCTS				
Rank	USPC class	USPC title	Number	Percentage (%)
1	424	Drug, bio-affecting and body treating compositions	117	4.13
2	514	Drug, bio-affecting and body treating compositions	96	3.39
3	362	Illumination	86	3.04
4	435	Chemistry: molecular biology and microbiology	80	2.83
5	439	Electrical connectors	66	2.33
6	428	Stock material or miscellaneous articles	50	1.77
7	257	Active solid-state devices	45	1.59
8	345	Computer graphics processing and selective visual display systems	41	1.45
9	361	Electricity: electrical systems and devices	40	1.41
10	536	Organic compounds	34	1.20
		Other	2116	76.86

Note: This table shows the top 10 technology classes of the first USPTO patent applications filed by Chinese applicants. The top panel considers all first-time Chinese applicants to the USPTO. The bottom considers the subset of first-time Chinese applicants to the USPTO in the matched CCTS-PatEx sample.

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Comparison of U.S. Patent Applicants and Other Exporters

	Matched patent applicants		*Other exporters*		*Difference*	
	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
Log exports	15.28	2.71	13.16	2.34	2.12***	0.021
Log exports to the U.S.	10.01	6.61	5.00	6.14	5.01***	0.054
Log exports to OECD	13.14	5.11	9.94	5.65	3.21***	0.050
Share of exports to the U.S.	0.22	0.30	0.14	0.28	0.090***	0.0025
Share of exports to OECD	0.54	0.36	0.52	0.41	0.024***	0.0037
Number of products	16.18	40.87	14.58	48.41	1.59***	0.43
Number of destinations	19.68	21.14	8.39	12.76	11.29***	0.11
Avg exports per dest-prod (1,000 RMB)	1423.76	8081.73	405.49	5826.35	1018.28***	51.67
# Observations	12,850		2,318,957			

Note: This table compares CCTS-PatEx matched exporters to other CCTS exporters. Columns 1-2 and 3-4 show the mean and standard deviation of key export statistics in the panel, respectively for CCTS-PatEx matched Chinese patent applicants and for all other CCTS exporters. Columns 5 and 6 show the mean and standard deviation of the difference in export statistics between the two groups. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Comparison of U.S. Patent Applicants and Other Exporters

	Matched patent applicants		*Other exporters*		*Differences*	
	Mean	sd	Mean	sd	Mean	sd
Log value of processing export	9.04	7.63	4.86	6.37	4.18***	0.056
Log value of export of heterogeneous products	13.41	5.19	11.25	4.87	2.15***	0.043
Log value of export to high-RLI countries	14.45	4.08	11.80	4.34	2.65***	0.038
Log value of export to high-IPR countries	15.00	3.13	12.44	3.55	2.57***	0.031
Share of processing export	0.34	0.41	0.20	0.35	0.14***	0.0031
Share of heterogeneous products	0.75	0.39	0.76	0.39	-0.0070**	0.0034
Share of export to high-RLI countries	0.81	0.27	0.76	0.34	0.043***	0.0030
Share of export to high-PRI countries	0.90	0.20	0.85	0.28	0.051***	0.0025
Number of observations	12,850		2,318,957			

Note: This table displays the additional comparison of PatEx-CCTS matched exporters and other exporters in CCTS. Column 1 and 2 show the mean and standard deviations of key export statistics of the PatEx-CCTS matched Chinese patent applicants across all years; Column 3 and 4 show the mean and standard deviations of key export statistics of the other exporters. Column 5 and 6 show the mean and standard deviation of the differences in export statistics between the two groups. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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An Illustrative Example of the Patent Examination Process

Still take **Shanghai Microelectronics Equipment Co.** as an example.

1. The company filed its first patent application (US7339289B2) on Aug. 19, 2005.
2. The case was first assigned to the art unit 2834, and then assigned to an examiner, Iraj Mohandesi, on Jul. 10, 2006.
   - Mr. Mohandesi examined 419 patent applications, of which 365 were finally approved.
3. The first action (a non-final rejection) was issued on **Aug. 10, 2006**.
   - The first action decision normally takes place about 1.5-2 years after the initial filing (Dyer et al., 2020).
   - We define the first *Notice of Allowance* or *Non-final Rejection*, whichever comes first, as the first action by USPTO.
   - The first action (initial decision) date is used as the starting point of the effect (Kline et al., 2019; Farre-Mensa, Hegde, and Ljungqvist, 2020).
     - Much of the uncertainty is resolved by the first action.
   - The application underwent another round of non-final rejection before obtaining a notice of allowance.
4. The patent was granted on Mar. 4, 2008.

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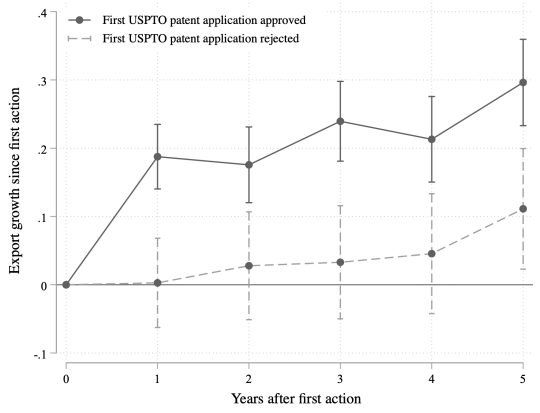
Export Growth since First Application



Note: This figure shows the average export growth rate of successful and unsuccessful first-time Chinese applicants to the USPTO, following the first action year of the application. Export growth is measured as $g_{ik} = (exp_{it+k} - exp_{it})/0.5(exp_{it+k} + exp_{it})$, where exp_{it} is the exports of firm i in t, the first action year of its first patent application, and exp_{it+k} is the exports of firm i k years after t. 95% confidence intervals are represented by the capped spikes.

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Balance Tests

Sample	*Firm Characteristic*	*Successful USPTO application*	*Examiner approval rate*
CCTS (Sample size = 1,156)	Log exports (CCTS)	-0.0209	0.0893
		(0.162)	(0.463)
	Log # products	-0.149*	-0.0974
		(0.0756)	(0.227)
	Log # destinations	-0.0252	0.141
		(0.0746)	(0.197)
	Log avg exports per dest-prod	0.0942	0.0223
		(0.125)	(0.373)
CCTS-ASIE (Sample size = 940)	Log sales	0.0363	-0.366
		(0.143)	(0.341)
	Log employment	-0.0109	-0.0127
		(0.0977)	(0.244)
	Log exports (ASIE)	0.241	-0.343
		(0.189)	(0.532)
	Operating profit margin	0.00974	-0.0323
		(0.00930)	(0.0223)

Note: This table reports results from regressing CCTS or CCTS-ASIE matched exporters' *ex-ante* characteristics on an indicator for a successful patent application and on examiner approval rate. The CCTS sample covers continuing exporters matched to USPTO patent applicants. The CCTS-ASIE sample covers all continuing CCTS exporters matched to both USPTO and ASIE. Regressions on the CCTS sample control for HS2 sector by year pair fixed effects. Regressions on the CCTS-ASIE sample control for CIC2 industry by year and ownership type by year pair fixed effects. Heteroskedasticity-consistent standard errors are clustered by examiner art unit. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Balance Tests

Sample	*Firm Characteristic*	*Successful USPTO application*	*Examiner approval rate*
CCTS (Sample size = 1,156)	Share of tech. related exports (conservative with NLP)	0.0219	0.145**
		(0.0286)	(0.0666)
	Share of tech. related exports (liberal with ALP)	0.00972	0.113
		(0.0306)	(0.0708)
	Share of differentiated exports	-0.0376*	0.0427
		(0.0201)	(0.0608)
	Share of high-quality-dispersion exports	0.0182	0.0302
		(0.0263)	(0.0607)
	Share of contract intensive exports	-0.00328	0.0206
		(0.0138)	(0.0371)
	Share of high-complexity exports	-0.00101	0.0268
		(0.0232)	(0.0571)
	Share of exports to the U.S.	-0.0405*	0.0127
		(0.0220)	(0.0466)
	Share of exports to high-income countries	-0.0452**	-0.0349
		(0.0175)	(0.0431)
	Share of exports to high-rule-of-law index countries	-0.0329**	-0.0616
		(0.0146)	(0.0390)

Note: This table reports results from regressing exporters' *ex-ante* characteristics on an indicator for a successful patent application and on examiner approval rate. The sample covers all continuing CCTS-PatEx matched exporters. All regressions control for HS2 by application year pair fixed effects. Heteroskedasticity-consistent standard errors are clustered by examiner art unit. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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Testing for Examiner Specialization

Righi and Simcoe (2019) point out that examiners may specialize in certain patents.

- Validation test: "[U]nder random assignment, the inclusion of control variables should not affect the magnitude of the estimated coefficients."
  - We use an alternative instrument that also excludes technology class by application year fixed effects.
  - We include examiner characteristics as controls (examiner's experience and number of foreign/Chinese patents examined).
- The point estimates fluctuate between 80% to 100%.

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Dependent variable	*Successful USPTO application*			
	(1)	(2)	(3)	(4)
Examiner approval rate (residual 1)	0.968***	0.870***		
	(0.0693)	(0.0894)		
Examiner approval rate (residual 2)			0.993***	0.872***
			(0.0678)	(0.0882)
Log exports	0.00227	0.00165	0.00323	0.00233
	(0.00567)	(0.00572)	(0.00579)	(0.00584)
Export tenure	-0.00789*	-0.00766*	-0.00770*	-0.00741*
	(0.00436)	(0.00435)	(0.00453)	(0.00448)
Log examiner's Chinese applications		-0.0142		-0.0170
		(0.0230)		(0.0235)
Log examiner's foreign applications		0.0610**		0.0767***
		(0.0267)		(0.0269)
Log examiner's years of experience		-0.0488		-0.0601
		(0.0425)		(0.0428)
HS2-year fixed effects	Yes	Yes	Yes	Yes
F-test: IV = 0	195.26***	94.70***	214.36***	97.61***
# Observations	1,156	1,156	1,156	1,156

Note: This table reports validation test results for the exogeneity of patent assignment to examiners. The sample covers all CCTS-PatEx matched exporters. Examiner approval rate (residual 1) is an examiner's approval rate demeaned by art unit and first-action year. Examiner approval rate (residual 2) is an examiner's approval rate demeaned by both art unit by first-action year and technology class by first-action year. All columns control for HS2 sector by year pair fixed effects. Heteroskedasticity-consistent standard errors are clustered by examiner art unit. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Placebo Test

Dependent variable	*Annualized 3-year export growth, 3-year lagged*		
	(1)	(2)	(3)
Successful USPTO application	0.00381	0.00926	0.0115
	(0.00845)	(0.0223)	(0.0215)
Log exports, 3-year lagged			-0.00952***
			(0.00146)
Export tenure, 3-year lagged			-0.00917***
			(0.00136)
HS2-year fixed effects	Yes	Yes	Yes
Model	OLS	2SLS	2SLS
F-stat		154.13	152.46
# Observations	947	947	947

Note: This table reports the estimated effect of a successful first U.S. patent application on the 3-year lagged annualized export growth of Chinese applicants as a placebo test. The sample covers all CCTS-PatEx matched exporters. Column 1 is estimated with OLS, while Columns 2 and 3 are estimated with 2SLS, using the demeaned examiner approval rate as an instrument. Column 3 controls for 3-year lagged log exports and export tenure. All columns include HS2 sector by year pair fixed effects. Heteroskedasticity-consistent standard errors are clustered by examiner art unit. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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Alternative Specifications

Dependent variable	*Annualized 3-year export growth*						
	Baseline	Alternative IV	Bootstrap	Examiner control		Alternative FEs	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Successful USPTO application	0.175***	0.160***	0.180***	0.247***	0.179***	0.193***	0.172***
	(0.0522)	(0.0540)	(0.0530)	(0.0734)	(0.0487)	(0.0513)	(0.0492)
Log exports	-0.0367***	-0.0367***	-0.0382***	-0.0367***	-0.0398***	-0.0376***	-0.0379***
	(0.00492)	(0.00491)	(0.00468)	(0.00499)	(0.00473)	(0.00400)	(0.00405)
Export tenure	-0.00299	-0.00313	-0.00207	-0.00248	-0.000505	-0.00242	-0.00163
	(0.00366)	(0.00364)	(0.00363)	(0.00381)	(0.00381)	(0.00294)	(0.00305)
Log examiner's Chinese applications				0.000780			
				(0.0149)			
Log examiner's foreign applications				-0.0204			
				(0.0210)			
Log examiner's years of experience				0.00210			
				(0.0278)			
HS2-application year fixed effects	Yes	Yes	Yes	Yes			
HS2-first-action year fixed effects					Yes		
Application year fixed effects						Yes	
First-action year fixed effects							Yes
F-stats	195.26	214.36		94.70	156.55	187.19	182.60
Observations	1,156	1,156	1,156	1,156	1,171	1,282	1,282

Note: This table reports the estimated effect of a successful first U.S. patent application on the subsequent export growth of Chinese applicants, controlling for patent family submissions to EPO, JPO, and CNIPA. The dependent variable is the annualized 3-year export growth rate. All columns include an indicator for whether the U.S. application is the priority claim of the patent family, and indicators for whether an application from the same patent family is ever filed respectively with EPO, JPO, and CNIPA. Column 1 is estimated with OLS, while Columns 2 and 3 are estimated with 2SLS, using the demeaned examiner approval rate as an instrument. Heteroskedasticity-consistent standard errors are clustered by examiner art unit. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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Controlling for Global Patenting

Dependent variable	*Annualized 3-year export growth*		
	(1)	(2)	(3)
Successful USPTO application	0.0674***	0.187***	0.171**
	(0.0200)	(0.0529)	(0.0678)
Successful USPTO application× USPTO priority			0.0434
			(0.106)
Log exports	-0.0378***	-0.0380***	-0.0381***
	(0.00493)	(0.00501)	(0.00503)
Export tenure	-0.00344	-0.00239	-0.00227
	(0.00349)	(0.00367)	(0.00370)
USPTO priority	-0.00218	-0.00693	-0.0351
	(0.0247)	(0.0250)	(0.0775)
EPO application	0.00134	0.00357	0.00475
	(0.0234)	(0.0242)	(0.0243)
JPO application	-0.0334	-0.0380	-0.0376
	(0.0232)	(0.0238)	(0.0239)
CNIPA application	0.0197	0.0190	0.0187
	(0.0240)	(0.0245)	(0.0243)
HS2-year fixed effects	Yes	Yes	Yes
Model	OLS	IV	IV
F-stat		191.28	57.73
# Observations	1,101	1,101	1,101

Note: This table reports the estimated effect of a successful first U.S. patent application on the subsequent export growth of Chinese applicants, controlling for patent family submissions to EPO, JPO, and CNIPA. The dependent variable is the annualized 3-year export growth rate. All columns include an indicator for whether the U.S. application is the priority claim of the patent family, and indicators for whether an application from the same patent family is ever filed respectively with EPO, JPO, and CNIPA. Column 1 is estimated with OLS, while Columns 2 and 3 are estimated with 2SLS, using the demeaned examiner approval rate as an instrument. Heteroskedasticity-consistent standard errors are clustered by examiner art unit. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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The Effect of Second Application

Dependent variable	*Annualized 3-year export growth*		
	(1)	(2)	(3)
Successful second USPTO application	0.0262	0.0309	0.0502
	(0.0177)	(0.0853)	(0.0824)
Log exports			-0.0104***
			(0.00278)
Export tenure			-0.00167
			(0.00243)
HS2-year fixed effects	Yes	Yes	Yes
Model	OLS	2SLS	2SLS
F-stat		10.87	11.19
# Observations	274	274	274

Note: This table reports the estimated effect of a successful second U.S. patent application on the subsequent export growth of Chinese applicants, conditional on a first patent application being successful. The dependent variable is the annualized 3-year export growth rate. The sample covers CCTS-PatEx matched exporters with a successful first U.S. patent application. Column 1 is estimated with OLS, while Columns 2 and 3 are estimated with 2SLS, using the demeaned examiner approval rate as an instrument. Column 3 controls for initial log exports and export tenure. All columns include HS2 sector by year pair fixed effects. Heteroskedasticity-consistent standard errors are clustered by examiner art unit. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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Three-part Decomposition

Dependent variable	*Components of annualized 3-year export growth*					
	Continuing dest-prod markets		Dropped dest-prod markets		New dest-prod markets	
	(1)	(2)	(3)	(4)	(5)	(6)
Successful USPTO application	0.0678*	0.0681*	-0.0850***	-0.0851***	0.0195	0.0217
	(0.0358)	(0.0349)	(0.0311)	(0.0309)	(0.0309)	(0.0260)
Log exports		-0.00977***		-0.00415*		-0.0311***
		(0.00292)		(0.00241)		(0.00232)
Export tenure		-0.00244		-0.00235		-0.00290*
		(0.00209)		(0.00204)		(0.00149)
HS2-year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
F-stat	198.07	195.26	198.07	195.26	198.07	195.26
# Observations	1,156	1,156	1,156	1,156	1,156	1,156

Note: This table reports the estimated effect of a successful first U.S. patent application on constituent components of the export growth of Chinese applicants. The sample covers all CCTS-PatEx matched exporters. All columns are estimated with 2SLS, using the demeaned examiner approval rate as an instrument. Columns 2, 4, and 6 control for initial log exports and export tenure. All columns include HS2 sector by year pair fixed effects. Heteroskedasticity-consistent standard errors are clustered by examiner art unit. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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ASIE Decomposition

Dependent variable	*Components of annualized 3-year export growth*			
	Incumbent dest-prod markets		New dest-prod markets	
	(1)	(2)	(3)	(4)
Successful USPTO application	0.157**	0.153**	0.0598**	0.0480**
	(0.0628)	(0.0610)	(0.0286)	(0.0230)
Log exports		-0.0120**		-0.0337***
		(0.00550)		(0.00323)
Export tenure		-0.00724**		-0.00685***
		(0.00332)		(0.00156)
Log employment		0.0110		0.0184***
		(0.00719)		(0.00421)
Industry-year fixed effects	Yes	Yes	Yes	Yes
Ownership-year fixed effects	Yes	Yes	Yes	Yes
F-stat	147.05	147.44	147.05	147.44
# Observations	940	940	940	940

Note: This table reports the estimated effect of a successful first U.S. patent application on constituent components of export growth of Chinese applicants in the subsample of CCTS-ASIE-PatEx matched exporters. All columns are estimated with 2SLS, using the demeaned examiner approval rate as an instrument. Columns 2, 4, and 6 control for initial log exports, export tenure, and log employment. All columns include CIC2 industry by year and ownership type by year pair fixed effects. Heteroskedasticity-consistent standard errors are clustered by examiner art unit. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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Export Margins

Dependent variable	*Annualized 3-year growth*			
	# Prod	# Dest	# Dest-prod	Avg exports per dest-prod
	(1)	(2)	(3)	(4)
Successful USPTO application	0.0660	0.0531	0.0782*	0.114**
	(0.0412)	(0.0344)	(0.0406)	(0.0478)
Log exports	-0.00183	-0.0128***	-0.0104***	-0.0372***
	(0.00329)	(0.00297)	(0.00361)	(0.00407)
Export tenure	-0.00442**	-0.00541**	-0.00626***	0.00286
	(0.00224)	(0.00212)	(0.00232)	(0.00310)
HS2-year fixed effects	Yes	Yes	Yes	Yes
F-stat	195.26	195.26	195.26	195.26
# Observations	1,156	1,156	1,156	1,156

Note: This table reports the estimated effect of a successful first U.S. patent application on the annualized 3-year growth rate of different export margins of Chinese applicants. The sample covers all CCTS-PatEx matched exporters. All columns are estimated with 2SLS, using the demeaned examiner approval rate as an instrument. All columns include HS2 sector by year pair fixed effects, and control for initial log exports and export tenure. Heteroskedasticity-consistent standard errors are clustered by examiner art unit. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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Firm-destination-product Level Outcomes

Panel A. Market survival and export growth conditional on survival

Dependent variable	*Survival indicator*			*Export value growth*		
	(1)	(2)	(3)	(4)	(5)	(6)
Successful USPTO application	0.0768***	0.127	0.143**	0.0218	0.0836	0.233***
	(0.0177)	(0.0809)	(0.0693)	(0.0143)	(0.0614)	(0.0821)
F-stat		27.97	105.87		21.20	57.23
# Observations	86,681	86,681	86,681	38,940	38,940	38,940

Panel B. Export price and quantity growth conditional on survival

Dependent variable	*Export price growth*			*Export quantity growth*		
	(1)	(2)	(3)	(4)	(5)	(6)
Successful USPTO application	0.0195	-0.0764	-0.00433	0.00875	0.135**	0.211**
	(0.0144)	(0.0728)	(0.0786)	(0.0176)	(0.0682)	(0.0917)
F-stat		15.10	45.66		15.10	45.66
# Observations	31,320	31,320	31,320	31,320	31,320	31,320

Controls	Firm level log exports and export tenure Firm-dest-prod level log exports and relative export tenure					
Fixed effects	HS6-year and destination-year fixed effects					
Model	OLS	IV	Weighted IV	OLS	IV	Weighted IV

Note: This table reports the estimated effect of a successful first U.S. patent application on the survival probability of incumbent firm-destination-product triplets and the growth in export value, price, and quantity of continuing firm-destination-product triplets. The sample in Columns 1-3 of Panel A (Panel B and Columns 4-6 of Panel A) covers all incumbent (all continuing) firm-destination-product triplets for CCTS-PatEx matched exporters. Columns 1 and 4 are estimated with OLS, while Columns 2, 3, 5, and 6 are estimated with 2SLS, using the demeaned examiner approval rate as an instrument. Columns 3 and 6 weight observations by their initial value share in a firm's export portfolio. All columns include HS6 by year and destination by year pair fixed effects, and control for firm-level initial log exports and tenure and firm-destination-product level initial log exports and relative tenure. Heteroskedasticity-consistent standard errors are clustered by examiner art unit. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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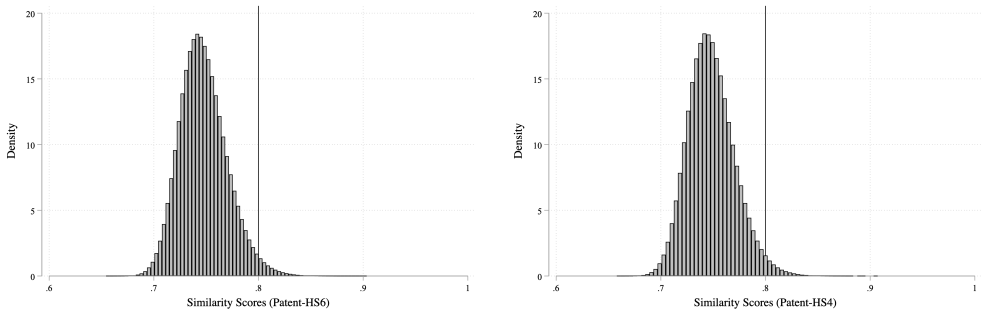
The NLP-based Semantic Similarity

- We compute the semantic similarity between patent texts and HS6 products following steps similar to Argente et al. (2023)
  1. Compile the key textual information from each patent application record, including the patent title, abstract, and USPC technology class description
  2. Concatenate and preprocess both textual datasets to remove unwanted characters and stop words
  3. Apply the lemmatizing algorithm using the WordNetLemmatizer from the NLTK Python module, which reduces words to their base or dictionary forms
  4. Vectorize the preprocessed datasets using the text-embedding-ada-002 model developed by OpenAI (similar to OpenAI' s GPT-2 model)
  5. Compute the cosine similarities between each patent word vector
     - The similarity score threshold is set at 0.8, which is about the 99 percentile of the distribution of similarity scores

The NLP-based Semantic Similarity

Figure: Distributions of Similarity Scores



Note: This figure plots the distributions of similarity scores between the patent texts and HS descriptions. The left panel shows the distribution of similarity scores between patent texts and descriptions of HS 6-digit codes, and the right panel shows the distribution of similarity scores between patent texts and descriptions of HS 4-digit codes.

The NLP-based Semantic Similarity

Validation check 1

- Patent title: fluorescent lamp driver
- Patent abstract: the present invention discloses a kind of fluorescent lamp driver, which consists of the multi-switch converting circuit, power transformer (t1), resonant inductor (l1), resonant capacitor (c3) and step-up transformer (t2). it features the followings: the primary winding (pw) of t1 connects with the ac output of multi-switch converting circuit. l1 and c3, after series connection, connect with the secondary winding (sw) of t1 through the pw of t2. the sw of t2 connects with the load output. in this invention, a resonant inductor is connected in series on the resonant loop to realize frequency and voltage modulation as well as the soft switch function of the primary power switch of the power transformer.
- USPC Description: electric lamp and discharge devices: systems
- Matched HS6 codes
  1. 850410* - Discharge lamps or tubes; ballasts therefor
  2. 900661 - Photographic flashlight apparatus; discharge lamp (electronic)
  3. 850490 - Electrical transformers, static converters and inductors; parts thereof

The NLP-based Semantic Similarity

Validation check 2

- Patent title: automatic tv standard determination method and apparatus thereof
- Patent abstract: an apparatus for automatically determining a tv standard of a tv channel comprises a frequency identification module and a determination module. the frequency identification module identifies a carrier frequency of an audio if signal of the tv channel to generate a frequency identification result. the determination module, which coupled to the frequency identification module, determines the tv standard of the tv channel according to the frequency identification result.
- USPC Description: television
- Matched HS6 codes
  1. 852510 - Transmission apparatus; for radio-telephony, radio-telegraphy, radio-broadcasting or television, whether or not incorporating reception or sound recording and reproducing apparatus
  2. 852520* - Transmission apparatus; for radio-telephony, radio-telegraphy, radio-broadcasting or television, with reception apparatus, with or without sound recording or reproducing apparatus
  3. 852813 - Television receivers; black and white or other monochrome, whether or not incorporating radio broadcast receivers or sound or video recording or reproducing apparatus

The ALP Weighting Algorithm

- The ALP weights are developed using the methodology from Lybbert and Zolas (2014).
  1. Compare keywords in 6-digit HS industry descriptions with keywords in patent abstracts.
  2. Tabulate the number of patents for each USPC/CPC to industry/product classification combination based on the m-to-m matches
  3. Re-weight the results using a modified Bayesian weighting scheme, the 'hybrid' weighting approach
     - It increases the weights of the specific matches and reduces the weights of the generalized matches
  4. For details, see Lybbert and Zolas (2014) and Goldschlag, Lybbert, and Zolas (2019).

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Decomposition by Types: Monopoly Power

Panel A. NLP-based semantic similarity with patent texts

	U.S. Related (1)	U.S. Unrelated (2)	Non-U.S. Related (3)	Non-U.S. Unrelated (4)
Successful USPTO Application	0.000594	0.0202	0.0182	0.139***
	(0.0171)	(0.0167)	(0.0246)	(0.0371)

Panel B. Lybbert and Zolas (2014) ALP similarity with patent classes

	U.S. Related (1)	U.S. Unrelated (2)	Non-U.S. Related (3)	Non-U.S. Unrelated (4)
Successful USPTO Application	0.0256*	-0.00485	0.0145	0.143***
	(0.0135)	(0.0213)	(0.0224)	(0.0409)
Controls	Log exports and export tenure			
HS2-year fixed effects	Yes	Yes	Yes	Yes
F-stat	195.257	195.257	195.257	195.257
# Observations	1,156	1,156	1,156	1,156

Note: This table reports the estimated effect of a successful first U.S. patent application on constituent components of the export growth of Chinese applicants. Total firm growth is decomposed four-way into exports to the U.S. vs. Rest of the World (ROW) and products that are technologically related vs. unrelated to the firm's patent. Products are technologically related to a patent or patent technology class if their descriptions have semantic similarity above 80% based on the NLP method in Panel A (see Appendix ?? for details) and ALP weights above 5% based on Lybbert and Zolas (2014) approach in Panel B. The sample covers all CCTS-PatEx matched exporters. All columns are estimated with 2SLS, using the demeaned examiner approval rate as an instrument. All columns include HS2 sector by year pair fixed effects, and control for initial log exports and firm export tenure. Heteroskedasticity-consistent standard errors are clustered by examiner art unit. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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Export Growth by Types: Monopoly Power

Panel A. NLP-based semantic similarity with patent texts

	U.S. Related (1)	U.S. Unrelated (2)	Non-U.S. Related (3)	Non-U.S. Unrelated (4)
Successful USPTO Application	0.0419	0.178*	0.0624	0.191***
	(0.138)	(0.106)	(0.0833)	(0.0730)
F-stat	74.43	133.06	125.96	182.68
# Observations	604	791	834	1,051

Panel B. Lybbert and Zolas (2014) ALP similarity with patent classes

	U.S. Related (1)	U.S. Unrelated (2)	Non-U.S. Related (3)	Non-U.S. Unrelated (4)
Successful USPTO Application	0.211	0.213**	0.0746	0.181***
	(0.191)	(0.0977)	(0.119)	(0.0639)
F-stat	36.05	129.75	103.40	189.08
# Observations	447	878	677	1,108

Controls	Log exports and export tenure			
HS2-year fixed effects	Yes	Yes	Yes	Yes

Note: This table reports the estimated effect of a successful first U.S. patent application on the subsequent export growth of Chinese applicants in each of four market types. These market types are defined based on the destination country (U.S. vs. Rest of the World, ROW) and product type (technologically related vs. unrelated to the firm's patent). Products are technologically related to a patent or patent technology class if their descriptions have semantic similarity above 80% based on the NLP method in Panel A (see Appendix ?? for details) and ALP weights above 5% based on Lybbert and Zolas (2014) approach in Panel B. The sample covers all CCTS-PatEx matched exporters. All columns are estimated with 2SLS, using the demeaned examiner approval rate as an instrument. All columns include HS2 sector by year pair fixed effects, and control for initial log exports and firm export tenure. Heteroskedasticity-consistent standard errors are clustered by examiner art unit. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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Decomposition by Types: Quality Signal

Panel A. Rauch (1999) HS6 product differentiation

	High income Differentiated (1)	High income Non-differentiated (2)	Low income Differentiated (3)	Low income Non-differentiated (4)
Successful USPTO Application	0.128***	0.0123	0.0341*	0.00395
	(0.0374)	(0.0219)	(0.0176)	(0.00571)

Panel B. Estimated quality dispersion across firms within HS6 product

	High income High quality dispersion (1)	High income Low quality dispersion (2)	Low income High quality dispersion (3)	Low income Low quality dispersion (4)
Successful USPTO Application	0.106***	0.0256	0.0307*	0.0173
	(0.0394)	(0.0325)	(0.0177)	(0.0140)
Controls		Log exports and export tenure		
HS2-year fixed effects	Yes	Yes	Yes	Yes
F-stat	195.26	195.26	195.26	195.26
# Observations	1,156	1,156	1,156	1,156

Note: This table reports the estimated effect of a successful first U.S. patent application on constituent components of the export growth of Chinese applicants. Total firm growth is decomposed four-way into exports to high- vs. low-income countries and products with high vs. low scope for quality differentiation. The sample covers all CCTS-PatEx matched exporters. All columns are estimated with 2SLS, using the demeaned examiner approval rate as an instrument. All columns include HS2 sector by year pair fixed effects, and control for initial log exports and firm export tenure. Heteroskedasticity-consistent standard errors are clustered by examiner art unit. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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Export Growth by Types: Quality Signal

Panel A. Rauch (1999) HS6 product differentiation

	High income Differentiated (1)	High income Non-differentiated (2)	Low income Differentiated (3)	Low income Non-differentiated (4)
Successful USPTO Application	0.133**	0.115	0.0420	0.133
	(0.0649)	(0.101)	(0.0845)	(0.162)
F-stat	179.53	135.60	147.76	75.38
# Observations	1,063	760	875	431

Panel B. Estimated quality dispersion across firms within HS6 product

	High income High quality dispersion (1)	High income Low quality dispersion (2)	Low income High quality dispersion (3)	Low income Low quality dispersion (4)
Successful USPTO Application	0.158**	0.0603	0.0733	0.331**
	(0.0642)	(0.0934)	(0.0897)	(0.138)
F-stat	173.753	146.97	146.076	89.311
# Observations	1,099	689	911	447
Controls		Log exports and export tenure		
HS2-year fixed effects	Yes	Yes	Yes	Yes

Note: This table reports the estimated effect of a successful first U.S. patent application on the subsequent export growth of Chinese applicants in each of four market types. These market types are defined based on the destination country (high-income vs. low-income) and product type (high vs. low scope for quality differentiation). The sample covers all CCTS-PatEx matched exporters. All columns are estimated with 2SLS, using the demeaned examiner approval rate as an instrument. All columns include HS2 sector by year pair fixed effects, and control for initial log exports and firm export tenure. Heteroskedasticity-consistent standard errors are clustered by examiner art unit. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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Decomposition by Types: Contractual Signal

Panel A. Nunn (2007) contract intensity

	High rule of law Contract intensive (1)	High rule of law Non-contract intensive (2)	Low rule of law Contract intensive (3)	Low rule of law Non-contract intensive (4)
Successful USPTO Application	0.115***	0.0369**	0.0150	0.0125
	(0.0418)	(0.0184)	(0.0176)	(0.00981)

Panel B. Levchenko (2007) complexity

	High rule of law High complexity (1)	High rule of law Low complexity (2)	Low rule of law High complexity (3)	Low rule of law Low complexity (4)
Successful USPTO Application	0.130***	0.0191	0.0217	0.00581
	(0.0382)	(0.0320)	(0.0212)	(0.00770)
Controls		Log exports and export tenure		
HS2-year fixed effects	Yes	Yes	Yes	Yes
F-stat	195.26	195.26	195.26	195.26
# Observations	1,156	1,156	1,156	1,156

Note: This table reports the estimated effect of a successful first U.S. patent application on constituent components of the export growth of Chinese applicants. Total firm growth is decomposed four-way into exports to countries with high vs. low rule of law and products with high vs. low contract reliance. The sample covers all CCTS-PatEx matched exporters. All columns are estimated with 2SLS, using the demeaned examiner approval rate as an instrument. All columns include HS2 sector by year pair fixed effects, and control for initial log exports and firm export tenure. Heteroskedasticity-consistent standard errors are clustered by examiner art unit. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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Export Growth by Types: Contractual Signal

Panel A. Nunn (2007) contract intensity

	High rule of law Contract intensive (1)	High rule of law Non-contract intensive (2)	Low rule of law Contract intensive (3)	Low rule of law Non-contract intensive (4)
Successful USPTO Application	0.112*	0.199**	0.0880	0.234
	(0.0578)	(0.0977)	(0.0991)	(0.145)
F-stat	177.79	133.13	131.87	78.63
# Observations	1,047	887	799	542

Panel B. Levchenko (2007) complexity

	High rule of law High complexity (1)	High rule of law Low complexity (2)	Low rule of law High complexity (3)	Low rule of law Low complexity (4)
Successful USPTO Application	0.115*	0.0576	0.153	0.0397
	(0.0669)	(0.0738)	(0.0992)	(0.113)
F-stat	170.25	174.76	122.36	135.54
# Observations	985	972	723	630
Controls		Log exports and export tenure		
HS2-year fixed effects	Yes	Yes	Yes	Yes

Note: This table reports the estimated effect of a successful first U.S. patent application on the subsequent export growth of Chinese applicants in each of four market types. These market types are defined based on the destination country (high vs. low rule of law) and product type (high vs. low contract reliance). The sample covers all CCTS-PatEx matched exporters. All columns are estimated with 2SLS, using the demeaned examiner approval rate as an instrument. All columns include HS2 sector by year pair fixed effects, and control for initial log exports and firm export tenure. Heteroskedasticity-consistent standard errors are clustered by examiner art unit. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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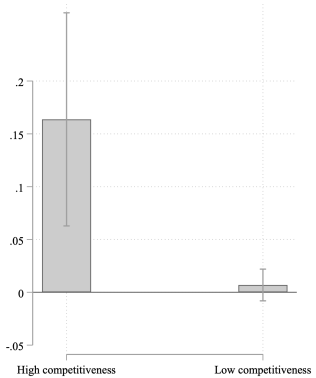
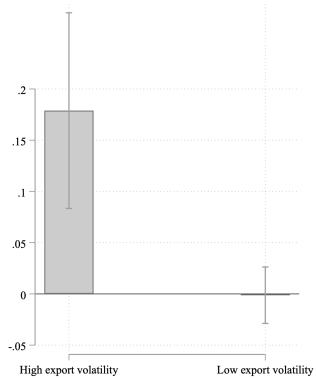
Additional Evidence of the Signaling Mechanism





Additional Evidence of the Signaling Mechanism (Cont.)

Panel A. Destination-product market HHI

Dependent variable	*Survival Indicator* (1)	*Export value growth* (2)
Successful USPTO application × HHI	-0.401***	0.0407
	(0.110)	(0.107)
F-stat	33.83	21.87
# Observations	86,627	38,822

Panel B. Export volatility in the destination-product market

Dependent variable	*Survival Indicator* (1)	*Export value growth* (2)
Successful USPTO application × Export volatility	0.271**	-0.176
	(0.107)	(0.126)
F-stat	32.99	20.74
# Observations	86,091	38,797

Controls	Firm-dest-prod level log exports, relative export tenure, and HHI/export volatility
Fixed effects	Firm-year, HS6-year, and destination-year fixed effects

Note: This table reports the heterogeneous effect of a successful first U.S. patent application on the survival probability and export growth across destination-product markets within firms. The sample in Columns 1 (Columns 2) covers all incumbent (all continuing) firm-destination-product triplets for CCTS-PatEx matched exporters. Destination-product markets have high information asymmetry if their competitiveness is above the median in Panel A and if their sales volatility is above the median in Panel B. Market competitiveness is the Herfindhal Index (HHI) across Chinese exporters in a given destination-product-year market. Market volatility is the coefficient of variation of exports within a firm-destination-product over time, averaged across firms to the destination-product level. All columns are estimated with 2SLS, using the demeaned examiner approval rate as an instrument. All columns include HS6 by year, destination by year, and firm by year pair fixed effects, and control for firm-destination-product level initial log exports and relative tenure. Heteroskedasticity-consistent standard errors are clustered by examiner art unit. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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Heterogeneous Effects by Export Tenure

Dependent variable	*Annualized 3-year export growth*		
	(1)	(2)	(3)
Successful USPTO application	0.175***	0.236***	0.0996
	(0.0522)	(0.0788)	(0.0790)
Log exports	-0.0367***	-0.0412***	-0.0274***
	(0.00492)	(0.00606)	(0.00915)
Export tenure	-0.00299	-0.0103	-0.00371
	(0.00366)	(0.00981)	(0.00764)
HS2-year fixed effects	Yes	Yes	Yes
Sample	All applicants	Tenure <= 5	Tenure > 5
F-stat	187.19	81.17	65.46
# Observations	1,156	646	427

Note: This table reports the heterogeneous effect of a successful first U.S. patent application on the subsequent annualized 3-year export growth of Chinese applicants with different export tenure. The sample in Columns 1 covers all CCTS-PatEx matched exporters. The sample in Column 2 (3) covers CCTS-PatEx matched exporters with export tenure below (above) the median (5 years). All columns are estimated with 2SLS, using the demeaned examiner approval rate as an instrument. All columns include HS2 sector by year pair fixed effects, and control for initial log exports and export tenure. Heteroskedasticity-consistent standard errors are clustered by examiner art unit. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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Testing the Financial Constraint Mechanism

Dependent variable	*Annualized 3-year export growth*					
	External Finnancial Dependence		*Liquidity Needs*		*Asset Tangibility*	
Firm Fin Vulnerability	High	Low	High	Low	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)
Successful USPTO application	0.149**	0.183***	0.154**	0.226***	0.138**	0.263***
	(0.0682)	(0.0615)	(0.0619)	(0.0766)	(0.0659)	(0.0813)
Difference (High - Low)	-0.0368		-0.799		-0.130	
	(0.0894)		(0.0971)		(0.0999)	
Controls	Log exports, export tenure					
HS2-year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
K-P rk Wald F-stats	147.46	135.58	180.43	101.28	138.46	102.99
Observations	473	644	646	470	591	511

Note: This table reports the heterogeneous effect of a successful first U.S. patent application on the subsequent annualized 3-year export growth of Chinese applicants with different levels of financial vulnerability. The sample in Columns 1, 3, and 5 (2, 4, and 6) covers CCTS-PatEx matched exporters with financial vulnerability above (below) the median. A firm's financial vulnerability is measured with the weighted average of industry-level financial vulnerability, using industries' share of firm exports as weights. Industry's financial vulnerability is measured by their external finance dependence, liquidity needs (inventories-to-sales ratio), or asset tangibility. All columns are estimated with 2SLS, using the demeaned examiner approval rate as an instrument. All columns include HS2 sector by year pair fixed effects, and control for initial log exports and export tenure. Heteroskedasticity-consistent standard errors are clustered by examiner art unit. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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Patent Filing in China

Dependent variable	*Annualized 3-year growth of CNIPA patents*		
	(1)	(2)	(3)
Successful UPSTO application	0.0659	-0.0583	-0.0494
	(0.0461)	(0.120)	(0.0993)
Log exports	0.0119*	0.0123*	0.00184
	(0.00624)	(0.00644)	(0.00640)
Export tenure	-0.00871	-0.00874	-0.00460
	(0.00654)	(0.00664)	(0.00637)
HS2-year fixed effects	Yes	Yes	Yes
Model	OLS	2SLS	2SLS
Sample	All applicants	All applicants	Continuing applicants
F-stat		146.65	147.78
Observations	797	797	724

Note: This table reports the estimated effect of a successful first U.S. patent application on a Chinese applicant's subsequent patent applications in China. The sample covers CCTS-ORBIS-PatEx matched exporters. Column 1 is estimated with OLS, while Columns 2 and 3 are estimated with 2SLS, using the demeaned examiner approval rate as an instrument. All columns include HS2 by application year pair fixed effects, and control for initial log exports and export tenure. Heteroskedasticity-consistent standard errors are clustered by examiner art unit. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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