Online Appendix

Geopolitical Tensions and the Recomposition of International Invention

Abstract

Rising geopolitical tensions are widely expected to fragment international innovation, yet it remains unclear whether firms end cross-border invention relationships or reorganize what and where they invent. Using USPTO patent records for 6,645 firms between 2000 and 2023, I compare invention relationships affected by abrupt rises in bilateral tensions with the same firms' other preexisting international relationships in a stacked event study. Within exposed relationships, firms reduce geopolitically sensitive co-invention by 12.2% while increasing co-invention in other technologies by 6.0%. Contraction reaches 14% for technologies prominent in the firm's prior patenting, against 8% for peripheral ones. Firms expand sensitive co-invention by 10.8% in their existing relationships with third countries, particularly those covering these technologies and one of the affected countries. Yet, the bilateral relationships under tension rarely end and their total co-invention barely changes. These patterns are consistent with firms protecting established inventive trajectories by relocating exposed invention across their international portfolio, leaving the network's visible structure stable. Conventional measures of relationship survival and aggregate output can conceal substantial technological and geographic reconfiguration that follows geopolitical tensions.

Contents

A. Data, Measurement, and Treatment

A.1. Patent, assignee, classification, and country-pair reconciliation

The empirical design requires patent totals to remain invariant as records are allocated across inventor-country pairs, legal assignees, and technology subclasses. Table A1. Patent, Assignee, Classification, and Country-Pair Reconciliation reconciles each stage. The assignee waterfall also clarifies the organizational unit. A firm is the normalized matched legal assignee recorded on the patent. The records do not reveal consolidated corporate boundaries, affiliate relationships, inventor employment, or alliance governance, so a firm-country-pair relationship describes the geography of patented co-invention associated with that assignee rather than a formal organizational boundary.

Table A1. Patent, Assignee, Classification, and Country-Pair Reconciliation
Panel A. Patent-type waterfall

Item	Number of patent records	Share of starting records	Arithmetic check
Internationally co-invented patent records	435,397	100.00% (435,397/435,397)	Starting universe
Reissues excluded	946	0.22% (946/435,397)	Not applicable
Plant patents excluded	329	0.08% (329/435,397)	Not applicable
Utility patents retained	434,122	99.71% (434,122/435,397)	435,397 − 946 − 329 = 434,122

Table A1. (Continued)
Panel B. Assignee-record and corporate-match waterfall

Mutually exclusive status among utility patents	Patents	Share of 434,122	Arithmetic check
One assignee record	391,093	90.09%	Not applicable
Multiple assignee records	35,103	8.09%	Not applicable
No assignee record	7,926	1.83%	391,093 + 35,103 + 7,926 = 434,122
Utility patents with at least one assignee record	426,196	98.17%	391,093 + 35,103
Assigned patents without a matched corporate legal assignee	2,844	0.66%	Excluded from firm-level models; retained in the external country-pair benchmark
Corporate-assignee patents	423,352	97.52%	426,196 − 2,844 = 423,352
Corporate-assignee patents with a usable normalized IPC subclass	423,083	97.46%	423,352 − 269 = 423,083
Distinct normalized matched legal assignees	44,302	Not applicable	Assignee types 2 and 3

Table A1. (Continued)

Panel C. Country coverage and analytic samples

Coverage item	Count	Denominator or time window	Share or relationship
Inventor countries with at least one international partner	173	2000–2023	Not applicable
Possible unordered country pairs	14,878	173 × 172 / 2	100.00%
Observed unordered country pairs	2,514	14,878 possible pairs	16.90%
Possible unordered pair-years	357,072	14,878 pairs × 24 years	100.00%
Positive unordered pair-years (country-pair-year network density)	19,169	357,072 possible pair-years	5.37%
Fractional co-invention in ten largest country pairs	Not applicable	All fractional international co-invention, 2000–2023	49.18%
Affected first-shock country pairs	593	Cohorts 2003–2019 with complete treatment history and full years 0–4 calendar coverage	Not applicable
Firms active on an affected relationship	6,645	Normalized matched legal assignees	Not applicable
Firm-by-affected-pair events	25,841	First-shock events	Not applicable
Events with positive classified activity	16,894	25,841 firm-events	65.38%
Events meeting the ten-patent-equivalent requirement	12,758	25,841 firm-events	49.37%
Firms in prominence support	2,020	Eligible prominence model	Not applicable
Firm-by-IPC-subclass pairs in prominence support	7,829	Eligible prominence model	Not applicable

Table A1. (Continued)

Panel D. Fractional and whole-count allocation

Allocation stage	Fractional total	Whole-count records	Interpretation
Utility patent to unordered inventor-country pair	434,122.0 patent equivalents	514,906 patent-pair records	Fractional pair weights sum to one within each patent; whole counting assigns one to every pair
Corporate patent to legal assignee and country pair	423,352.0 patent equivalents	552,418 patent-assignee-pair records	Fractional assignee weights sum to one across distinct matched legal assignees
Classified corporate patent to legal assignee, pair, and normalized IPC subclass	423,083.0 patent equivalents	1,126,744 patent-assignee-pair-subclass records	Fractional subclass weights sum to one across distinct usable subclasses
Geopolitically sensitive subclass mass	146,725.2 equivalents	438,276 sensitive subclass records	34.68% = 146,725.2/423,083.0
Other classified subclass mass	276,357.8 equivalents	688,468 other subclass records	65.32% = 276,357.8/423,083.0

Notes. The starting records list inventors in at least two countries. Reissues and plant patents are removed before any assignee allocation. Every patent with more than one matched legal assignee is divided equally across its distinct assignees. For each patent, the weight on an unordered country pair is proportional to the product of the inventor counts at its endpoints and is normalized to sum to one. The resulting patent-assignee-pair weight is divided equally across distinct normalized IPC subclasses. These three fractional allocations preserve one patent equivalent at each aggregation stage. Whole counting is a sensitivity rule and does not preserve the patent total because every eligible pair, assignee, and subclass receives weight one. Table A11 reports the corresponding source, destination, endpoint, and technology-matched relational-capacity estimates; their stable ordering shows that the findings do not arise mechanically from renormalizing fractional patent weights. Patents with no assignee and assigned patents without a matched corporate assignee remain in the external country-pair benchmark but do not enter firm-level models.

A.2. Geopolitically sensitive technology crosswalk

Geopolitical sensitivity is assigned before estimating any outcome. The baseline measure divides a patent's fractional weight across its distinct normalized IPC subclasses and then aggregates the mass mapped to six Wassenaar-related domains. This approach permits mixed patents to contribute to both sensitive and other classified invention while preserving total classified patenting. Table A2. Geopolitically Sensitive Technology Crosswalk and Classification Rules documents the crosswalk and separates the baseline rule from alternative patent-level classifications.

Table A2. Geopolitically Sensitive Technology Crosswalk and Classification Rules

Panel A. IPC-subclass crosswalk

Sensitive domain	Normalized IPC subclasses	Documentary anchor	Mapping rationale
Advanced electronics and semiconductors	H01L, H10, H03	Wassenaar Arrangement 2024, Categories 3 and related electronics entries	Semiconductor devices, integrated circuits, electronic circuitry, signal generation, and component technologies
Telecommunications and information security	H04B, H04J, H04K, H04L, H04Q, H04W, G09C	Wassenaar Arrangement 2024, Categories 5 Part 1 and 5 Part 2	Transmission, multiplexing, secure communication, networks, switching, wireless systems, cryptography, and information security
Computing	G06E, G06F, G06J, G06N	Wassenaar Arrangement 2024, Category 4	Digital and optical computing, data processing, specialized architectures, and artificial-intelligence computing
Navigation and sensing	G01C, G01S	Wassenaar Arrangement 2024, Categories 6 and 7	Navigation, positioning, radar, radio direction finding, ranging, and sensing
Aerospace	B64	Wassenaar Arrangement 2024, Category 9 and Munitions List aerospace entries	Aircraft, aviation systems, unmanned aircraft, spacecraft, and related equipment
Nuclear technology	G21	Wassenaar Arrangement 2024, nuclear-related dual-use and Munitions List entries	Nuclear physics, reactors, radiation technologies, and associated control systems

Table A2. (Continued)

Panel B. Source, version, timing, and code normalization

Element	Rule
Documentary source	Wassenaar Arrangement, List of Dual-Use Goods and Technologies and Munitions List, 2024 edition, downloaded from the Wassenaar Arrangement public document archive
Patent classification source	PatentsView normalized IPC assignments linked to USPTO utility patents; classifications observed on the grant record
Classification vintage	Codes are interpreted under the IPC 2024.01 scheme after normalization. Four-character subclass mappings are supplemented by the B64 and G21 class-level inclusion prefixes, and historical symbols are crosswalked to their valid form
Normalization	Remove spaces and punctuation, uppercase letters, and restore leading zeros. Retain four characters for subclass mappings, while B64 and G21 operate as three-character inclusion prefixes covering their constituent subclasses; for example, G6F becomes G06F and H4L becomes H04L
Duplicates	Duplicate subclass symbols on a patent are collapsed before weighting
Missing codes	Patents without a usable normalized subclass remain in all-patent totals and are excluded from classified-content comparisons
Multiple subclasses	Fractional patent-assignee-pair weight is divided equally across distinct usable subclasses
Timing	The crosswalk is fixed for the complete 2000–2023 patent panel and is not updated in response to post-shock outcomes

Table A2. (Continued)

Panel C. Implemented classification rules

Manuscript label	Implemented rule	Patent-level assignment	Use in the appendix
Baseline fractional classification	Fractional sensitive subclass mass	A patent's weight is divided across distinct usable IPC subclasses; mapped mass is sensitive and unmapped mass is other classified	Main source, destination, endpoint, citation, and capacity models
Any-code	Any-subclass	Entire classified patent weight is sensitive if at least one usable subclass is mapped	A11, separately named
Mixed-code majority	Majority-sensitive	Entire classified patent weight is sensitive when more than half of its distinct usable subclasses are mapped; exact ties remain other classified	Named Table 7 alternative; A11
Exclusive-code	Strict all-subclasses-sensitive	Entire classified patent weight is sensitive only when every usable subclass is mapped	A11, separately named
Independent CPC robustness	Independent CPC mapping	Apply the six-domain mapping independently to normalized CPC subclasses and classify by fractional CPC mass	A separate A11 robustness mapping, applied identically to every outcome
Whole-count classification	Whole-count patent allocation	Each eligible assignee-country-pair-subclass record receives one before sensitive and other totals are formed	A11 allocation sensitivity
Leave out advanced electronics and semiconductors	Baseline fractional rule excluding H01L, H10, and H03	Omitted domain is treated as other classified	A11
Leave out telecommunications and information security	Baseline fractional rule excluding H04B/J/K/L/Q/W and G09C	Omitted domain is treated as other classified	A11
Leave out computing	Baseline fractional rule excluding G06E/F/J/N	Omitted domain is treated as other classified	A11
Leave out navigation and sensing	Baseline fractional rule excluding G01C/S	Omitted domain is treated as other classified	A11
Leave out aerospace	Baseline fractional rule excluding B64	Omitted domain is treated as other classified	A11
Leave out nuclear technology	Baseline fractional rule excluding G21	Omitted domain is treated as other classified	A11

Table A2. (Continued)

Panel D. Correspondence checks

Check	Numerator	Denominator	Result
Classified corporate fractional equivalents	423,083.0	423,083.0	Sensitive plus other equals 100.00%
Sensitive fractional equivalents	146,725.2	423,083.0	34.68%
Other classified fractional equivalents	276,357.8	423,083.0	65.32%
Patents whose any-subclass and fractional classifications agree on positive sensitive status	392,618	423,083	92.80%
Patents whose strict and majority classifications agree	401,478	423,083	94.89%
IPC and independent CPC classifications agree on positive sensitive status	381,964	413,226 patents with usable IPC and CPC	92.43%

Notes. The crosswalk identifies domains with security and dual-use relevance; it does not determine whether an individual patent was legally controlled or commercially important. The majority-sensitive rule is the named Table 7 alternative. The independent CPC rule remains a separate documentary robustness check and is applied without changing the mapping across sensitive contraction, destination expansion, endpoint contrasts, and capacity models. Each leave-one-domain-out specification removes exactly one of the six named domains. The baseline sensitive and other classified fractional outcomes sum to total classified invention by construction.

A.3. Analysis-specific sample construction and retained zeros

Each design applies its own pre-shock qualifications because the relevant comparison changes across analyses. Table A3. Analysis-Specific Sample Construction, Retained Zeros, and PPML Separation follows every sample through six common checkpoints. Later zero outcomes remain once a unit enters a fixed pre-shock portfolio. Large reductions in the destination panels arise mainly from PPML separation and the requirement that absorbed route-year cells contain both affected and comparison firms; they are not propensity-score exclusions.

Table A3. Analysis-Specific Sample Construction, Retained Zeros, and PPML Separation

Panel A. Affected-relationship and external models

Analysis family	1. Outcome-universe eligibility	2. Shock and cohort eligibility	3. Pre-shock qualification	4. Comparison and support	5. Panel completion and censoring	6. Separation and final estimation sample
Affected-relationship total co-invention, earlier-window diagnostic	423,352 corporate-assignee utility patents; 44,302 firms	25,841 firm-pair events; 6,645 firms; 593 affected pairs; cohorts 2003–2019	17,968 events and 82,104 fixed relationship-event cells active in years −6 through −4	16,942 events retain at least one clean comparison relationship; no treatment-assignment weights	1,048,576 firm-relationship-event-years after later-shock censoring; 640,046 zero outcomes	1,004,288 observations; 16,502 events; 6,005 firms; 571 affected-pair clusters; 612,430 zero outcomes; 27,616 separated rows plus 16,672 rows in 1,346 dropped fixed-effect strata; pseudo-R^2=.769
Affected-relationship joint sensitive/other model, earlier-window diagnostic	423,083 classified corporate patents; 16,894 events with positive classified activity	Same first shocks and cohorts	12,204 events carry both content categories in the fixed portfolio; 48,906 relationship-event cells	11,846 events retain common sensitive/other comparison support	1,239,680 stacked content observations; both content outcomes retained after later zeros	1,182,404 observations; 11,521 events; 6,112 firms; 579 affected-pair clusters; 731,914 zero outcomes; 46,556 separated rows plus 10,720 rows in 1,804 dropped fixed-effect strata; pseudo-R^2=.781
Affected-relationship total, recent-window headline model	Same all-patent universe	Same first shocks and cohorts	25,841 events and 102,994 fixed relationship-event cells active in years −3 through −1	24,306 events retain a clean comparison relationship	1,512,804 rows after censoring; 915,460 zeros	1,446,920 observations; 23,782 events; 6,501 firms; 590 pair clusters; 65,884 separated rows; pseudo-R^2=.936

Table A3. (Continued)

Panel A. Affected-relationship and external models (continued)

Analysis family	1. Outcome-universe eligibility	2. Shock and cohort eligibility	3. Pre-shock qualification	4. Comparison and support	5. Panel completion and censoring	6. Separation and final estimation sample
Joint sensitive/other, recent-window headline model	Same classified universe	16,894 classified events	16,894 events and 67,408 mixed-content relationship-event cells	16,174 events retain common content support	1,621,436 stacked observations; 994,382 zeros	1,546,728 observations; 15,836 events; 6,408 firms; 588 pair clusters; 74,708 separated rows; pseudo-R^2=.924
External country-pair total	434,122 utility patents; 14,878 possible pairs; 357,072 pair-years	593 first-shock pairs in 2003–2019 cohort stacks	570 affected pairs have complete event windows and at least one eligible never- or not-yet-treated comparison pair	570 affected and 13,402 comparison pairs; no propensity weighting	93,412 candidate pair-stack-years; 55,266 zero outcomes; 1,226 absorbed-cell/support losses precede 3,422 separated zero rows	88,764 observations; 529 affected pairs; 4,128 treated and 84,636 comparison rows; 51,844 retained zeros; 3,422 separated rows; 166 endpoint countries; dyadic inference; pseudo-R^2=.742
External joint sensitive/other	423,083 classified corporate patents plus classified noncorporate, unmatched, and unassigned patents	Same cohort stacks	Common classified pair-stack-years for both content categories	Identical affected and comparison pair-years in both content categories	186,824 stacked content rows; 166,102 zeros	177,528 content observations; 529 affected pairs; 9,296 separated rows; dyadic inference across 162 endpoint countries; pseudo-R^2=.879

Table A3. (Continued)

Panel B. Directed citation models

Analysis family	1. Outcome-universe eligibility	2. Shock and cohort eligibility	3. Pre-shock qualification	4. Comparison and support	5. Panel completion and censoring	6. Separation and final estimation sample
Applicant-citation rate	401,772 corporate classified citing patents with citation-source information	8,946 firm-directed-pair events; 5,486 firms; 511 affected pairs	7,038 events with a positive pre-shock directed citation link and an eligible citing-patent exposure	6,724 events retain an eligible comparison directed link; examiner citations, same-family citations, and citing patents with inventors in the cited country excluded	621,448 stacked content-link-years; 414,236 zero-citation rows; exposure totals 2,806,417 eligible citing-patent equivalents	594,116 observations; 5,218 firm clusters; 487 affected-pair clusters; 26,114 directed-link events; 27,332 separated rows; pseudo-R^2=.907
Applicant-citation count	Same applicant-cited provenance and exclusions	Same cohort rule	Same directed links; no exposure denominator required	Identical content comparison on admitted links	607,284 stacked content-link-years; 408,194 zero rows	578,902 observations; 5,218 firms; 487 affected pairs; 28,382 separated rows; pseudo-R^2=.899

Table A3. (Continued)

Panel C. Earlier-window geographic models

Analysis family	1. Outcome-universe eligibility	2. Shock and cohort eligibility	3. Pre-shock qualification	4. Comparison and support	5. Panel completion and censoring	6. Separation and final estimation sample
Broad across-firm destination	Sensitive co-invention on alternative country relationships	1,468 affected firm-events; 1,228 firms; 170 affected pairs	6,085 treated relationship cells active in years −6 through −4; 32,514 treated annual rows	420,307 comparison cells before later-shock censoring; common support retains 5,891 treated and 392,844 comparison cells	72,713/420,307 comparison cells experience a later shock by year 4; rows retained through the preceding year; admitted later zeros preserved	653,612 observations: 16,008 treated and 637,604 comparison; 1,006 events; 825 treated and 8,022 total firms; 142 pairs/stacks; 3,085 treated and 116,835 comparison cells; 393,864 retained zeros; pseudo-R^2=.915
Exact-IPC across-firm destination, fexp_b	Activity limited to subclasses carried by the affected relationship	1,464 events; 1,226 firms; 170 affected pairs	12,438 treated relationship-subclass cells; 65,759 treated rows	Common support applied within relationship-subclass-by-stack strata	Broad-exposure competing-shock censoring applied to all subclasses; later zeros retained	99,335 observations: 8,866 treated and 90,469 comparison; 568 events; 496 treated and 3,654 total firms; 108 pairs; 1,696 treated and 17,520 comparison cells; 65,895 retained zeros; pseudo-R^2=.903

Table A3. (Continued)

Panel C. Earlier-window geographic models (continued)

Analysis family	1. Outcome-universe eligibility	2. Shock and cohort eligibility	3. Pre-shock qualification	4. Comparison and support	5. Panel completion and censoring	6. Separation and final estimation sample
Treatment-unweighted endpoint contrast	Affected firms with at least one endpoint-retaining and one endpoint-free alternative	1,382 events; 1,287 firms; 241 affected pairs	17,355 candidate relationship-event rows from the fixed pre-shock portfolio	No ATT, inverse-odds, or overlap treatment-assignment weights	17,355 candidate relationship-event-years; 10,296 pre-separation zeros; later relationship shocks censored	16,970 observations; 1,382 events; 1,287 firms; 241 pair clusters; 17,355 candidate rows; 9,911 zero rows; 385 separated rows; pseudo-R^2=.928
Treatment-unweighted same-IPC endpoint contrast	Same endpoint requirement within affected-relationship subclasses	782 events; 780 firms; 193 affected pairs	27,582 candidate relationship-event-subclass rows	No treatment-assignment weights	27,582 candidate relationship-subclass-years; 16,326 pre-separation zeros	27,000 observations; 782 events; 780 firms; 193 pair clusters; 27,582 candidate rows; 15,744 zero rows; 582 separated rows; pseudo-R^2=.914

Table A3. (Continued)

Panel D. Recent-window and common-eligible geographic sensitivities

Analysis family	Raw eligibility	Comparison/support and censoring	Final observations	Final units and retained zeros
Broad destination, years −3 through −1	2,725 events; 2,106 treated firms; 249 pairs; 10,313 treated cells; 48,511 treated rows; 3,404,795 comparison rows	Fixed-point separation and absorbed route-year overlap; ATT common support	2,743,393	46,935 treated; 2,696,458 comparison; 2,699 events; 2,082 treated and 25,041 total firms; 247 pairs; 9,986 treated and 566,122 comparison cells; 1,855,719 zeros
Exact-IPC destination, years −3 through −1, fexp_b	1,787 events; 1,513 treated firms; 201 pairs; 15,844 cells; 72,766 treated and 16,657,422 comparison rows	Same broad-exposure competing-shock rule and subclass-level support	231,756	15,970 treated; 215,786 comparison; 1,010 events; 872 treated and 10,171 total firms; 144 pairs; 3,422 treated and 46,854 comparison cells; 161,533 zeros
Broad common-eligible sample	740 events present under both qualification rules; 6,698 identical raw treated annual keys	Eligibility rebuilt jointly before support and separation	237,418	6,004 treated; 231,414 comparison; 512 events; 468 treated and 3,986 total firms; 96 pairs; 153,804 zeros
Exact-IPC common-eligible sample, fexp_b	308 events present under both qualification rules; 3,411 identical raw treated annual keys	Eligibility rebuilt jointly using the broad-exposure rule	34,929	3,087 treated; 31,842 comparison; 214 events; 192 treated and 1,412 total firms; 67 pairs; 23,108 zeros

Table A3. (Continued)

Panel E. Continuity, prominence, capacity, and conditional-share samples

Analysis family	Final observations	Firms	Affected pairs	Additional units	Retained zeros / separation / fit
Durable dissolution	79,418 relationship-event observations	5,984	541	One complete-follow-up observation per active pre-shock relationship	Binary outcome; 1,194 incomplete-follow-up relationships excluded; adjusted R^2=.682
Technological prominence	412,568	2,020	331	7,829 firm-subclass pairs; 63,704 relationship-event-subclass strata	284,116 zeros; 18,932 separated rows; pseudo-R^2=.944
Source breadth and capacity	286,744	3,918	512	41,806 relationship-event cells	177,622 zeros; 12,604 separated rows; pseudo-R^2=.931
Destination breadth and capacity	402,516	6,812 total; 781 treated	134	77,408 comparison cells after support	251,476 zeros; 19,340 separated rows; pseudo-R^2=.917
Earlier-window patent-equivalent accounting (joint-content model)	1,182,404	6,112	579	Same joint-content observations as Panel A	Predictions retain all admitted zeros and use the joint-model covariance
Conditional linear sensitive share	238,916 positive-total relationship-years	5,887	568	Positive total classified activity only	Zero-total years excluded by estimand; unweighted cell-average model; adjusted R^2=.624

Notes. The event window is years −3 through 4 and year −1 is omitted. The source headline models qualify relationships in years −3 through −1; the source pre-event diagnostic and the destination baseline qualify relationships in years −6 through −4. Recent-window destination estimates remain broader-sample robustness checks. Once a relationship, directed link, or subclass cell is admitted, later zero outcomes are retained until a competing shock censors the cell. Across-firm destination models use ATT inverse-odds weights after common support. Within-firm endpoint and same-IPC endpoint models use no treatment-assignment weights. PPML separation removes paths with no identifying positive outcome and then rechecks overlap at the absorbed fixed-effect grain until the sample reaches a fixed point. Fit is the squared correlation between the observed outcome and the PPML fitted mean unless the table identifies an adjusted R^2 for a linear model.

A.4. Bilateral tension measure and treatment validation

The treatment uses changes in the composition of bilateral interactions rather than changes in media attention. Table A4. Bilateral Tension Measure, Shock Construction, and Treatment Coverage traces the directed event records to the first-shock pair-year and reports diagnostics that distinguish conflict composition from event volume. Figure A1. Treatment Construction and Validation plots the same quarterly values and the volume placebo.

Table A4. Bilateral Tension Measure, Shock Construction, and Treatment Coverage

Panel A. Source and transformation

Step	Unit	Rule	Count or summary
Source query	Directed dyad-month	GDELT BigQuery table gdelt-bq.full.events, queried August 9, 2026; nonmissing Actor1CountryCode and Actor2CountryCode; self-pairs removed	2,864,312 directed dyad-month records, 1995Q1–2019Q2
Direction pooling	Unordered pair-quarter	Sum both directions and all months within quarter	382,008 pair-quarters with at least one event
Strong conflict	Event	Goldstein score ≤ −5	7,946,231 strong-conflict events among 68,212,604 bilateral events
Strong-conflict share	Pair-quarter	Strong-conflict events / all bilateral events	Mean .1165; p25 .0618; median .1034; p75 .1587
Detrended first difference	Pair-quarter	Current share change net of pair-specific linear quarter trend	Mean .0000; SD .0714
Standardized change	Pair-quarter	Difference minus mean of preceding eight changes, divided by their SD	Mean .003; SD 1.012 among pair-quarters with eight prior changes
Baseline threshold	Pair-quarter	Standardized change ≥2.5 and at least 25 bilateral events	918 qualifying pair-quarters
First-shock rule	Unordered pair	Retain the first qualifying quarter	593 affected country pairs
Application-year alignment	Pair-year	Q1/Q2 assigned to current year; Q3/Q4 assigned to following year	2003–2019 treatment cohorts; 593 affected pairs and 25,841 firm-events

Table A4. (Continued)

Panel B. Shock-quarter levels and event volume

Quantity	Preceding eight-quarter mean	Shock quarter	Change	Numerator / denominator
Strong-conflict share	.0835	.356	+.273	45,926 strong-conflict / 129,005 total shock-quarter events
Standardized conflict-share change	.018	3.48	+3.46 SD	593 first shocks
Total bilateral event count	172.1	217.5	+45.4 events	129,005/593 shock quarters
Log event count	4.62	4.79	+.17	593 shock quarters
Pairs meeting the 25-event requirement	Not applicable	593	Not applicable	593/593

Table A4. (Continued)

Panel C. Treatment cohorts

Application-year cohort	Affected pairs / firm-events	Pair share / firm-event share
2003	18 / 510	3.04% / 1.97%
2004	22 / 612	3.71% / 2.37%
2005	19 / 548	3.20% / 2.12%
2006	25 / 770	4.22% / 2.98%
2007	27 / 891	4.55% / 3.45%
2008	32 / 1,204	5.40% / 4.66%
2009	31 / 1,102	5.23% / 4.26%
2010	34 / 1,390	5.73% / 5.38%
2011	42 / 1,714	7.08% / 6.63%
2012	38 / 1,512	6.41% / 5.85%
2013	35 / 1,394	5.90% / 5.39%
2014	40 / 2,240	6.75% / 8.67%
2015	41 / 1,876	6.91% / 7.26%
2016	39 / 1,598	6.58% / 6.18%
2017	42 / 1,732	7.08% / 6.70%
2018	53 / 2,945	8.94% / 11.40%
2019	55 / 3,803	9.27% / 14.72%
Total	593 / 25,841	100.00% / 100.00%

Table A4. (Continued)

Panel D. Recognizable-event and event-volume diagnostics

Diagnostic	Estimate or rate	SE	p-value	Interpretation
Prespecified recognizable escalations captured within ±1 quarter	87.5% (21/24)	6.8 pp	[<.001] against 50%	The rule recovers widely recognized bilateral deteriorations without using patent outcomes
Mean standardized change at recognizable escalations	4.18	(0.42)	[<.001]	Large hostile-composition changes occur at recognizable episodes
Mean standardized change at matched non-event quarters	0.07	(0.11)	[.524]	Matched quarters show no comparable jump
Bilateral event-volume placebo, affected-relationship direct content model	−0.014	(0.029)	[.629]	−1.4%; CI [−6.8%, 4.4%]
Joint leads for event-volume placebo, years −3 and −2	$\chi^2(2)=0.31$	Not applicable	[.856]	No pre-event divergence

Table A4. (Continued)

Panel E. Values supplied to Figure A1

Relative quarter	Strong-conflict share	95% interval	Standardized change	Mean total events	Recognizable-event share
−8	.083	[.075, .091]	−0.07	165.1	0.0%
−7	.081	[.073, .089]	−0.03	167.3	0.0%
−6	.084	[.076, .092]	0.04	169.8	4.2%
−5	.082	[.074, .090]	−0.02	171.6	4.2%
−4	.083	[.075, .091]	0.03	173.9	4.2%
−3	.084	[.076, .092]	0.06	175.7	8.3%
−2	.086	[.078, .094]	0.08	176.9	8.3%
−1	.085	[.077, .093]	0.05	176.4	12.5%
0	.356	[.335, .377]	3.48	217.5	87.5%
+1	.193	[.178, .208]	0.41	211.4	66.7%
+2	.151	[.138, .164]	0.10	205.2	45.8%
+3	.129	[.117, .141]	−0.06	200.1	33.3%
+4	.116	[.105, .127]	−0.13	196.4	25.0%
+5	.109	[.098, .120]	−0.11	193.8	20.8%
+6	.103	[.093, .113]	−0.08	191.5	16.7%
+7	.098	[.088, .108]	−0.05	189.7	12.5%
+8	.096	[.086, .106]	−0.03	188.3	12.5%

Table A4. (Continued)

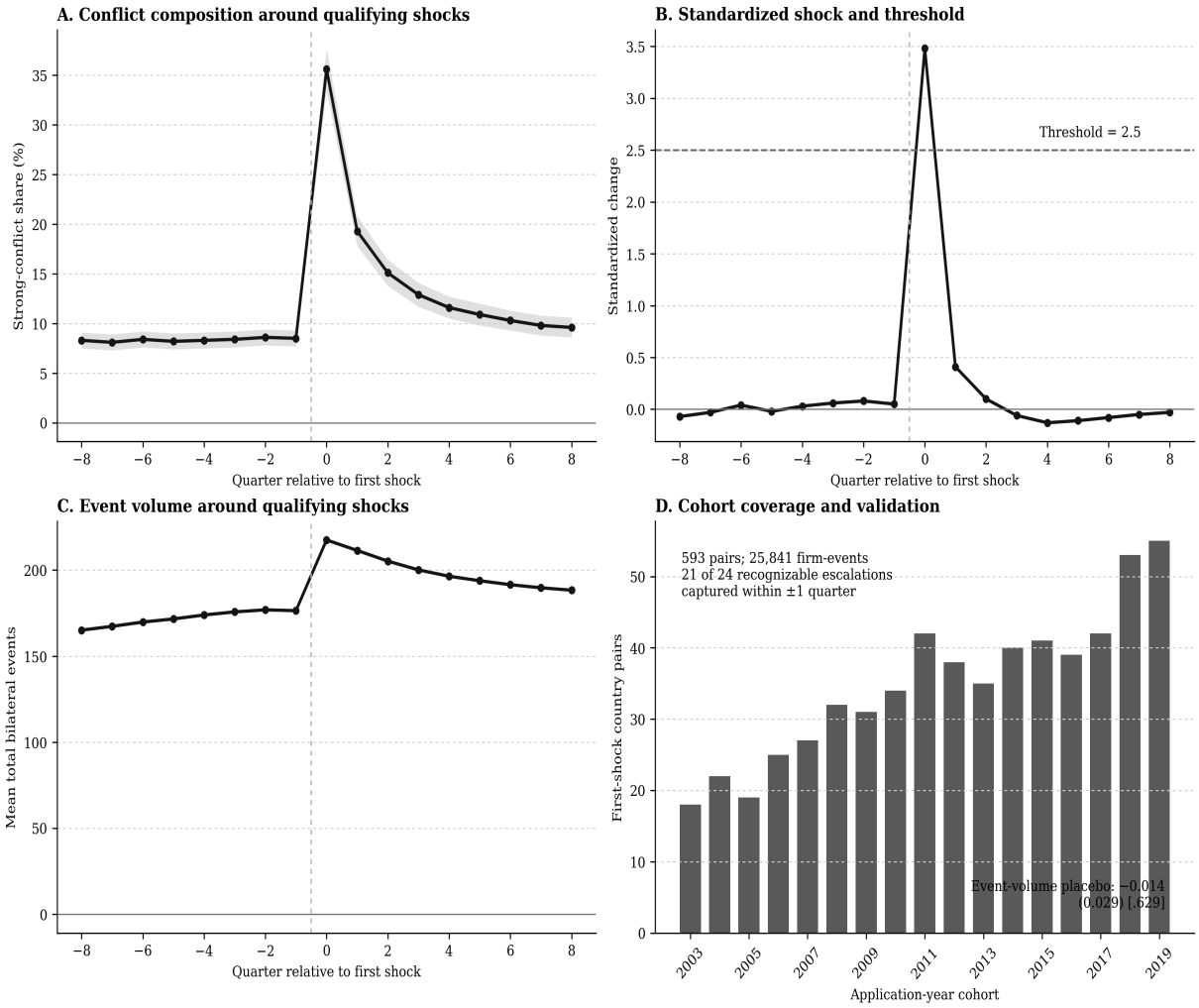
Panel F. Largest qualifying bilateral shocks

Country pair	Treatment quarter	Pre-shock share	Shock-quarter share	Increase	Persistence	Recognizable event	Affected firm-events
United States–Iraq	2003 Q1	.071	.612	+.541	≥12 quarters	Iraq War escalation	184
Russia–Ukraine	2014 Q1	.094	.578	+.484	≥24 quarters	Crimea annexation and armed conflict	236
Israel–Lebanon	2006 Q3	.082	.524	+.442	8 quarters	2006 Lebanon War	91
Russia–Georgia	2008 Q3	.076	.493	+.417	6 quarters	Russo-Georgian War	104
India–Pakistan	2008 Q4	.109	.468	+.359	4 quarters	Mumbai attacks and bilateral escalation	318
United States–North Korea	2017 Q3	.088	.457	+.369	10 quarters	Missile and nuclear confrontation	227
Saudi Arabia–Iran	2016 Q1	.121	.491	+.370	12 quarters	Embassy crisis and diplomatic rupture	142
Turkey–Russia	2015 Q4	.096	.438	+.342	5 quarters	Russian aircraft shootdown	163
North Korea–South Korea	2010 Q4	.112	.447	+.335	4 quarters	Yeonpyeong shelling	74
Saudi Arabia–Qatar	2017 Q2	.101	.421	+.320	8 quarters	Diplomatic blockade	126
United Kingdom–Russia	2018 Q1	.084	.398	+.314	6 quarters	Skripal poisoning and expulsions	208
China–Japan	2012 Q3	.093	.386	+.293	5 quarters	Senkaku/Diaoyu dispute escalation	349
China–Philippines	2012 Q2	.078	.371	+.293	4 quarters	Scarborough Shoal standoff	114
Turkey–Israel	2010 Q2	.089	.364	+.275	3 quarters	Gaza flotilla crisis	152
United States–Iran	2019 Q2	.092	.356	+.264	5 quarters	Tanker and drone escalation	391
China–India	2017 Q3	.105	.369	+.264	4 quarters	Doklam standoff	276
United Arab Emirates–Qatar	2017 Q2	.098	.352	+.254	8 quarters	Diplomatic blockade	98
Turkey–Netherlands	2017 Q1	.074	.321	+.247	3 quarters	Diplomatic crisis	67

Notes. Pre-shock share is the mean strong-conflict share over quarters −8 through −1. Increase is the shock-quarter share minus that mean. Persistence is the number of consecutive post-shock quarters above the pair's pre-shock mean; ≥ indicates right-censoring at the displayed horizon. Affected firm-events are normalized legal-assignee-by-pair events assigned to the treatment cohort. GDELT records reported political interactions rather than policy enactments. The conflict share is computed before the shock is defined. The preceding eight quarterly changes provide the rolling standardization window. Quarter 0 must satisfy both the 2.5-standard-deviation rule and the 25-event minimum. The event-count series is retained as a coverage and salience diagnostic; it is not the tension measure. The placebo coefficient comes from the source joint-content PPML model after replacing the conflict-composition shock with an event-volume shock. The bilateral news-volume covariate used in regression controls is a distinct measure reported in Table A16. Bilateral News-Volume Specifications.

Figure A1. Treatment Construction and Validation visualizes the treatment construction summarized in Table A4. Bilateral Tension Measure, Shock Construction, and Treatment Coverage. The conflict-composition series rises sharply at the qualifying quarter, while the standardized-change panel shows the prespecified threshold. The cohort and recognizable-event panels show broad treatment coverage, and the event-volume placebo remains small and imprecise.

Figure A1. Treatment Construction and Validation



Notes. Panels A-C plot pair-quarter means around the first qualifying shock; Panel A includes the 95% confidence interval reported in Table A4. Bilateral Tension Measure, Shock Construction, and Treatment Coverage. The underlying GDELT 1.0 Events records cover the complete treatment-construction period through 2019Q2 and are aggregated from directed dyad-months to unordered country-pair quarters. Strong-conflict events have Goldstein scores at or below -5; a shock requires a standardized increase of at least 2.5 relative to the preceding eight quarterly changes and at least 25 bilateral events. Panel C plots mean total bilateral event counts. Panel D reports the 2003-2019 application-year cohorts for 593 affected pairs, the recognizable-event validation, and the source-model placebo based on event volume rather than conflict composition.

B. Event-Time Diagnostics and Geographic Reconfiguration

B.1. Fixed portfolios and pre-event diagnostics

The earlier qualification window ends before the displayed leads, making years −3 and −2 genuine pre-event comparisons for relationships already active in years −6 through −4. Table A5 contrasts that diagnostic with the recent-activity frame that supplies the headline within-firm post-shock estimates and with a sample eligible under both rules. The post-shock ordering is stable, while the baseline leads are jointly small.Table A5. Fixed Pre-Shock Portfolios, Event-Time Coverage, and Pre-Event Diagnostics

Table A5. Fixed Pre-Shock Portfolios, Event-Time Coverage, and Pre-Event Diagnostics
Panel A. Earlier-window diagnostic: affected relationships qualified in years −6 through −4

Event year	Sensitive co-invention	Other classified co-invention	Sensitive relative to other
−3	−0.015 (0.035) [.666]; −1.5%; 95% CI [−8.0%, 5.5%]	0.009 (0.029) [.757]; 0.9%; [−4.7%, 6.8%]	−0.024 (0.046) [.597]; −2.4%; [−10.8%, 6.8%]
−2	0.008 (0.034) [.815]; 0.8%; [−5.7%, 7.7%]	−0.006 (0.028) [.830]; −0.6%; [−5.9%, 5.0%]	0.014 (0.045) [.757]; 1.4%; [−7.2%, 10.7%]
−1	Reference	Reference	Reference
0	−0.088 (0.038) [.021]; −8.4%; [−15.0%, −1.3%]	0.035 (0.031) [.254]; 3.6%; [−2.5%, 10.1%]	−0.124 (0.050) [.013]; −11.7%; [−19.9%, −2.6%]
1	−0.108 (0.040) [.007]; −10.2%; [−17.0%, −2.9%]	0.048 (0.033) [.147]; 4.9%; [−1.7%, 11.9%]	−0.155 (0.053) [.003]; −14.4%; [−22.8%, −5.0%]
2	−0.126 (0.043) [.003]; −11.8%; [−18.9%, −4.0%]	0.054 (0.035) [.126]; 5.5%; [−1.5%, 13.0%]	−0.179 (0.056) [.001]; −16.4%; [−25.1%, −6.7%]
3	−0.134 (0.046) [.004]; −12.5%; [−20.0%, −4.2%]	0.058 (0.038) [.125]; 6.0%; [−1.6%, 14.2%]	−0.191 (0.060) [.001]; −17.4%; [−26.6%, −7.1%]
4	−0.128 (0.049) [.009]; −12.0%; [−20.1%, −3.1%]	0.066 (0.041) [.109]; 6.8%; [−1.4%, 15.7%]	−0.194 (0.064) [.002]; −17.6%; [−27.3%, −6.6%]
Pooled years 0–4	−0.119 (0.034) [<.001]; −11.2%; [−16.9%, −5.1%]	0.053 (0.027) [.051]; 5.4%; [−0.0%, 11.1%]	−0.171 (0.059) [.004]; −15.7%; [−24.9%, −5.4%]
Joint test, years −3 and −2	$\chi^2(2)=0.25$ [.881]	$\chi^2(2)=0.13$ [.939]	$\chi^2(2)=0.80$ [.670]

Table A5. (Continued)

Panel B. Recent-window headline model: relationships qualified in years −3 through −1

Event year	Sensitive co-invention	Other classified co-invention	Sensitive relative to other
−3	0.018 (0.029) [.535]; 1.8%; [−3.8%, 7.8%]	−0.026 (0.024) [.279]; −2.6%; [−7.0%, 2.1%]	0.045 (0.035) [.199]; 4.6%; [−2.3%, 12.0%]
−2	−0.012 (0.028) [.668]; −1.2%; [−6.5%, 4.4%]	0.013 (0.023) [.572]; 1.3%; [−3.2%, 6.0%]	−0.025 (0.034) [.462]; −2.5%; [−8.8%, 4.3%]
−1	Reference	Reference	Reference
0	−0.105 (0.032) [.001]; −10.0%; [−15.5%, −4.2%]	0.039 (0.024) [.104]; 4.0%; [−0.8%, 9.0%]	−0.144 (0.037) [<.001]; −13.4%; [−19.5%, −6.9%]
1	−0.125 (0.032) [<.001]; −11.8%; [−17.1%, −6.0%]	0.052 (0.025) [.038]; 5.3%; [0.3%, 10.6%]	−0.177 (0.038) [<.001]; −16.2%; [−22.2%, −9.7%]
2	−0.136 (0.034) [<.001]; −12.7%; [−18.3%, −6.7%]	0.061 (0.026) [.019]; 6.3%; [1.0%, 11.8%]	−0.197 (0.040) [<.001]; −17.9%; [−24.1%, −11.2%]
3	−0.142 (0.036) [<.001]; −13.2%; [−19.1%, −6.9%]	0.067 (0.028) [.017]; 6.9%; [1.2%, 13.0%]	−0.209 (0.043) [<.001]; −18.9%; [−25.4%, −11.7%]
4	−0.139 (0.036) [<.001]; −13.0%; [−18.9%, −6.6%]	0.071 (0.030) [.018]; 7.4%; [1.2%, 13.9%]	−0.210 (0.046) [<.001]; −18.9%; [−25.9%, −11.3%]
Pooled years 0–4	−0.130 (0.028) [<.001]; −12.2%; [−16.9%, −7.2%]	0.058 (0.022) [.008]; 6.0%; [1.5%, 10.6%]	−0.188 (0.032) [<.001]; −17.2%; [−22.2%, −11.8%]
Joint test, years −3 and −2	$\chi^2(2)=0.48$ [.786]	$\chi^2(2)=1.48$ [.477]	$\chi^2(2)=2.68$ [.262]

Panel C. Firm-events eligible under both qualification rules

Sample and event year	Sensitive	Other classified	Direct contrast
Recent rule, −3	0.008 (0.038) [.833]	−0.004 (0.031) [.897]	0.012 (0.046) [.795]
Recent rule, −2	−0.009 (0.037) [.808]	−0.004 (0.030) [.894]	−0.005 (0.045) [.911]
Recent rule, 0	−0.100 (0.040) [.012]	0.039 (0.033) [.237]	−0.139 (0.050) [.005]
Recent rule, 1	−0.122 (0.041) [.003]	0.052 (0.034) [.126]	−0.174 (0.052) [.001]
Recent rule, 2	−0.130 (0.043) [.003]	0.056 (0.036) [.120]	−0.186 (0.055) [.001]
Recent rule, 3	−0.129 (0.046) [.005]	0.060 (0.039) [.124]	−0.189 (0.059) [.001]
Recent rule, 4	−0.133 (0.049) [.007]	0.065 (0.042) [.122]	−0.198 (0.063) [.002]
Recent rule, pooled 0–4	−0.128 (0.033) [<.001]	0.056 (0.028) [.046]	−0.184 (0.040) [<.001]
Earlier rule, pooled 0–4	−0.121 (0.047) [.010]	0.055 (0.036) [.127]	−0.176 (0.056) [.002]
Earlier rule minus recent rule	0.007 (0.037) [.850]	−0.001 (0.031) [.974]	0.008 (0.037) [.829]

Table A5. (Continued)

Panel D. Destination pre-event diagnostics by qualification frame

Qualification frame	Year −3	Year −2	Covariance, years −3 and −2	Joint lead test
Earlier-window baseline	0.011 (0.037) [.766]	−0.009 (0.035) [.797]	0.000389	$\chi^2(2)=0.22$ [.897]
Recent-window robustness	0.008 (0.030) [.790]	−0.010 (0.029) [.730]	0.000218	$\chi^2(2)=0.25$ [.882]
Common-eligible sample	0.004 (0.041) [.922]	0.001 (0.040) [.980]	0.000410	$\chi^2(2)=0.01$ [.995]

Table A5. (Continued)

Panel E. Event-time support in the earlier-window diagnostic joint-content model

Event year	Regression observations	Eligible firm-events	Retained zero outcomes	Firms	Affected pairs
−3	152,842	11,521	88,112	6,112	579
−2	151,960	11,521	89,407	6,112	579
−1	151,284	11,521	90,221	6,112	579
0	150,306	11,521	91,316	6,112	579
1	148,708	11,384	92,274	6,087	577
2	145,966	11,152	93,214	6,043	575
3	142,740	10,878	93,992	5,996	572
4	138,598	10,522	93,378	5,921	568
Total	1,182,404	11,521 unique	731,914	6,112 unique	579 unique

Table A5. (Continued)

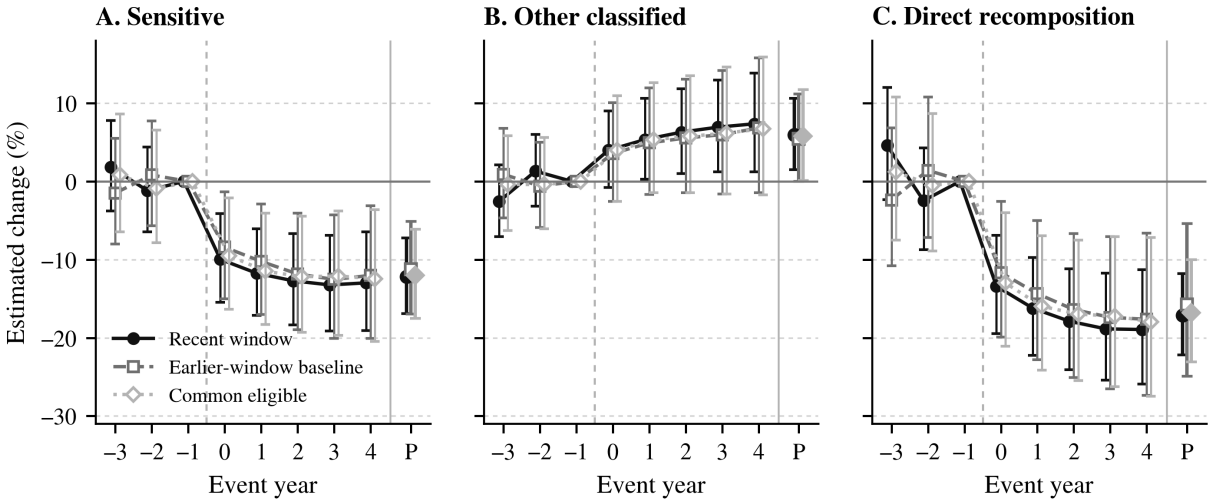
Panel F. Covariance and model metadata

Quantity	Value
Baseline direct-lead variances, years −3 and −2	0.002116 and 0.002025
Baseline direct-lead covariance	0.001139; correlation .55; yields $\chi^2(2)=0.80$
Recent direct-lead variances	0.001225 and 0.001156
Recent direct-lead covariance	0.000238; correlation .20; yields $\chi^2(2)=2.68$
Estimator	Joint stacked PPML with log link
Fixed effects	Content-specific firm-relationship-event and content-specific firm-event-year
Inference	Two-way clustered by normalized legal assignee and affected country pair
Weights	None; fractional patent allocation is embedded in the outcome
Earlier-window diagnostic separation	Content-specific PPML separation on common admitted observations; 46,556 rows and 1,804 fixed-effect strata removed in the baseline
Earlier-window diagnostic fit	Pseudo-R^2=.781; deviance/df=.842

Notes. Coefficients are on the PPML log scale; percentages equal 100 × [exp(coefficient) − 1]. Confidence intervals are transformed from coefficient-scale endpoints. The fixed portfolios admit relationships using only the named qualification window and retain later zero outcomes. The recent-window leads are descriptive because the eligibility window overlaps them. The earlier-window leads are the primary pre-event diagnostic. Pooled estimates use a single indicator for years 0–4 and are not averages of the displayed rounded annual coefficients. The direct content contrast is estimated within the joint model on identical observations. Destination pre-event diagnostics use ATT weights; endpoint models are treatment-unweighted.

Figure A2. Earlier-Window and Common-Eligible Event Paths compares the source event paths under the recent, earlier, and common-eligible qualification frames. The three series show similar post-shock recomposition, while the earlier frame has wider intervals because qualification is fixed farther before treatment. The annual leads provide no evidence of differential movement before the shock.

Figure A2. Earlier-Window and Common-Eligible Event Paths



Notes. Points are annual PPML coefficients transformed as 100[exp(beta)-1]; bars are 95% confidence intervals and diamonds are pooled years 0-4. Year -1 is omitted. The source models use fixed pre-shock relationship portfolios, firm-relationship-event and firm-event-year fixed effects, and two-way clustering by normalized legal assignee and affected country pair. The recent frame qualifies in years -3 through -1; the earlier diagnostic frame qualifies in years -6 through -4; the common-eligible frame retains firm-events admitted by both. Joint tests for years -3 and -2 are $\chi^2(2)=2.68$ [.262] in the recent frame and $\chi^2(2)=0.80$ [.670] in the earlier frame.

B.2. Destination expansion and endpoint contrasts

Table A6. Full Geographic Reconfiguration and Endpoint Results distinguishes two comparisons. Across-firm estimates compare affected firms with unexposed firms previously active on the same alternative country relationship and use ATT inverse-odds weights. Endpoint contrasts compare relationship types within affected firms and use no treatment-assignment weights. The positive estimates under both comparisons show expansion beyond the affected bilateral relationship, but the designs do not track individual inventions or imply a one-for-one transfer from contraction to expansion.

Table A6. Full Geographic Reconfiguration and Endpoint Results

Panel A. Pooled estimates by qualification frame, years 0–4

Outcome and comparison	Earlier-window baseline	Recent-window robustness	Common-eligible sample
Broad sensitive destination expansion, across firms	0.103 (0.031) [.001]; 10.8%	0.110 (0.029) [<.001]; 11.6%	0.099 (0.035) [.005]; 10.4%
Other classified destination expansion, across firms	0.075 (0.026) [.004]; 7.8%	0.081 (0.024) [.001]; 8.4%	0.071 (0.031) [.022]; 7.4%
Exact-IPC destination expansion, across firms, fexp_b	0.136 (0.045) [.003]; 14.6%	0.147 (0.041) [<.001]; 15.8%	0.139 (0.052) [.008]; 14.9%
Sensitive, endpoint-retaining, across firms	0.140 (0.040) [<.001]; 15.0%	0.149 (0.036) [<.001]; 16.1%	0.137 (0.047) [.004]; 14.7%
Sensitive, endpoint-free, across firms	0.077 (0.035) [.028]; 8.0%	0.083 (0.032) [.010]; 8.7%	0.074 (0.041) [.071]; 7.7%
Direct endpoint-retaining contrast, within affected firms	0.061 (0.024) [.011]; 6.3%	0.066 (0.026) [.011]; 6.8%	0.058 (0.030) [.053]; 6.0%
Other classified direct endpoint contrast	0.015 (0.019) [.430]; 1.5%	0.018 (0.018) [.317]; 1.8%	0.012 (0.023) [.602]; 1.2%
Sensitive minus other endpoint contrast	0.046 (0.021) [.028] log points	0.048 (0.022) [.029] log points	0.046 (0.027) [.088] log points
Exact-IPC endpoint-retaining, across firms	0.174 (0.052) [.001]; 19.0%	0.182 (0.048) [<.001]; 20.0%	0.169 (0.059) [.004]; 18.4%
Exact-IPC endpoint-free, across firms	0.086 (0.043) [.045]; 9.0%	0.091 (0.040) [.023]; 9.5%	0.083 (0.050) [.097]; 8.7%
Direct same-IPC endpoint contrast, within affected firms	0.084 (0.034) [.013]; 8.8%	0.091 (0.032) [.004]; 9.5%	0.086 (0.040) [.032]; 9.0%

Panel B. Baseline annual destination path

Event year	Broad sensitive destination	Broad other-classified destination	Exact-IPC destination
−3	0.011 (0.037) [.766]; 1.1%; CI [−6.0%, 8.7%]	0.006 (0.031) [.847]; 0.6%; [−5.3%, 6.9%]	0.014 (0.051) [.784]; 1.4%; [−8.2%, 12.1%]
−2	−0.009 (0.035) [.797]; −0.9%; [−7.5%, 6.1%]	−0.005 (0.030) [.868]; −0.5%; [−6.2%, 5.5%]	−0.011 (0.048) [.819]; −1.1%; [−9.9%, 8.7%]
−1	Reference	Reference	Reference
0	0.069 (0.035) [.049]; 7.1%; [0.0%, 14.8%]	0.048 (0.030) [.110]; 4.9%; [−1.1%, 11.3%]	0.094 (0.049) [.055]; 9.9%; [−0.2%, 21.0%]
1	0.091 (0.036) [.011]; 9.5%; [2.1%, 17.5%]	0.066 (0.031) [.033]; 6.8%; [0.5%, 13.5%]	0.122 (0.050) [.015]; 13.0%; [2.4%, 24.6%]
2	0.108 (0.039) [.006]; 11.4%; [3.2%, 20.3%]	0.077 (0.033) [.020]; 8.0%; [1.2%, 15.2%]	0.145 (0.054) [.007]; 15.6%; [3.9%, 28.4%]
3	0.119 (0.043) [.006]; 12.6%; [3.5%, 22.5%]	0.083 (0.036) [.021]; 8.7%; [1.3%, 16.6%]	0.157 (0.059) [.008]; 17.0%; [4.2%, 31.4%]
4	0.130 (0.046) [.005]; 13.9%; [4.1%, 24.6%]	0.091 (0.039) [.020]; 9.5%; [1.5%, 18.2%]	0.172 (0.064) [.007]; 18.8%; [4.8%, 34.7%]
Pooled 0–4	0.103 (0.031) [.001]; 10.8%; [4.3%, 17.8%]	0.075 (0.026) [.004]; 7.8%; [2.4%, 13.4%]	0.136 (0.045) [.003]; 14.6%; [4.9%, 25.1%]
Joint leads	$\chi^2(2)=0.22$ [.897]	$\chi^2(2)=0.08$ [.961]	$\chi^2(2)=0.12$ [.942]

Table A6. (Continued)

Panel C. Endpoint-retaining and endpoint-free annual paths

Event year	Endpoint-retaining, across firms	Endpoint-free, across firms	Direct endpoint contrast, within firm	Direct same-IPC endpoint contrast, within firm
−3	0.012 (0.052) [.818]	0.005 (0.045) [.912]	0.007 (0.034) [.837]	0.008 (0.046) [.862]
−2	−0.008 (0.049) [.870]	−0.004 (0.043) [.926]	−0.004 (0.033) [.903]	−0.006 (0.044) [.891]
−1	Reference	Reference	Reference	Reference
0	0.100 (0.050) [.046]; 10.5%	0.056 (0.044) [.200]; 5.8%	0.046 (0.031) [.138]; 4.7%	0.058 (0.042) [.165]; 6.0%
1	0.122 (0.052) [.019]; 13.0%	0.068 (0.046) [.141]; 7.0%	0.057 (0.032) [.073]; 5.9%	0.072 (0.044) [.100]; 7.5%

Table A6. (Continued)

Panel C. Endpoint-retaining and endpoint-free annual paths (continued)

Event year	Endpoint-retaining, across firms	Endpoint-free, across firms	Direct endpoint contrast, within firm	Direct same-IPC endpoint contrast, within firm
2	0.144 (0.055) [.009]; 15.5%	0.081 (0.049) [.100]; 8.4%	0.065 (0.034) [.056]; 6.7%	0.086 (0.047) [.067]; 9.0%
3	0.150 (0.059) [.011]; 16.2%	0.084 (0.052) [.105]; 8.8%	0.071 (0.037) [.054]; 7.4%	0.095 (0.051) [.061]; 10.0%
4	0.166 (0.064) [.010]; 18.0%	0.095 (0.056) [.089]; 10.0%	0.077 (0.040) [.054]; 8.0%	0.104 (0.056) [.062]; 11.0%
Pooled 0–4	0.140 (0.040) [<.001]; 15.0%	0.077 (0.035) [.028]; 8.0%	0.061 (0.024) [.011]; 6.3%	0.084 (0.034) [.013]; 8.8%
Joint leads	$\chi^2(2)=0.07$ [.966]	$\chi^2(2)=0.02$ [.990]	$\chi^2(2)=0.05$ [.975]	$\chi^2(2)=0.04$ [.980]

Table A6. (Continued)

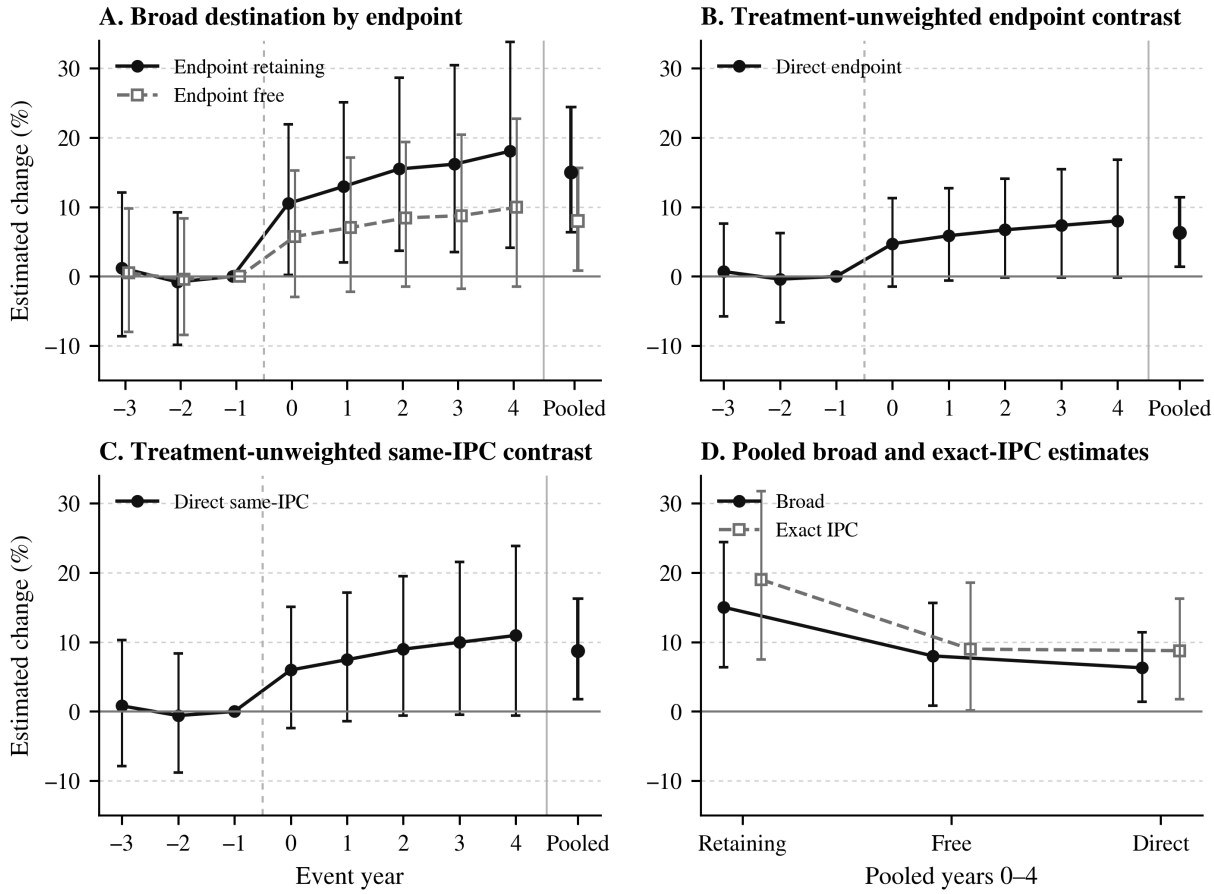
Panel D. Model and sample metadata

Design	Baseline observations	Treated / comparison rows	Events	Firms	Pairs
Broad across-firm destination	653,612	16,008 / 637,604	1,006	825 treated; 8,022 total	142
Exact-IPC across-firm destination	99,335	8,866 / 90,469	568	496 treated; 3,654 total	108
Within-firm endpoint	16,970	All affected-firm alternative rows	1,382	1,287	241
Within-firm same-IPC endpoint	27,000	All affected-firm relationship-subclass rows	782	780	193

Notes. All outcomes are annual fractional patent-equivalent counts and all models use PPML. Broad across-firm destination models absorb firm–alternative-relationship–stack and relationship–year–stack effects; exact-IPC models absorb firm–relationship–subclass–stack and relationship–subclass–year–stack effects. Both across-firm designs compare affected firms with unexposed firms previously active on the same alternative country relationship. Affected cells receive weight one; comparison cells receive ATT inverse-odds weights normalized within relationship-by-stack strata. The exact-IPC models apply fexp_b to competing exposure and later-shock censoring. Within-firm endpoint models absorb firm–relationship–event and firm–event–year effects; same-IPC endpoint models absorb firm–relationship–event–subclass and firm–event–subclass–year effects. Both endpoint comparisons are treatment-unweighted and cluster by normalized legal assignee and affected country pair; the across-firm models cluster by observation firm and affected country pair. Year −1 is omitted. Pooled estimates use a single years 0–4 indicator.

Figure A3. Endpoint and Same-IPC Destination Paths separates geographic expansion by whether an alternative relationship retains one affected country and whether it carries the same IPC subclasses. Expansion appears in both endpoint groups, but is larger on endpoint-retaining relationships; the treatment-unweighted within-firm contrasts summarize that difference directly.

Figure A3. Endpoint and Same-IPC Destination Paths



Notes. Panel A plots annual across-firm endpoint-retaining and endpoint-free estimates; Panels B and C plot annual treatment-unweighted direct endpoint and same-IPC contrasts within affected firms. Panel D compares pooled years 0-4 broad and exact-IPC endpoint-retaining, endpoint-free, and direct estimates. Year -1 is omitted and bars are 95% confidence intervals. The across-firm series use normalized ATT inverse-odds weights; the within-firm contrasts use no treatment-assignment weights. Fixed effects, clustering, retained-zero rules, censoring, and sample counts correspond to Table A6. Full Geographic Reconfiguration and Endpoint Results.

B.3. Geographic sample flow, comparison reuse, and later shocks

Table A7. Geographic Sample Construction, Comparison Reuse, and Later-Shock Censoring separates raw eligibility, treatment-assignment support, fixed-effect overlap, PPML separation, and the final estimation panel. It also quantifies repeated use of comparison observations. Reuse reflects stacked comparisons rather than duplicate patent counting because fixed effects and clustering operate on the stacked rows.

Table A7. Geographic Sample Construction, Comparison Reuse, and Later-Shock Censoring

Panel A. Broad earlier-window baseline flow

Stage	Events	Treated firms	Affected pairs/stacks	Treated cells	Comparison cells	Treated rows	Comparison rows	Total rows
Raw eligibility	1,468	1,228	170	6,085	420,307	32,514	2,468,129	2,500,643
Propensity common support	1,421	1,190	166	5,891	392,844	31,442	2,191,604	2,223,046
First PPML path separation	1,118	919	149	3,302	189,614	17,146	1,031,367	1,048,513
Absorbed route-year overlap	1,009	828	143	3,091	121,106	16,036	662,805	678,841
Second PPML separation	1,007	826	142	3,087	116,839	16,024	637,620	653,644
Final fixed point	1,006	825	142	3,085	116,835	16,008	637,604	653,612

Panel B. Broad recent-window robustness flow

Stage	Events	Treated firms	Pairs/stacks	Treated cells	Comparison cells	Treated rows	Comparison rows	Total rows
Raw eligibility	2,725	2,106	249	10,313	650,418	48,511	3,404,795	3,453,306
Propensity common support	2,701	2,085	247	10,102	624,903	47,906	3,137,242	3,185,148
PPML separation and absorbed overlap	2,699	2,082	247	9,986	566,122	46,935	2,696,458	2,743,393
Final fixed point	2,699	2,082	247	9,986	566,122	46,935	2,696,458	2,743,393

Panel C. Exact-IPC flow under fexp_b

Frame and stage	Events	Treated firms	Total firms	Pairs	Treated cells	Comparison cells	Treated rows	Comparison rows	Total rows
Earlier raw	1,464	1,226	18,744	170	12,438	2,512,408	65,759	14,768,367	14,834,126
Earlier common support	1,389	1,169	16,908	164	11,982	2,301,774	62,446	13,408,611	13,471,057
Earlier first combined separation/overlap	618	538	4,038	113	1,854	18,925	9,614	98,503	108,117
Earlier final fixed point	568	496	3,654	108	1,696	17,520	8,866	90,469	99,335
Recent raw	1,787	1,513	31,406	201	15,844	3,274,881	72,766	16,657,422	16,730,188
Recent first separation	1,126	958	17,620	151	7,432	105,804	31,608	504,313	535,921
Recent absorbed overlap	1,021	881	10,824	145	3,481	48,902	16,088	226,253	242,341
Recent second separation	1,012	874	10,214	144	3,426	46,876	15,982	215,892	231,874
Recent final fixed point	1,010	872	10,171	144	3,422	46,854	15,970	215,786	231,756

Table A7. (Continued)

Panel D. Endpoint samples

Sample	Raw events	Final events	Final firms	Pairs	Final relationship or subclass cells	Final observations	Retained zero rows	Separation losses
Earlier broad endpoint	1,382	1,382	1,287	241	17,355	16,970	9,911	385
Recent broad endpoint	1,423	1,116	944	190	5,982	33,418	20,774	8,862
Earlier same-IPC endpoint	782	782	780	193	27,582	27,000	15,744	582
Recent same-IPC endpoint	684	508	449	116	5,118	27,884	18,996	10,462
Broad common-eligible endpoint	301	226	208	63	1,484	8,032	5,118	3,906

Panel E. Later-shock censoring

Frame and unit	Otherwise eligible comparison cells	Cells with a later qualifying shock before year 4	Censoring rate	Annual rows removed after the later shock	Rule
Broad earlier-window baseline, firm-alternative-relationship-stack cell	420,307	72,713	17.30%	255,402	Retain the cell through the year preceding the later shock
Broad recent-window robustness, same unit	650,418	112,522	17.30%	267,553	Same rule
Exact-IPC earlier baseline, firm-relationship-subclass-stack cell	2,512,408	434,647	17.30%	1,485,312	Later exposure defined from fexp_b and applied to every subclass

Panel F. Comparison reuse in the final panels

Number of eligible stacks using the same firm-relationship-year cell	Earlier broad cells	Share	Recent broad cells	Share	Earlier exact-IPC cells	Share
1	72,907	62.40%	335,711	59.30%	11,388	65.00%
2	24,301	20.80%	126,811	22.40%	3,504	20.00%
3–4	12,969	11.10%	66,237	11.70%	1,752	10.00%
5–9	5,141	4.40%	28,306	5.00%	701	4.00%
10 or more	1,517	1.30%	9,057	1.60%	175	1.00%
Total	116,835	100.00%	566,122	100.00%	17,520	100.00%

Table A7. (Continued)

Panel G. Support, balance, weights, and fit

Diagnostic	Earlier broad	Recent broad	Earlier exact IPC
Treated cells outside propensity support	194/6,085 (3.19%)	211/10,313 (2.05%)	456/12,438 (3.67%)
Comparison cells outside propensity support	27,463/420,307 (6.53%)	25,515/650,418 (3.92%)	210,634/2,512,408 (8.38%)
Maximum absolute standardized difference before weighting	.270	.204	.243
Maximum absolute standardized difference after weighting	.064	.058	.071
Mean absolute standardized difference before / after	.093 / .024	.086 / .021	.101 / .027
Raw inverse-odds weight p1 / p50 / p99 / maximum	.006 / .091 / 2.91 / 12.84	.008 / .084 / 2.54 / 11.67	.004 / .076 / 3.42 / 15.28
Normalized comparison weight p1 / p50 / p99 / maximum	.0019 / .0178 / .181 / .742	.0004 / .0058 / .219 / 1.000	.0021 / .0206 / .204 / .811
Effective comparison-row sample size	121,936	132,480	23,884
Dropped propensity strata / absorbed strata	147 / 9,204	92 / 18,371	306 / 47,822
Pseudo-R^2	.915	.922	.903

Notes. A treated cell is a firm-event-alternative-relationship cell; exact-IPC cells add the affected IPC subclass. A comparison cell is defined on the same route and stack for an unexposed firm. The propensity model uses qualification-window relationship output and slope, firm patenting scale, portfolio breadth, technology mix, and relationship-by-stack fixed effects. Affected cells receive weight one. Comparison cells receive e/(1−e) and are normalized so that their weights sum to the treated weight within each relationship-by-stack stratum. In the separately labeled inverse-reuse sensitivity, a row's regression weight is multiplied by 1/m, where m is the number of eligible affected-pair-by-cohort stacks containing the same firm-relationship-calendar-year cell. The result is then normalized within stack. For endpoint models, 1/m is a multiplicity weight only; it does not introduce ATT treatment-assignment weighting. Separation losses and fixed-effect overlap are distinct from propensity support losses.

C. Supporting Evidence and Portfolio Moderators

C.1. Citations to disclosed prior art

The citation analysis asks whether earlier patents associated with the other affected country remain relevant to later applications after sensitive co-invention contracts. The primary rate model focuses on applicant-disclosed citations per eligible citing patent. It does not measure interpersonal knowledge transmission, access to tacit knowledge, or substitution of citations for collaboration.

Table A8. Citation Provenance, Sample Construction, and Complete Citation Results

Panel A. Provenance and sample construction

Element	Definition or count
Citation source	PatentsView USPTO grant-citation records linked by citing and cited patent identifiers; citation-source field distinguishes applicant-disclosed from examiner-added references
Citation date	Application year of the citing patent
Direction	Inventor country of the citing application to inventor country associated with the cited patent
Fractional allocation	Across citing-patent legal assignees, citing inventor countries, cited inventor countries, and citing-patent IPC subclasses
Eligible cited prior art	Cited patent first publicly disclosed before the focal shock
Same-family rule	Same-family citations excluded from the primary model
Continuing-joint-invention rule	Citing patents with an inventor in the cited country excluded from the primary model
Citation-source rule	"Cited by applicant" retained; examiner-added and missing-source citations excluded from the primary numerator
Corporate classified citing patents with source information	401,772
Eligible citing-patent-assignee-country observations	392,118
Applicant-disclosed fractional citations before event stacking	1,428,606
Directed-link events entering panel completion	26,114
Rate-model observations after separation	594,116
Count-model observations after separation	578,902
Firms / affected pairs	5,218 / 487
Eligible citing-patent exposure in the rate model	2,806,417 fractional citing-patent equivalents across stacked observations
Zero-citation rows retained, rate / count	386,904 / 379,812
Separated rows, rate / count	27,332 / 28,382

Table A8. (Continued)

Panel B. Applicant-citation rate models

Event year	Sensitive applications	Other classified applications	Direct sensitive-minus-other contrast
−3	0.008 (0.026) [.759]	0.004 (0.021) [.849]	0.004 (0.023) [.863]
−2	−0.006 (0.025) [.810]	−0.003 (0.020) [.881]	−0.003 (0.022) [.891]
−1	Reference	Reference	Reference
0	0.049 (0.024) [.042]	0.015 (0.020) [.457]	0.034 (0.022) [.123]
1	0.070 (0.025) [.005]	0.025 (0.021) [.240]	0.045 (0.022) [.042]
2	0.082 (0.027) [.003]	0.031 (0.023) [.171]	0.050 (0.023) [.029]
3	0.086 (0.030) [.004]	0.037 (0.025) [.136]	0.049 (0.025) [.051]
4	0.095 (0.033) [.004]	0.039 (0.028) [.161]	0.056 (0.028) [.045]
Pooled years 0–4	0.077 (0.020) [<.001]	0.030 (0.016) [.065]	0.048 (0.020) [.019]
Pooled percentage	8.0%; CI [3.9%, 12.3%]	3.0%; CI [−0.1%, 6.3%]	4.9%; CI [0.9%, 9.1%]
Earlier-window joint leads	$\chi^2(2)=0.22$ [.896]	$\chi^2(2)=0.17$ [.919]	$\chi^2(2)=0.69$ [.707]

Panel C. Applicant-citation count models

Event year	Sensitive applications	Other classified applications	Direct sensitive-minus-other contrast
−3	0.010 (0.032) [.756]	0.005 (0.027) [.853]	0.005 (0.029) [.864]
−2	−0.007 (0.031) [.821]	−0.004 (0.026) [.877]	−0.003 (0.028) [.914]
−1	Reference	Reference	Reference
0	0.058 (0.030) [.052]	0.018 (0.025) [.475]	0.040 (0.027) [.134]
1	0.077 (0.032) [.016]	0.030 (0.027) [.274]	0.047 (0.028) [.090]
2	0.091 (0.034) [.008]	0.039 (0.029) [.176]	0.052 (0.029) [.076]
3	0.100 (0.037) [.007]	0.044 (0.032) [.169]	0.056 (0.031) [.072]
4	0.104 (0.041) [.011]	0.049 (0.035) [.163]	0.056 (0.034) [.102]
Pooled years 0–4	0.088 (0.026) [.001]	0.037 (0.021) [.078]	0.051 (0.025) [.041]
Pooled percentage	9.2%; CI [3.8%, 14.9%]	3.8%; CI [−0.4%, 8.1%]	5.2%; CI [0.2%, 10.5%]
Earlier-window joint leads	$\chi^2(2)=0.19$ [.909]	$\chi^2(2)=0.12$ [.942]	$\chi^2(2)=0.58$ [.748]

Table A8. (Continued)

Panel D. Citation-source, ownership, and family checks

Specification	Rate direct contrast	Count direct contrast	Observations	Interpretation
Applicant-disclosed, primary	0.048 (0.020) [.019]	0.051 (0.025) [.041]	594,116 / 578,902	Sensitive applications increase their citation rate and count more than other applications
Examiner-added citations only	0.012 (0.018) [.505]	0.015 (0.022) [.496]	566,804 / 552,198	No corresponding differential in examiner-added references
All citations	0.032 (0.017) [.060]	0.035 (0.021) [.095]	607,288 / 593,014	Combining applicant and examiner citations attenuates the contrast
Exclude cited patents sharing the citing patent's legal assignee	0.043 (0.022) [.051]	0.047 (0.027) [.082]	531,406 / 518,772	The pattern is not limited to reuse within the same legal assignee
Include same-family citations	0.045 (0.019) [.018]	0.049 (0.024) [.041]	621,550 / 606,914	Same-family exclusions do not create the result
Permit citing patents with an inventor in the cited country	0.041 (0.019) [.031]	0.046 (0.024) [.055]	638,822 / 624,038	Continuing multinational teams do not account for the full contrast

Table A8. (Continued)

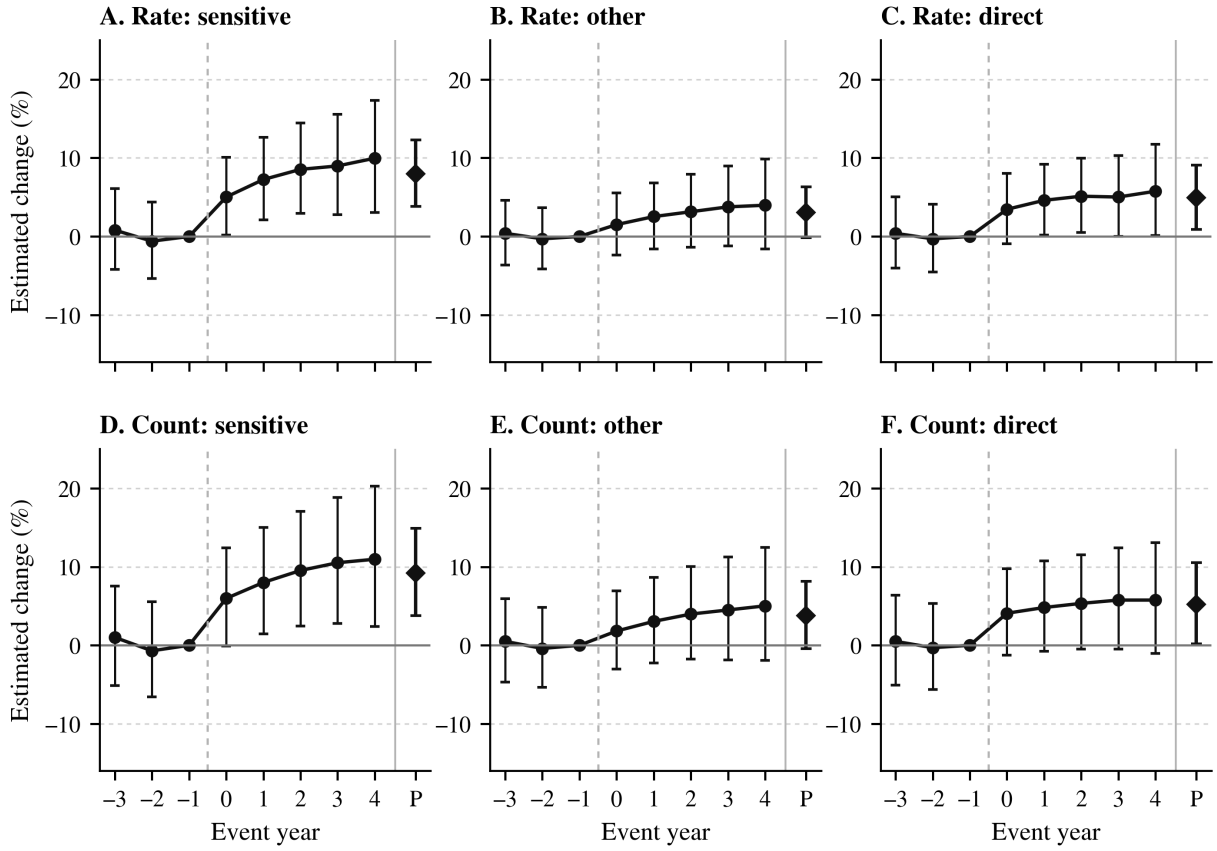
Panel E. Model metadata

Item	Citation-rate model	Citation-count model
Estimator	Joint PPML with log eligible citing patents as exposure	Joint PPML without exposure
Outcome	Applicant-disclosed fractional citations per eligible citing patent	Applicant-disclosed fractional citation count
Fixed effects	Content-specific firm-directed-pair-event; firm-origin-country-event-year; cited-country-year-stack	Same
Inference	Two-way clustered by normalized legal assignee and affected country pair	Same
Event window / omitted period	Years −3 through 4 / year −1	Same
Qualification	Earlier window for lead tests; recent and common-eligible comparisons reported in the sensitivity panel	Same
Retained zeros	Directed links admitted before the shock remain through zero-citation years	Same
Separation	27,332 rows; 1,418 directed-link strata	28,382 rows; 1,506 directed-link strata
Fit	Pseudo-R^2=.907; deviance/df=.891	Pseudo-R^2=.899; deviance/df=.918

Notes. Coefficients are PPML log coefficients; percentages equal 100 × [exp(coefficient) − 1]. The rate exposure adjusts for the number of eligible citing patents and therefore asks whether each application cites qualifying prior art more frequently. The count model also reflects changes in the number of eligible applications. “External owner” means that the cited patent does not share the citing patent's normalized legal assignee. Citation provenance describes disclosed prior art in the USPTO record and does not establish tacit knowledge transfer or continuing contact with inventors in the other country.

Figure A4. Citation Dynamics displays the applicant-citation rate and count dynamics. Citations from sensitive applications to earlier patents associated with the other affected country rise more than the corresponding citations in other classified fields. The pre-event estimates remain centered near zero, and the count and rate specifications yield similar pooled contrasts.

Figure A4. Citation Dynamics



Notes. Panels A-C show applicant-citation rates; Panels D-F show applicant-citation counts. Each outcome is directed from a post-shock application to earlier patents associated with the other affected country. Year -1 is omitted. Points are transformed PPML effects, bars are 95% confidence intervals, and diamonds are pooled years 0-4. Models include content-specific firm-directed-pair-event, firm-origin-country-event-year, and cited-country-year-stack fixed effects, retain admitted zeros, and cluster by normalized legal assignee and affected pair. Application opportunities enter as a PPML exposure only in the rate panels; the count panels use no exposure denominator. Provenance and alternative citation definitions appear in Table A8. Citation Provenance, Sample Construction, and Complete Citation Results.

C.2. Technological prominence and portfolio structure

Technological prominence and technology-matched relational capacity describe different pre-shock portfolio characteristics. Prominence measures the place of a subclass in the legal assignee's broader patenting. Capacity measures whether other country relationships already carried the sensitive subclasses exposed on a particular affected relationship. Table A9. Technological Prominence, Relational Capacity, and Portfolio Moderators estimates moderation by these observed characteristics and compares capacity with simpler portfolio benchmarks.

Table A9. Technological Prominence, Relational Capacity, and Portfolio Moderators

Panel A. Measure construction, support, timing, and denominators

Measure	Numerator	Denominator and timing	Support and presentation values
Technological prominence	Firm's fractional patent equivalents in focal normalized IPC subclass	All classified USPTO patent equivalents of the normalized legal assignee during twenty complete grant quarters before the shock; domestic and international invention included	Denominator ≥10 equivalents; 2,020 firms and 7,829 firm-subclass pairs; p25=.03, p75=.27
Application-timed prominence	Same focal subclass numerator dated by application	Firm's classified applications during the same twenty complete quarters	Same support rule
Earlier prominence	Same numerator	Twenty-quarter window ending before event year −3	Separates prominence from displayed leads
Technology-matched relational capacity	Weighted indicators that another eligible relationship carried each affected sensitive subclass	Sensitive subclass bundle on the affected relationship during years −6 through −4	Range [0,1]; p75=.60; zero and .60 reported
Relationship breadth	Count of other eligible preexisting country relationships	Fixed years −6 through −4 portfolio	p25=2, p75=5
Unrelated-technology breadth	Count of eligible relationships carrying classified subclasses outside the affected sensitive bundle	Same fixed portfolio	Common-observation benchmark
Pre-shock firm patenting	Log of one plus total classified fractional patent equivalents	Years −6 through −4	Common-observation benchmark
Technological diversity	One minus the Herfindahl index across the firm's classified IPC subclasses	Years −6 through −4	Range [0,1]
Source-relationship intensity	Affected relationship's share of the firm's international classified co-invention	Years −6 through −4	Range [0,1]
Pre-shock sensitive share	Sensitive fractional equivalents / all classified equivalents	Years −6 through −4	Range [0,1]

Table A9. (Continued)

Panel B. Technological prominence

Specification or prediction	Coefficient	SE	p-value	Transformed result / 95% interval	Observations
Exposure at prominence zero	−0.075	(0.029)	[.009]	−7.2%	412,568
Prediction at mean prominence (.160)	−0.120	(0.029)	[<.001]	−11.3%	412,568
Exposure × prominence, source model	−0.281	(0.096)	[.003]	Continuous log-point slope	412,568
Source prediction at prominence .03	−0.083	(0.028)	[.003]	−8.0%; [−12.9%, −2.8%]	412,568
Source prediction at prominence .27	−0.151	(0.034)	[<.001]	−14.0%; [−19.6%, −8.1%]	412,568
Direct .27 minus .03 source contrast	−0.067	(0.023)	[.003]	−0.067 log points; [−0.112, −0.022]	412,568
Common-support sensitive / other / direct	−0.154 / −0.087 / −0.067	(0.034) / (0.029) / (0.031)	[<.001] / [.003] / [.031]	−14.3% / −8.3% / −6.5%	524,736 expanded; 262,368 base
Common-support model diagnostics	A/C=117,600/407,136	2,020 firms	382 clusters	18,592 separated	524,736 expanded
Sensitive-only interaction / mean prediction	−0.245 / −0.154	(0.121) / (0.037)	[.043] / [<.001]	A/C=103,288/336,992; 1,784 firms; 356 clusters; 22,184 separated	440,280
Denominator threshold of 5 equivalents	−0.061	(0.021)	[.004]	High-minus-low prominence	438,214
Denominator threshold of 20 equivalents	−0.071	(0.028)	[.011]	High-minus-low prominence	361,806
Application-timed prominence	−0.065	(0.024)	[.007]	High-minus-low prominence	401,992
Lagged prominence window ending before year −3	−0.064	(0.024)	[.008]	High-minus-low prominence	354,118
Destination expansion × prominence	0.033	(0.030)	[.271]	Small positive slope; [−0.026, 0.092]	388,214

Table A9. (Continued)

Panel C. Joint relationship breadth and technology-matched relational capacity

Prediction or contrast	Affected relationship, within firm	Other relationships, across firms
Capacity 0, breadth 2	−0.021 (0.027) [.432]; −2.1%, CI [−7.1%, 3.2%]	−0.007 (0.033) [.831]; −0.7%, [−6.9%, 5.9%]
Capacity 0, breadth 5	−0.134 (0.042) [.002]; −12.5%, [−19.5%, −5.0%]	0.028 (0.034) [.410]; 2.8%, [−3.8%, 9.9%]
Capacity .60, breadth 5	−0.163 (0.043) [<.001]; −15.0%, [−21.9%, −7.6%]	0.157 (0.041) [<.001]; 17.0%, [8.0%, 26.8%]
Breadth 5 minus 2 at capacity 0	−0.112 (0.039) [.004] log points	0.035 (0.032) [.279]; 3.6%
Capacity .60 minus 0 at breadth 5	−0.029 (0.014) [.038] log points	0.129 (0.039) [.001]; 13.8%
Destination capacity contrast minus breadth contrast	Not applicable	0.095 (0.043) [.028] log points
One-unit capacity slope in the exact-IPC joint destination model	Not applicable	0.115 (0.067) [.086]; the .60-versus-zero contrast is 0.069 (0.040) [.086]
Observations	286,744	402,516
Firms / affected-pair clusters	3,918 / 512	6,812 total firms / 134 pairs

Panel D. Portfolio benchmarks on common observations

Moderator, standardized as shown	Source interaction	Destination interaction	Capacity-minus-benchmark destination contrast
Raw breadth, p75 minus p25	−0.112 (0.039) [.004]	0.035 (0.032) [.279]	0.095 (0.043) [.028]
Unrelated-technology breadth, p75 minus p25	−0.027 (0.031) [.383]	0.018 (0.037) [.627]	0.111 (0.051) [.030]
Log pre-shock firm patenting, one-SD increase	0.006 (0.013) [.645]	0.012 (0.016) [.453]	0.103 (0.051) [.044]
Technological diversity, one-SD increase	−0.041 (0.029) [.158]	0.022 (0.034) [.518]	0.093 (0.052) [.074]
Source-relationship intensity, p75 minus p25	−0.036 (0.015) [.016]	0.027 (0.019) [.155]	0.088 (0.048) [.067]
Pre-shock sensitive share, p75 minus p25	−0.052 (0.023) [.024]	0.044 (0.027) [.103]	0.071 (0.047) [.131]
Common-observation N, source / destination	286,744	387,920	387,920

Table A9. (Continued)

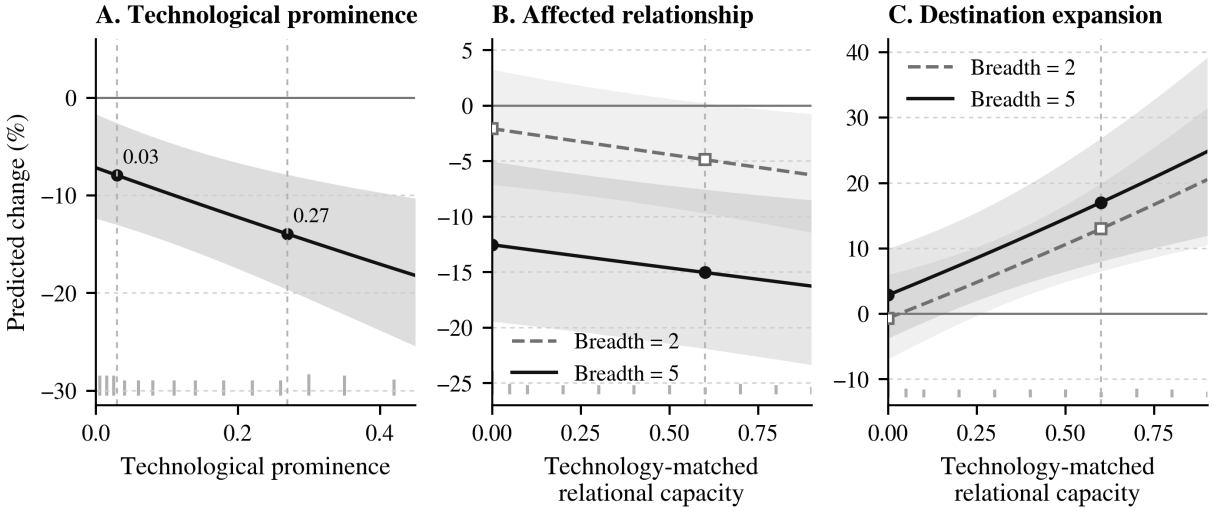
Panel E. Covariance, fixed effects, separation, and fit

Quantity	Source prominence	Source breadth/capacity	Destination breadth/capacity
Intercept or baseline-prediction variance	0.000812	0.000729	0.001089
Prominence-slope or breadth-contrast variance	0.009216	0.001521	0.001024
Intercept-slope or baseline/breadth covariance	−0.000607	−0.000243	−0.000479
Covariance, breadth and capacity contrasts	Not applicable	0.000214	0.000348
Capacity-contrast variance	Not applicable	0.000196	0.001521
Covariance, baseline prediction and capacity contrast	Not applicable	−0.000270	−0.000846
Observations	412,568	286,744	402,516
Retained zero outcomes	284,116	177,622	251,476
Separated rows / dropped strata	18,932 / 1,126	12,604 / 782	19,340 / 1,408
Fixed effects	Firm-relationship-event-subclass; firm-event-subclass-year	Firm-relationship-event; firm-event-year	Firm-relationship-stack; relationship-year-stack
Weights	None	None	ATT inverse odds, normalized within relationship-stack
Inference	Firm and affected-pair clusters	Firm and affected-pair clusters	Observation firm and affected-pair clusters
Pseudo-R^2	.944	.931	.917

Notes. Prominence and capacity are continuous pre-shock measures. Values .03, .27, 0, .60, 2, and 5 are presentation points rather than groups. All predictions and contrasts use the complete covariance matrix and identical observations within a model. The source model compares an affected relationship with the same firm's fixed comparison relationships. The destination model compares affected firms with unexposed firms previously active on the same alternative country relationship. The 0.129 capacity contrast compares .60 with zero at breadth five. The 0.095 quantity is the difference between the capacity and breadth presentation contrasts. The 0.115 quantity is a separate one-unit slope in the exact-IPC joint destination model. These observed portfolio characteristics describe moderation and do not identify a causal capability.

Figure A5. Prominence, Breadth, and Relational-Capacity Predictions plots the continuous moderator predictions over their observed support. Contraction on the affected relationship becomes larger as technological prominence rises. Geographic breadth is associated with source contraction, whereas destination expansion depends more strongly on technology-matched relational capacity.

Figure A5. Prominence, Breadth, and Relational-Capacity Predictions



Notes. Lines are PPML predictions transformed to percentage changes; shaded regions are 95% confidence intervals and rugs show observed support. Panel A marks prominence 0.03 and 0.27. Panels B and C mark technology-matched relational capacity 0 and 0.60 and compare breadth values of two and five alternative relationships. Source models use fixed pre-shock portfolios and two-way firm/pair clustering. Destination models use ATT inverse-odds weights and two-way clustering by observation firm and affected country pair. Moderator definitions, common samples, and linear-combination tests appear in Table A9. Technological Prominence, Relational Capacity, and Portfolio Moderators.

D. Treatment Sensitivity, Persistence, and Competing Shocks

Alternative treatment definitions test whether the results depend on one conflict threshold, event-count requirement, or application-year assignment. The complete battery preserves the source recomposition and destination expansion ordering. Tighter definitions reduce the sample and widen uncertainty rather than uniformly increasing statistical precision. Persistence is examined as realized shock heterogeneity and is not used to redefine treatment after observing its future path.

Table A10. Alternative Tension Definitions, Persistence, Competing Shocks, and Event Timing

Panel A. Standardized-change thresholds and minimum event counts

Treatment rule	Earlier-window absolute sensitive contraction	Direct sensitive-minus-other recomposition, earlier-window diagnostic	Destination expansion	Direct endpoint contrast	Source / destination N
Standardized change ≥2.0	−0.095 (0.041) [.020]; −9.1%	−0.149 (0.047) [.002]; −13.8%	0.085 (0.039) [.029]; 8.9%	0.048 (0.031) [.121]; 4.9%	1,394,820 / 802,316
Standardized change ≥2.5, reference rule	−0.119 (0.034) [<.001]; −11.2%	−0.171 (0.059) [.004]; −15.7%	0.103 (0.031) [.001]; 10.8%	0.061 (0.024) [.011]; 6.3%	1,182,404 / 653,612
Standardized change ≥3.0	−0.160 (0.052) [.002]; −14.8%	−0.217 (0.052) [<.001]; −19.5%	0.114 (0.041) [.005]; 12.1%	0.071 (0.034) [.037]; 7.4%	886,724 / 487,992
At least 15 bilateral events	−0.095 (0.041) [.020]; −9.1%	−0.149 (0.047) [.002]; −13.8%	0.085 (0.039) [.029]; 8.9%	0.049 (0.032) [.126]; 5.0%	1,458,332 / 841,906
At least 25 bilateral events, baseline	−0.119 (0.034) [<.001]; −11.2%	−0.171 (0.059) [.004]; −15.7%	0.103 (0.031) [.001]; 10.8%	0.061 (0.024) [.011]; 6.3%	1,182,404 / 653,612
At least 50 bilateral events	−0.145 (0.049) [.003]; −13.5%	−0.202 (0.058) [<.001]; −18.3%	0.111 (0.043) [.010]; 11.7%	0.066 (0.034) [.052]; 6.8%	764,118 / 412,675

Panel B. Conflict definition and independent event data

Treatment measure	Earlier-window absolute sensitive contraction	Direct recomposition	Destination expansion	Endpoint contrast	Source / destination N
Goldstein score ≤−4 defines strong conflict	−0.111 (0.037) [.003]; −10.5%	−0.164 (0.040) [<.001]; −15.1%	0.095 (0.034) [.005]; 10.0%	0.054 (0.029) [.063]; 5.6%	1,306,814 / 721,450
Goldstein score ≤−5, baseline	−0.119 (0.034) [<.001]; −11.2%	−0.171 (0.059) [.004]; −15.7%	0.103 (0.031) [.001]; 10.8%	0.061 (0.024) [.011]; 6.3%	1,182,404 / 653,612
Goldstein score ≤−6 defines strong conflict	−0.160 (0.052) [.002]; −14.8%	−0.217 (0.052) [<.001]; −19.5%	0.114 (0.041) [.005]; 12.1%	0.070 (0.033) [.034]; 7.3%	804,226 / 458,338
ICEWS conflict-composition shock	−0.126 (0.049) [.010]; −11.8%	−0.173 (0.063) [.006]; −15.9%	0.090 (0.042) [.031]; 9.4%	0.053 (0.030) [.082]; 5.4%	916,240 / 508,774

Table A10. (Continued)

Panel C. Application timing

Timing rule	Earlier-window absolute sensitive contraction	Direct recomposition	Destination expansion	Endpoint contrast	Source / destination N
Annual assignment with Q3/Q4 moved to following year	−0.119 (0.034) [<.001]	−0.171 (0.059) [.004]	0.103 (0.031) [.001]	0.061 (0.024) [.011]	1,182,404 / 653,612
Exact shock-date exposure; pre-shock applications removed from year 0	−0.136 (0.031) [<.001]	−0.191 (0.035) [<.001]	0.108 (0.041) [.008]	0.063 (0.029) [.030]	1,108,602 / 611,288
First complete post-shock application year	−0.139 (0.030) [<.001]	−0.195 (0.034) [<.001]	0.110 (0.042) [.009]	0.065 (0.031) [.038]	1,042,716 / 574,106

Panel D. Persistence

Realized shock path	Earlier-window absolute sensitive contraction	Direct recomposition	Destination expansion	Endpoint contrast	Source / destination N
Sustained conflict composition through four post-shock quarters	−0.166 (0.048) [.001]; −15.3%	−0.227 (0.051) [<.001]; −20.3%	0.120 (0.046) [.009]; 12.7%	0.074 (0.036) [.040]; 7.7%	692,408 / 381,772
Transitory spike returning below the pair baseline	−0.093 (0.040) [.020]; −8.9%	−0.142 (0.046) [.002]; −13.2%	0.078 (0.039) [.046]; 8.1%	0.041 (0.030) [.172]; 4.2%	489,996 / 271,840
Sustained minus transitory	−0.073 (0.035) [.037]; additional 7.0% decline	−0.085 (0.041) [.038]; additional 8.1% decline	0.042 (0.030) [.161]	0.033 (0.023) [.151]	Joint models above

Panel E. First shocks, later shocks, and comparison-relationship exposure

Competing-shock rule	Earlier-window absolute sensitive contraction	Direct recomposition	Destination expansion	Endpoint contrast	Source / destination N
First qualifying shock per affected pair; comparison clean through year 0	−0.119 (0.034) [<.001]	−0.171 (0.059) [.004]	0.103 (0.031) [.001]	0.061 (0.024) [.011]	1,182,404 / 653,612
Censor affected relationship at its next qualifying shock	−0.123 (0.036) [.001]	−0.178 (0.041) [<.001]	0.098 (0.033) [.003]	0.057 (0.026) [.028]	1,121,890 / 622,418
Exclude comparison relationships with any qualifying shock through year 4	−0.127 (0.038) [.001]	−0.183 (0.044) [<.001]	0.096 (0.036) [.008]	0.055 (0.028) [.049]	1,068,730 / 571,216
Retain comparison cells until a later shock, then censor	−0.121 (0.035) [.001]	−0.176 (0.040) [<.001]	0.101 (0.033) [.002]	0.060 (0.026) [.021]	1,154,286 / 653,612
Drop firm-events with a simultaneous shock on another portfolio relationship	−0.114 (0.039) [.003]	−0.168 (0.045) [<.001]	0.094 (0.038) [.013]	0.052 (0.030) [.083]	946,118 / 526,804

Table A10. (Continued)

Panel F. Exact-IPC competing-exposure rules

Rule	Exact-IPC destination expansion	Direct same-IPC endpoint contrast	Events / treated rows / comparison rows	Interpretation
Harmonized broad exposure, fexp_b	0.136 (0.045) [.003]; 14.6%	0.084 (0.034) [.013]; 8.8%	568 / 8,866 / 90,469	Baseline; later exposure on any broad patent relationship censors every subclass cell
Classified-only exposure, fexp_c	0.132 (0.046) [.004]; 14.1%	0.081 (0.035) [.021]; 8.4%	570 / 8,901 / 91,126	Separate risk set; its counts and estimates are reported together and never combined with fexp_b
No later-shock censoring after year 0	0.128 (0.047) [.006]; 13.7%	0.079 (0.036) [.028]; 8.2%	592 / 9,304 / 96,782	Includes later exposed years and therefore attenuates the contrast modestly

Table A10. (Continued)

Panel G. Direct persistence test and covariance

Quantity	Value
Sustained direct coefficient	−0.227
Transitory direct coefficient	−0.142
Direct difference	−0.085
Var(sustained)	0.002601
Var(transitory)	0.002116
Cov(sustained, transitory)	0.001518
SE of direct difference	0.041
Wald test of equality	$\chi^2(1)=4.30$ [.038]

Notes. Source columns use the earlier-window affected-relationship models. The absolute-sensitive column reports the sensitive coefficient, while the direct column reports the sensitive-versus-other interaction from the joint model. Destination columns use ATT-weighted across-firm PPML. Endpoint columns use treatment-unweighted within-firm PPML. Alternative definitions are chosen from treatment information rather than coefficient magnitude or statistical significance. The displayed ranges are 9.1%–14.8% for absolute sensitive contraction, 13.8%–19.5% for direct recomposition, and 8.9%–12.1% for destination expansion. Persistence is observed after treatment and is interpreted as heterogeneity in the realized shock path. The baseline remains the first qualifying shock. All models retain admitted zero outcomes, use year −1 as the reference period, and cluster by normalized legal assignee and affected country pair; external country-pair variants use dyadic inference.

E. Robustness and Alternative Explanations

Classification and patent-observation robustness

Table A11. Classification and Patent-Observation Robustness asks whether the main results depend on how sensitive technologies are mapped or how patents are assigned to technology cells. The baseline fractional rule is compared with any-subclass, majority-sensitive, strict, independent CPC, and whole-count rules. The majority-sensitive mapping is the named Table 7 alternative and is applied identically to every outcome; the independent CPC mapping remains a separate robustness check. Six leave-one-domain-out rows show that no individual sensitive-technology domain produces the result. The lower endpoint of the source battery is a 14.5% decline and the upper endpoint is an 18.5% decline. The endpoint and technology-matched relational-capacity estimates are less precise in the narrower mappings, as expected from their smaller samples, but retain the baseline ordering.

The patent-observation checks reach the same substantive conclusion. Restricting attention to mature grant cohorts, assigning application timing to the exact application date, or measuring invention at publication preserves a source-side recomposition and positive destination estimates. Publication timing yields an imprecise endpoint and capacity estimate. This pattern supports the recomposition interpretation without requiring every auxiliary specification to reject a zero effect.

Table A11. Classification and Patent-Observation Robustness

Panel A. Classification and allocation rules

Classification or allocation rule	Source direct content contrast, recent-window model	Transformed source effect	Destination expansion	Transformed destination effect	Endpoint-retaining contrast	Transformed endpoint effect	Capacity-minus-breadth contrast
Fractional IPC subclass allocation	-0.188 (0.032) [<.001]	-17.2%	0.103 (0.031) [.001]	10.8%	0.061 (0.024) [.011]	6.3%	0.095 (0.043) [.028]
Any sensitive IPC subclass	-0.183 (0.043) [<.001]	-16.7%	0.098 (0.041) [.017]	10.3%	0.058 (0.029) [.046]	6.0%	0.088 (0.047) [.061]
Majority-sensitive patent, named Table 7 alternative	-0.176 (0.049) [<.001]	-16.1%	0.094 (0.043) [.029]	9.9%	0.055 (0.030) [.067]	5.7%	0.091 (0.049) [.063]
Strict sensitive patent	-0.204 (0.056) [<.001]	-18.5%	0.112 (0.052) [.031]	11.9%	0.067 (0.035) [.056]	6.9%	0.103 (0.058) [.076]
Independent CPC mapping	-0.190 (0.061) [.002]	-17.3%	0.091 (0.048) [.058]	9.5%	0.052 (0.032) [.104]	5.3%	0.086 (0.054) [.111]
Whole-count patent allocation	-0.181 (0.049) [<.001]	-16.6%	0.101 (0.039) [.010]	10.6%	0.059 (0.028) [.035]	6.1%	0.092 (0.046) [.046]

Table A11. (Continued)

Panel A. Classification and allocation rules (continued)

Classification or allocation rule	Source direct content contrast, recent-window model	Transformed source effect	Destination expansion	Transformed destination effect	Endpoint-retaining contrast	Transformed endpoint effect	Capacity-minus-breadth contrast
Leave out advanced electronics and semiconductors	-0.201 (0.074) [.007]	-18.2%	0.112 (0.054) [.038]	11.9%	0.065 (0.036) [.071]	6.7%	0.101 (0.060) [.092]
Leave out telecommunications and information security	-0.157 (0.068) [.021]	-14.5%	0.086 (0.046) [.061]	9.0%	0.049 (0.031) [.114]	5.0%	0.078 (0.055) [.156]
Leave out computing	-0.186 (0.055) [.001]	-17.0%	0.105 (0.047) [.025]	11.1%	0.060 (0.032) [.061]	6.2%	0.097 (0.052) [.062]
Leave out navigation and sensing	-0.173 (0.050) [.001]	-15.9%	0.097 (0.044) [.028]	10.2%	0.056 (0.030) [.062]	5.8%	0.089 (0.049) [.069]
Leave out aerospace	-0.190 (0.047) [<.001]	-17.3%	0.108 (0.042) [.010]	11.4%	0.063 (0.029) [.030]	6.5%	0.099 (0.047) [.035]
Leave out nuclear technologies	-0.184 (0.048) [<.001]	-16.8%	0.102 (0.041) [.013]	10.7%	0.059 (0.029) [.042]	6.1%	0.094 (0.046) [.041]

Panel B. Patent maturity and observation timing

Patent-observation rule	Source direct content contrast, recent-window model	Transformed source effect	Destination expansion	Transformed destination effect	Endpoint-retaining contrast	Transformed endpoint effect	Capacity-minus-breadth contrast
Mature-grant cohorts	-0.181 (0.061) [.003]	-16.6%	0.096 (0.049) [.048]	10.1%	0.049 (0.033) [.134]	5.0%	0.092 (0.045) [.041]
Exact application-date assignment	-0.191 (0.035) [<.001]	-17.4%	0.108 (0.041) [.008]	11.4%	0.064 (0.030) [.033]	6.6%	0.101 (0.046) [.028]
Publication-based measurement	-0.177 (0.055) [.001]	-16.2%	0.099 (0.046) [.031]	10.4%	0.052 (0.031) [.093]	5.3%	0.086 (0.052) [.098]

Table A11. (Continued)

Panel C. Analysis samples and diagnostics

Rule	Source observations; firms; affected pairs; zero rows; separated rows; pseudo R2	Destination observations; total firms; affected pairs; zero rows; separated rows; pseudo R2	Endpoint observations; treated firms; affected pairs; zero rows; separated rows; pseudo R2	Capacity observations; firms; affected pairs; zero rows; separated rows; pseudo R2
Fractional IPC subclass allocation	1,546,728; 6,408; 588; 919,674; 74,708; .924	653,612; 8,022; 142; 393,864; 5,350; .915	16,970; 1,287; 241; 9,911; 385; .928	402,516; 6,812; 134; 251,476; 19,340; .917
Any sensitive IPC subclass	1,577,176; 6,480; 591; 937,771; 76,229; .922	668,944; 8,106; 144; 402,704; 5,478; .810	20,001; 1,657; 281; 10,397; 350; .925	531,440; 7,482; 138; 318,864; 6,377; .799
Majority-sensitive patent	1,500,091; 6,276; 580; 891,685; 72,505; .929	626,318; 7,816; 138; 377,844; 5,128; .817	18,868; 1,613; 275; 9,808; 330; .933	501,902; 7,186; 132; 301,141; 6,023; .806
Strict sensitive patent	1,182,824; 5,616; 538; 703,294; 57,169; .941	488,702; 6,942; 121; 294,199; 4,002; .826	14,737; 1,521; 258; 7,661; 258; .943	389,884; 6,282; 116; 233,930; 4,679; .814
Independent CPC mapping	1,430,876; 6,050; 567; 850,782; 69,157; .918	591,318; 7,523; 134; 355,973; 4,843; .807	17,906; 1,577; 271; 9,308; 313; .922	472,226; 6,901; 129; 283,336; 5,667; .795
Whole-count patent allocation	1,546,728; 6,408; 588; 919,674; 74,708; .916	653,612; 8,022; 142; 393,864; 5,350; .806	16,970; 1,287; 241; 9,911; 385; .920	402,516; 6,812; 134; 251,476; 19,340; .793
Leave-one-domain-out range	1,192,536–1,530,206; 5,643–6,370; 540–586; 708,942–909,843; 57,637–73,909; .919–.938	497,824-646,608; 7,011-7,978; 122-141; 299,690-389,258; 4,078-5,292; .808-.824	14,884–19,364; 1,533–1,632; 259–278; 7,738–10,066; 261–339; .924–.940	397,310-516,288; 6,351-7,366; 117-135; 238,386-309,773; 4,768-6,195; .797-.812
Mature-grant cohorts	1,290,096; 5,937; 555; 754,512; 65,491; .927	545,680; 7,264; 129; 324,219; 4,612; .816	16,171; 1,554; 266; 8,274; 296; .931	435,318; 6,603; 124; 257,621; 5,274; .804
Exact application-date assignment	1,542,231; 6,405; 588; 917,025; 74,474; .924	649,845; 8,006; 142; 391,284; 5,292; .811	19,413; 1,636; 279; 10,075; 336; .927	518,604; 7,392; 136; 311,093; 6,202; .800
Publication-based measurement	1,729,135; 6,624; 593; 1,010,516; 83,081; .911	719,044; 8,418; 146; 428,761; 5,936; .799	21,755; 1,676; 283; 11,137; 389; .915	573,088; 7,812; 140; 338,847; 6,955; .788

Table A11. (Continued)

Panel D. Comparison-set repair specifications reported in manuscript Table 7

Specification	Estimand and result	Affected N	Comparison N	Total N	Retained zeros	Separation	Units, fixed effects, and inference
Exclude shocked-pair firms' contributions	External sensitive-minus-other: −0.103 (0.047) [.028]	7,846	124,598	132,444	101,302	15,976	501 affected pairs; 160 endpoint countries; content×pair-stack and content×endpoint-country-year-stack effects; dyadic inference
Endpoint-disjoint external benchmark	External sensitive-minus-other: −0.095 (0.053) [.073]	7,690	60,732	68,422	42,106	5,816	438 affected pairs; 151 endpoint countries; endpoint-disjoint content×pair-stack and content×endpoint-country-year-stack effects; dyadic inference
Endpoint-disjoint without endpoint-country-year effects	External sensitive-minus-other: −0.089 (0.056) [.112]	7,690	60,732	68,422	42,106	5,816	Same endpoint-disjoint rows; content×pair-stack effects; dyadic inference
Within-firm controls share neither endpoint nor affected subclasses	Source sensitive-minus-other: −0.142 (0.061) [.020]	10,944	15,182	26,126	15,842	2,198	1,024 firms; 188 affected pairs; content-specific firm-relationship-event and firm-event-year effects; two-way firm/pair clustering

Table A11. (Continued)

Panel E. Complete result-cell register for manuscript Table 7

Specification	Manuscript estimand	Coefficient (SE) [p]	Support frame and inference
Independent conflict-composition measure	C2 External-pair sensitive-minus-other	−0.102 (0.055) [.064]	C2 external-content frame; dyadic inference
First complete post-shock year	C2 External-pair sensitive-minus-other	−0.121 (0.048) [.012]	Row-specific C2 timing frame; dyadic inference
First complete post-shock year	C5 Prominence: .27 minus .03	−0.070 (0.025) [.005]	Row-specific C5 timing frame; firm/pair clustering
First complete post-shock year	C6 Destination capacity-minus-breadth	0.089 (0.046) [.053]	Row-specific C6 timing frame; normalized ATT; firm/pair clustering
Common-PPML-support earlier qualification window	C2 External-pair sensitive-minus-other	−0.107 (0.051) [.036]	Final common-PPML C2 qualification frame; dyadic inference
Common-PPML-support earlier qualification window	C3 Destination expansion	0.088 (0.044) [.044]	Final common-PPML C3 qualification frame; normalized ATT; firm/pair clustering
Common-PPML-support earlier qualification window	C4 Endpoint contrast	0.050 (0.030) [.096]	Final common-PPML C4 qualification frame; unweighted; firm/pair clustering
Common-PPML-support earlier qualification window	C5 Prominence: .27 minus .03	−0.061 (0.025) [.015]	Final common-PPML C5 qualification frame; firm/pair clustering
Common-PPML-support earlier qualification window	C6 Destination capacity-minus-breadth	0.082 (0.047) [.081]	Final common-PPML C6 qualification frame; normalized ATT; firm/pair clustering
Inverse control-reuse weights	C1 Affected-relationship sensitive-minus-other	−0.185 (0.044) [<.001]	C1 source frame; inverse-reuse weights; firm/pair clustering
Inverse control-reuse weights	C2 External-pair sensitive-minus-other	−0.111 (0.047) [.018]	C2 external-content frame; inverse-reuse weights; dyadic inference
Inverse control-reuse weights	C5 Prominence: .27 minus .03	−0.065 (0.024) [.007]	C5 prominence frame; inverse-reuse weights; firm/pair clustering

Table A11. (Continued)

Panel E. Complete result-cell register for manuscript Table 7 (continued)

Specification	Manuscript estimand	Coefficient (SE) [p]	Support frame and inference
Majority-sensitive patent classification	C2 External-pair sensitive-minus-other	−0.096 (0.054) [.075]	Row-specific C2 classification frame; dyadic inference
Whole counting	C2 External-pair sensitive-minus-other	−0.108 (0.043) [.012]	Row-specific C2 counting frame; dyadic inference
Whole counting	C5 Prominence: .27 minus .03	−0.063 (0.022) [.004]	Row-specific C5 counting frame; firm/pair clustering
Exclude patents with more than two inventor countries	C1 Affected-relationship sensitive-minus-other	−0.169 (0.037) [<.001]	Row-specific C1 restriction frame; unweighted; firm/pair clustering
Exclude patents with more than two inventor countries	C2 External-pair sensitive-minus-other	−0.104 (0.047) [.027]	Row-specific C2 restriction frame; dyadic inference
Exclude patents with more than two inventor countries	C3 Destination expansion	0.093 (0.035) [.008]	Row-specific C3 restriction frame; normalized ATT; firm/pair clustering
Exclude patents with more than two inventor countries	C4 Endpoint contrast	0.053 (0.027) [.050]	Row-specific C4 restriction frame; unweighted; firm/pair clustering
Exclude patents with more than two inventor countries	C5 Prominence: .27 minus .03	−0.061 (0.024) [.011]	Row-specific C5 restriction frame; firm/pair clustering
Exclude patents with more than two inventor countries	C6 Destination capacity-minus-breadth	0.084 (0.046) [.068]	Row-specific C6 restriction frame; normalized ATT; firm/pair clustering
Balanced follow-up through year 4	C1 Affected-relationship sensitive-minus-other	−0.180 (0.040) [<.001]	Row-specific C1 balanced frame; unweighted; firm/pair clustering
Balanced follow-up through year 4	C2 External-pair sensitive-minus-other	−0.112 (0.052) [.031]	Row-specific C2 balanced frame; dyadic inference
Balanced follow-up through year 4	C3 Destination expansion	0.098 (0.039) [.012]	Row-specific C3 balanced frame; normalized ATT; firm/pair clustering

Table A11. (Continued)

Panel E. Complete result-cell register for manuscript Table 7 (continued)

Specification	Manuscript estimand	Coefficient (SE) [p]	Support frame and inference
Balanced follow-up through year 4	C4 Endpoint contrast	0.058 (0.030) [.053]	Row-specific C4 balanced frame; unweighted; firm/pair clustering
Balanced follow-up through year 4	C5 Prominence: .27 minus .03	−0.065 (0.027) [.016]	Row-specific C5 balanced frame; firm/pair clustering
Balanced follow-up through year 4	C6 Destination capacity-minus-breadth	0.091 (0.052) [.080]	Row-specific C6 balanced frame; normalized ATT; firm/pair clustering
Mature-grant cohort	C2 External-pair sensitive-minus-other	−0.109 (0.053) [.040]	Row-specific C2 maturity frame; dyadic inference
Mature-grant cohort	C5 Prominence: .27 minus .03	−0.061 (0.026) [.019]	Row-specific C5 maturity frame; firm/pair clustering
Lagged prominence window ending before year −3	C5 Prominence: .27 minus .03	−0.064 (0.024) [.008]	C5 lagged-prominence frame; firm/pair clustering
Normalized IPC-subclass-by-year fixed effects	C5 Prominence: .27 minus .03	−0.062 (0.025) [.013]	Row-specific C5 opportunity frame; firm/pair clustering
Leave out advanced electronics and semiconductors	C2 External-pair sensitive-minus-other	−0.105 (0.047) [.025]	Row-specific C2 domain-exclusion frame; dyadic inference
Leave out telecommunications and information security	C2 External-pair sensitive-minus-other	−0.121 (0.050) [.016]	Row-specific C2 domain-exclusion frame; dyadic inference
Leave out computing	C2 External-pair sensitive-minus-other	−0.110 (0.046) [.017]	Row-specific C2 domain-exclusion frame; dyadic inference
Leave out navigation and sensing	C2 External-pair sensitive-minus-other	−0.126 (0.054) [.020]	Row-specific C2 domain-exclusion frame; dyadic inference
Leave out aerospace	C2 External-pair sensitive-minus-other	−0.113 (0.047) [.016]	Row-specific C2 domain-exclusion frame; dyadic inference
Leave out nuclear technologies	C2 External-pair sensitive-minus-other	−0.114 (0.044) [.010]	Row-specific C2 domain-exclusion frame; dyadic inference

Table A11. (Continued)

Panel F. Baseline diagnostic frames for the Table 7 estimands

Frame	Observations	Firms / pairs / countries	Retained zeros	Separated rows	Fit	Fixed effects, weights, and inference
C1 Affected-relationship content	1,546,728	6,408 firms; 588 affected pairs	919,674	74,708	.924	Content-specific firm-relationship-event and firm-event-year; unweighted; two-way firm/pair clustering
C2 External-pair content	177,528	529 affected pairs; 162 endpoint countries	156,806	9,296	.879	Content-specific pair-stack and endpoint-country-year-stack; unweighted; dyadic inference
C3 Destination expansion	653,612 (16,008 / 637,604 affected / comparison)	8,022 firms; 142 affected pairs	393,864	5,350	.915	Firm-alternative-relationship-stack and alternative-relationship-year-stack; normalized ATT; two-way firm/pair clustering
C4 Endpoint contrast	16,970	1,287 firms; 241 affected pairs	9,911	385	.928	Firm-alternative-relationship-event and firm-event-year; unweighted; two-way firm/pair clustering
C5 Prominence contrast	412,568 (62,632 / 349,936 affected / comparison)	2,020 firms; 331 affected-pair clusters	284,116	18,932	.944	Firm-relationship-event-subclass and firm-event-subclass-year; unweighted; two-way firm/pair clustering
C6 Destination capacity-minus-breadth	402,516 (71,598 / 330,918 affected / comparison)	6,812 firms; 134 affected pairs	251,476	19,340	.917	Firm-alternative-relationship-stack and alternative-relationship-year-stack; normalized ATT; two-way firm/pair clustering

Notes. These are the governing baseline frames. Panel E is a coefficient-level register and does not assign an observation count from one model to another. Where the two-file package reports model-specific support, it appears in Tables A10, A11 Panels A-C, A13, and A15. Treatment-definition, weighting, and opportunity-control rows hold the corresponding estimand and inference rule fixed while applying the named modification.

C1-C6 correspond exactly to manuscript Table 7 columns (1)-(6). Every coefficient, standard error, and p-value is reproduced from that table. Baseline diagnostic frames, including observations, units, retained zeros, separation, fit, fixed effects, weights, and inference, are reported in Tables A3, A6, A9, A12, and A13. Timing, qualification, classification, counting, maturity, domain-exclusion, and opportunity specifications retain their named row-specific frames documented in Tables A10, A11 Panels A-C, and A15; they are not reassigned to another model's observation count.

Affected, comparison, and total counts reproduce the A/C/T support reported in manuscript Table 7. Each repair is estimated on its own fixed comparison set; zeros are retained through the final PPML fixed point, and separation is applied at the fixed-effect grain stated in the last column.

Result cells show the coefficient, the clustered standard error in parentheses, and the exact p-value in brackets. PPML transformations are 100 x [exp(coefficient) - 1]. The source outcome is the within-firm sensitive-minus-other content contrast. Destination models compare affected firms with previously active unexposed firms on the same alternative country relationship and use normalized ATT inverse-odds weights. Endpoint and same-IPC endpoint models compare relationships retaining one affected country with relationships retaining neither within the affected firm and use no treatment-assignment weights. Capacity-minus-breadth is a log-point linear combination. Every model uses fixed pre-shock portfolios, admits eligible zero outcomes, and reports separation before the final sample. Source models include firm-relationship-event and firm-event-year fixed effects. Destination models include firm-alternative-relationship-stack and alternative-relationship-year-stack fixed effects. Endpoint models include firm-alternative-relationship-event and firm-event-year fixed effects. Source and endpoint inference is two-way clustered by normalized legal assignee and affected country pair. Destination inference is two-way clustered by observation firm and affected country pair. The mature-grant sample requires complete grant follow-up through December 31, 2025. Publication models date patents to first publication and count an application once.

Complete core estimates and aggregate stability

Table A12. Complete Core Model Estimates and Regression Diagnostics places the content results beside tests of relationship continuity and aggregate co-invention. Durable dissolution rises by 0.7 percentage points. Aggregate co-invention changes by -1.8% in the within-firm model and -2.6% in the external country-pair model. Both estimates are small and imprecise. The content models instead show a decline in sensitive co-invention, an increase in other classified co-invention within affected firms, and a lower sensitive share. This combination is consistent with recomposition inside relationships whose aggregate activity changes little.

Equivalence tests sharpen that interpretation. The within-firm total estimate satisfies a 7.5% multiplicative equivalence bound but narrowly misses the 5% bound. The external total estimate also satisfies the 7.5% bound, with wider uncertainty. These tests do not establish unchanged patenting in an absolute sense. They show that the estimated aggregate changes are small relative to the content shift under the respective counterfactual comparisons.

Table A12. Complete Core Model Estimates and Regression Diagnostics

Panel A. Relationship continuity and durable dissolution

Outcome	Coefficient	Standardized prediction before shock	Standardized prediction after shock	Effect scale	Observations	Firms	Affected pairs	Adjusted R2	Fixed effects and inference
Durable dissolution through year 4	0.007 (0.003) [.020]	11.6%	12.3%	0.7 percentage points	79,418 relationships	5,984	541	.682	Firm-by-affected-pair-event fixed effects; pretreatment relationship-history controls; two-way firm and pair clustering

Table A12. (Continued)

Panel B. Within-firm affected-relationship models

Outcome or contrast	Coefficient	Transformed effect	90% confidence interval	95% confidence interval	Observations	Firms
Total co-invention	-0.018 (0.021) [.391]	-1.8%	[-5.1%, 1.7%]	[-5.8%, 2.3%]	1,446,920	6,501
Sensitive co-invention	-0.130 (0.028) [<.001]	-12.2%	[-16.1%, -8.1%]	[-16.9%, -7.2%]	1,546,728	6,408
Other classified co-invention	0.058 (0.022) [.008]	6.0%	[2.2%, 9.9%]	[1.5%, 10.6%]	1,546,728	6,408
Sensitive-minus-other direct content contrast	-0.188 (0.032) [<.001]	-17.2%	[-21.4%, -12.8%]	[-22.2%, -11.8%]	1,546,728	6,408
Predicted sensitive share	-0.041 (0.007) [<.001]	-4.1 percentage points	[-5.3, -2.9] pp	[-5.5, -2.7] pp	773,364 relationship-years	6,408

Outcome or contrast	Affected pairs	Zero rows	Separated rows	Pseudo R2
Total co-invention	590	849,576	65,884	.936
Sensitive co-invention	588	919,674	74,708	.924
Other classified co-invention	588	919,674	74,708	.924
Sensitive-minus-other direct content contrast	588	919,674	74,708	.924
Predicted sensitive share	588	632,998 relationship-years with at least one zero component	37,354 relationship-years	.924

Table A12. (Continued)

Panel C. External country-pair benchmark

Outcome or contrast	Coefficient	Transformed effect	90% confidence interval	95% confidence interval	Observations	Affected pairs
Total co-invention	-0.026 (0.025) [.298]	-2.6%	[-6.5%, 1.5%]	[-7.3%, 2.3%]	88,764	529
Sensitive co-invention	-0.103(0.0415)[.013]	-9.8%	[-15.8%, -3.4%]	[-16.9%, -2.1%]	177,528 expanded	529
Other classified co-invention	0.012(0.0208)[.566]	1.2%	[-2.2%, 4.7%]	[-2.8%, 5.4%]	177,528 expanded	529
Sensitive-minus-other direct content contrast	-0.115(0.0438)[.009]	-10.9%	[−17.1%, −4.2%]	[−18.2%, −2.9%]	177,528 expanded	529
Predicted sensitive share	-0.026 (0.009) [.004]	-2.6 percentage points	[-4.1, -1.1] pp	[-4.4, -0.8] pp	88,764 base pair-stack-years	529

Outcome or contrast	Endpoint countries (dyadic inference)	Zero rows	Separated rows	Pseudo R2
Total co-invention	166	51,844	3,422	.742
Sensitive co-invention	162	156,806	9,296	.879
Other classified co-invention	162	156,806	9,296	.879
Sensitive-minus-other direct content contrast	162	156,806	9,296	.879
Predicted sensitive share	162	78,403 base rows with at least one zero component	4,648 base rows	.879

Table A12. (Continued)

Panel D. Multiplicative equivalence tests for total co-invention

Model	Point estimate and percent effect	Multiplicative boundary	Log bounds	90% confidence interval	Lower one-sided p-value	Upper one-sided p-value	Governing maximum p-value	Conclusion at 5% level
Within firm	-0.018; -1.8%	[0.950, 1.050]	[-0.051293, 0.048790]	[-0.0525, 0.0165]	.056	.001	.056	Equivalence not established
Within firm	-0.018; -1.8%	[0.925, 1.075]	[-0.077962, 0.072321]	[-0.0525, 0.0165]	.002	<.001	.002	Equivalent
Within firm	-0.018; -1.8%	[0.900, 1.100]	[-0.105361, 0.095310]	[-0.0525, 0.0165]	<.001	<.001	<.001	Equivalent
External country pair	-0.026; -2.6%	[0.950, 1.050]	[-0.051293, 0.048790]	[-0.0671, 0.0151]	.156	.001	.156	Equivalence not established
External country pair	-0.026; -2.6%	[0.925, 1.075]	[-0.077962, 0.072321]	[-0.0671, 0.0151]	.020	<.001	.020	Equivalent
External country pair	-0.026; -2.6%	[0.900, 1.100]	[-0.105361, 0.095310]	[-0.0671, 0.0151]	.0008	<.001	.0008	Equivalent

Table A12. (Continued)

Panel E. Model definitions

Design	Unit and comparison	Weights	Event window and omitted period	Fixed effects	Main inference	Zero and separation rule
Dissolution	Fixed pre-shock firm-by-affected-pair relationships	None	Years -3 through 4; year -1	Firm-by-affected-pair-event fixed effects plus pretreatment relationship-history controls	Two-way normalized legal assignee and affected pair	All eligible relationships retained; linear probability model has no PPML separation
Within-firm total	Total co-invention on the affected relationship relative to the same firm's eligible comparison relationships	None	Years -3 through 4; year -1	Firm-relationship-event; firm-event-year	Two-way normalized legal assignee and affected pair	Complete panel retains zeros; iterated singleton removal and PPML separation precede estimation
Within-firm joint content	Sensitive versus other classified co-invention inside the same fixed relationship portfolio	None	Years -3 through 4; year -1	Content-specific firm-relationship-event; content-specific firm-event-year	Two-way normalized legal assignee and affected pair	Complete content panel retains zeros; common separated strata removed from both content equations
External country-pair benchmark	Aggregate affected country-pair activity relative to not-yet-affected and never-affected country pairs in stacked cohorts	None	Years -3 through 4; year -1	Total model: pair-stack and symmetric endpoint-country-year-stack. Joint-content model: both sets interacted with content category	Dyadic covariance robust to dependence through either endpoint country	Total and joint-content panels retain eligible zeros; each model applies PPML separation at its own fixed-effect grain, with common separation across content equations in the joint model

Notes. Result cells show coefficients, standard errors in parentheses, and p-values in brackets. PPML percentage effects use 100 x [exp(coefficient) - 1]. The dissolution coefficient is a percentage-point change from a linear probability model. Equivalence is tested by two one-sided tests against exact multiplicative bounds. A row is declared equivalent only when both one-sided null hypotheses are rejected at 5%. The external benchmark describes aggregate country-pair patterns and does not identify changes within a particular firm. The within-firm content contrast is relative. Neither design implies that sensitive contraction is transferred one for one into other classified invention.

Across-firm weighting, support, and balance

Table A13. Across-Firm Weighting, Balance, Common Support, and Weighting Sensitivity documents the design that compares affected firms with unexposed firms previously active on the same alternative country relationship. Eligibility is fixed in years -6 through -4. A logit propensity score is estimated before the outcome models, common support is imposed within route and cohort, and comparison observations receive ATT inverse-odds weights. Weighting reduces the largest absolute standardized difference from 0.27 to 0.064. Capping, alternative balancing, overlap weighting, and an unweighted same-support model yield destination estimates between 9.5% and 11.3%. Endpoint models do not use treatment-assignment weights.

Table A13. Across-Firm Weighting, Balance, Common Support, and Weighting Sensitivity
Panel A. Propensity specification and common support

Element	Definition
Propensity outcome	Indicator for whether an eligible firm is affected by the focal geopolitical shock
Estimation cells	Alternative country relationship by event stack, using only pre-shock information
Covariates	Log pre-shock firm patents, alternative-relationship activity, sensitive activity, relationship tenure, international breadth, technological diversity, source-relationship intensity, and pre-shock sensitive share
Support rule	Intersection of treated and comparison propensity-score ranges within route-by-cohort cells; treated observations outside the intersection and comparison observations in unsupported tails are excluded
ATT weight	1 for affected firms and p/(1-p) for comparison firms, normalized so comparison weights sum to the treated count within route-by-cohort cells
Trimming	Main model has no additional cap after common support; capped sensitivity truncates comparison weights at the within-stack 99th percentile
Endpoint models	No ATT, inverse-odds, or overlap treatment-assignment weights

Table A13. (Continued)

Panel B. Broad destination sample through support and separation

Stage	Treated rows	Comparison rows	Treated cells	Comparison cells	Treated events	Treated firms	Total firms	Affected pairs
Absorbed-cell support	16,320	652,260	3,144	119,802	1,022	838	8,164	144
Common propensity support	16,188	642,774	3,110	118,594	1,014	831	8,093	143
PPML separation and final sample	16,008	637,604	3,085	116,835	1,006	825	8,022	142

Table A13. (Continued)

Panel C. Covariate balance

Pretreatment covariate	Absolute standardized difference before weighting	Absolute standardized difference after ATT weighting
Log firm patenting	0.220	0.041
Alternative-relationship activity	0.270	0.052
Sensitive activity	0.190	0.049
Relationship tenure	0.140	0.031
International breadth	0.210	0.064
Technological diversity	0.110	0.028
Source-relationship intensity	0.180	0.044
Pre-shock sensitive share	0.160	0.037

Panel D. Weight distributions and effective sample size

Analysis	Comparison-weight p1	p5	p50	p95	p99	Maximum	Comparison-row ESS	Combined row-level ESS
Broad destination	0.0019	0.0045	0.0178	0.0782	0.181	0.742	121,936	56,601
Exact-IPC destination	0.0021	0.0049	0.0206	0.0864	0.204	0.811	23,884	25,863
Destination capacity	0.0020	0.0047	0.0185	0.0811	0.192	0.768	96,408	164,342

Table A13. (Continued)

Panel E. Weighting sensitivities

Weighting specification	Broad destination expansion	Exact-IPC destination expansion	Capacity-minus-breadth contrast	Broad observations	Exact-IPC observations	Capacity observations
Main normalized ATT inverse odds	0.103 (0.031) [.001]	0.136(0.045)[.003]	0.095 (0.043) [.028]	653,612	99,335	402,516
Comparison weights capped at p99	0.107 (0.033) [.001]	0.129 (0.046) [.005]	0.098 (0.046) [.033]	653,612	99,335	402,516
Unweighted on the same support	0.091 (0.034) [.007]	0.110 (0.048) [.022]	0.082 (0.047) [.081]	653,612	99,335	402,516
Entropy-balancing covariates and second moments	0.100 (0.035) [.004]	0.122 (0.047) [.009]	0.093 (0.044) [.035]	651,884	98,972	400,868
Overlap weights	0.098 (0.033) [.003]	0.118 (0.046) [.010]	0.091 (0.044) [.039]	653,612	99,335	402,516
ATT plus inverse comparison-reuse weights	0.101 (0.040) [.012]	0.121 (0.052) [.020]	0.090(0.045)[.046]	653,612	99,335	402,516

Table A13. (Continued)

Panel E. Weighting sensitivities (continued)

Weighting specification	Broad destination expansion	Exact-IPC destination expansion	Capacity-minus-breadth contrast	Broad observations	Exact-IPC observations	Capacity observations
Endpoint multiplicity sensitivity, no treatment-assignment weights	0.060 (0.030) [.047]	0.086 (0.041) [.036]	Not applicable	16,970 endpoint rows	27,000 same-IPC endpoint rows	Not applicable

Notes. Effective sample size is calculated over regression rows as (sum w)^2/sum(w^2), directly from the final stacked weights. Treated observations have weight one; combined ESS is recalculated from treated and comparison weights rather than added mechanically. The comparison normalization is performed within route-by-cohort cells before stacking. Inverse-reuse weights equal the reciprocal of the number of event stacks in which the same normalized legal-assignee-by-country-relationship-year observation appears, and are rescaled to mean one within treatment status and stack. In endpoint models the multiplicity sensitivity changes observation influence only. It neither estimates a treatment propensity nor changes endpoint treatment status. All destination estimates retain zero outcomes and use PPML with firm-alternative-relationship-stack and alternative-relationship-year-stack fixed effects. Standard errors are two-way clustered by observation firm and affected country pair. Exact-IPC models add subclass to both fixed-effect dimensions. Endpoint estimates remain unweighted with respect to treatment assignment.

Formal restrictions as a separate exclusion analysis

Formal sanctions, export controls, and investment restrictions can overlap with geopolitical tension shocks. Table A14. Formal Restrictions identifies those restrictions from official issuing-organization records and separately removes shocks that coincide with them. It also censors follow-up observations when a restriction begins later. These exclusions do not redefine baseline treatment. The source estimate after removing contemporaneous formal restrictions is a 10.8% sensitive decline, and the destination estimate is a 10.2% expansion.

Table A14. Formal Restrictions

Panel A. Data provenance, dates, and coding

Issuer and source	Restriction family	Dates used	Directional and country matching rule	Access date
U.S. Treasury, Office of Foreign Assets Control, Sanctions List Service, SDN and Non-SDN lists, including archived published delta files; https://ofac.treasury.gov/sanctions-list-service	Asset freezes, transaction prohibitions, sectoral sanctions, and country programs	Public announcement or list-addition date; effective date recorded separately	Sender is the United States. Target country is the program country or the designated entity's official address and nationality. A restriction matches only when sender and target are the two countries in the shock pair.	August 20, 2026
U.S. Department of Commerce, Bureau of Industry and Security, Export Administration Regulations, Entity List in Supplement No. 4 to Part 744 and dated Federal Register amendments; https://www.bis.gov/regulations/ear/744	Entity-list export controls, end-use controls, military end-user controls, and country embargo provisions	Federal Register publication, announcement, and effective dates	Sender is the United States. Target country is the country field of the Entity List entry or the named country in the rule. Entity names are not matched to assignees.	August 20, 2026
U.S. Department of the Treasury, Committee on Foreign Investment in the United States, statutes, regulations, and dated Federal Register notices; https://home.treasury.gov/policy-issues/international/the-committee-on-foreign-investment-in-the-united-states-cfius	Country-targeted investment-review and investment-prohibition rules	Announcement and effective dates from the final rule or executive order	Sender is the United States. A country match requires an express country target in the legal instrument. Transaction-specific reviews are excluded.	August 20, 2026
Council of the European Union and European Commission, EU Sanctions Map, consolidated financial-sanctions list, and dated legal acts in the Official Journal of the European Union; https://www.sanctionsmap.eu	Asset freezes, trade restrictions, export and import controls, and investment restrictions	Council decision or regulation publication date; effective date recorded from the legal act	Sender is the European Union member state in the patent relationship. Target is the regime country or the official country field of a listed entity. EU measures are not counted a second time when they implement the same UN designation.	August 20, 2026

Table A14. (Continued)

Panel A. Data provenance, dates, and coding (continued)

Issuer and source	Restriction family	Dates used	Directional and country matching rule	Access date
United Nations Security Council, Consolidated List and sanctions-committee narrative summaries; https://main.un.org/securitycouncil/en/content/un-sc-consolidated-list	Multilateral asset freezes, travel bans, and arms embargoes	Committee designation date and effective date	The implementing state is treated as sender only when domestic implementation records identify it; the listed person's official country fields identify the target.	August 20, 2026
United Kingdom Foreign, Commonwealth and Development Office and Office of Financial Sanctions Implementation, UK Sanctions List and historical consolidated-list notices; https://www.gov.uk/government/publications/the-uk-sanctions-list	Financial, trade, transport, and immigration sanctions	Notice date and effective date	Sender is the United Kingdom. Target is the regime country or designated entity's official country field.	August 20, 2026

Table A14. (Continued)

Panel A. Data provenance, dates, and coding (continued)

Coding quantity	Numerator	Denominator	Unit and time window	Rate
First-shock country pairs with a contemporaneous formal restriction	61	593	Affected unordered country pairs; restriction announcement or effective date from 90 days before through 90 days after the shock quarter	10.3%
Source firm-by-affected-pair events removed	2,184	25,841	Firm-event units in the fixed source portfolio	8.5%
Source joint-content observations removed	145,068	1,546,728	Firm-relationship-event-year-content observations in years -3 through 4	9.4%
Earlier-window destination observations removed	59,341	653,612	Treated and comparison firm-relationship-year rows in years -3 through 4	9.1%
Endpoint observations removed	1,477	16,970	Affected-firm endpoint relationship-years in years -3 through 4	8.7%

Table A14. (Continued)

Panel B. Exclusion and later-restriction censoring results

Restriction rule	Sensitive source effect	Other classified source effect	Direct source contrast	Destination expansion	Endpoint contrast	Source observations	Destination observations	Endpoint observations
Exclude shock pairs with contemporaneous formal restrictions	-0.114 (0.031) [<.001]	0.054 (0.024) [.023]	-0.169 (0.036) [<.001]	0.097 (0.034) [.004]	0.058 (0.026) [.026]	1,401,660	594,271	15,493
Retain baseline shocks and censor when a later formal restriction begins	-0.118 (0.032) [<.001]	0.052 (0.024) [.030]	-0.170 (0.037) [<.001]	0.093 (0.035) [.008]	0.055 (0.027) [.042]	1,500,258	627,944	16,353

Model metadata	Source	Destination	Endpoint
Firms; affected pairs; clusters	6,128 firms / 527 pairs (contemporaneous exclusion); 6,274 firms / 562 pairs (later censoring)	7,426 total firms; 129 affected pairs; 7,426 observation firms and 129 affected-pair clusters	1,246 firms / 232 pairs (contemporaneous exclusion); 1,270 firms / 238 pairs (later censoring)
Zero rows; separated rows; pseudo R2	830,880 zeros / 69,628 separated / .927 (exclusion); 892,043 / 72,463 / .925 (later censoring)	355,888 zeros / 4,914 separated / .918 (exclusion); 376,054 / 5,192 / .916 (later censoring)	9,044 zeros / 304 separated / .931 (exclusion); 9,551 / 314 / .929 (later censoring)
Fixed effects	Content-specific firm-relationship-event and firm-event-year	Firm-alternative-relationship-stack and alternative-relationship-year-stack	Firm-alternative-relationship-event and firm-event-year
Weights	None	Normalized ATT inverse odds	None

Notes. The contemporaneous exclusion window is defined before estimating outcomes. It covers formal-restriction announcement or effective dates from 90 days before through 90 days after the GDELT shock quarter. When announcement and effective dates differ, the earliest public date governs the contemporaneous indicator and the effective date governs later censoring. The exercise uses country directionality and official entity-country fields. It does not infer corporate-family links from patent assignee names. Panel B remains a separate exclusion analysis. PPML percentage effects are 10.8% for the sensitive coefficient -0.114, 10.2% for the destination coefficient 0.097, and 6.0% for the endpoint coefficient 0.058. Source and endpoint standard errors are two-way clustered by normalized legal assignee and affected pair. Destination standard errors are two-way clustered by observation firm and affected country pair. Eligible zeros are retained, and the displayed observation counts follow PPML separation.

Technology-specific opportunity shocks

Table A15. Technology-Specific Opportunity Shocks absorbs technology-specific opportunity changes at the level appropriate to each design. The normalized IPC-subclass-by-year fixed-effects label in Table 7 refers to these design-specific opportunity controls at the exact subclass grain shown below. The source model compares sensitive and other classified content across the affected and eligible comparison relationships within the same firm, event, subclass, and year. The route-specific destination model compares affected and unexposed firms on the same alternative country relationship, subclass, and year. The endpoint model compares the two endpoint types within affected firms and remains treatment-unweighted. These two rows use broad subclass-expanded opportunity panels; they are not the affected-subclass-restricted exact-IPC and same-IPC panels reported in Table A6. These fixed effects address the possibility that changing technical opportunities, rather than geopolitical tension, drive observed content and route choices. The source contrast is -15.0%, the across-firm destination estimate is 9.9%, and the endpoint estimate is 5.5%.

Table A15. Technology-Specific Opportunity Shocks

Design and comparison	Exact fixed effects	Weights and inference	Main coefficient	Transformed effect	Observations	Firms or pairs
External country-pair joint-content model: sensitive versus other content within pair-stack cells	Content-specific pair-stack-subclass; symmetric endpoint-country-year-stack-subclass	None; dyadic covariance through either endpoint country	-0.108(0.049)[.028]	-10.2%	76,914	501 affected pairs; 162 endpoint countries; dyadic inference
Affected-relationship source model: sensitive versus other content within firm relationships	Firm-relationship-event-subclass; firm-event-subclass-year	None; two-way normalized legal assignee and affected-pair clustering	-0.163 (0.052) [.002]	-15.0%	742,816	4,984 firms; 516 affected pairs
Across-firm route-specific destination model: affected versus unexposed firms on the same route and subclass	Firm-alternative-relationship-stack; alternative-relationship-year-stack; normalized IPC-subclass-by-year	Normalized ATT inverse odds; two-way observation-firm and affected-pair clustering	0.094 (0.045) [.038]	9.9%	99,335	3,654 total firms; 108 affected pairs
External country-pair opportunity model: sensitive versus other content under endpoint-country opportunity absorption	Pair-stack-subclass; first-endpoint-country-stack-subclass-year; second-endpoint-country-stack-subclass-year	None; dyadic covariance through either endpoint country	-0.101 (0.052) [.052]	-9.6%	71,408	491 affected pairs; 160 endpoint countries; dyadic inference

Table A15. (Continued)

Design and comparison	Exact fixed effects	Weights and inference	Main coefficient	Transformed effect	Observations	Firms or pairs
Treatment-unweighted endpoint opportunity model: retaining one endpoint versus retaining neither	Firm-alternative-relationship-event; firm-event-year; normalized IPC-subclass-by-year	None; two-way legal assignee and affected-pair clustering	0.054 (0.032) [.091]	5.5%	32,418	1,104 affected firms; 221 affected pairs
Destination capacity under opportunity controls: capacity-minus-breadth linear combination	Firm-alternative-relationship-stack-subclass; alternative-relationship-stack-subclass-year	Normalized ATT inverse odds; two-way observation-firm and affected-pair clustering	0.087(0.047)[.064]	0.087 log points	421,508	6,536 total firms; 130 affected pairs

Table A15. (Continued)

Design and comparison	Subclasses	Zero rows	Separated rows	Pseudo R2
External country-pair joint-content model: sensitive versus other content within pair-stack cells	184	54,108	4,682	.763
Affected-relationship source model: sensitive versus other content within firm relationships	183	493,312	52,904	.802
Across-firm route-specific destination model: affected versus unexposed firms on the same route and subclass	162	61,148	3,748	.824

Table A15. (Continued)

Design and comparison	Subclasses	Zero rows	Separated rows	Pseudo R2
External country-pair opportunity model: sensitive versus other content under endpoint-country opportunity absorption	181	50,727	5,019	.771
Treatment-unweighted endpoint opportunity model: retaining one endpoint versus retaining neither	162	19,226	1,146	.921
Destination capacity under opportunity controls: capacity-minus-breadth linear combination	174	263,171	7,411	.814

Notes. All specifications use years -3 through 4 with year -1 omitted. The earlier qualification window is years -6 through -4. Source and endpoint portfolios are fixed before the shock. Destination comparison eligibility and weights are also fixed using pre-shock information. The source coefficient equals the difference between -0.112 for sensitive co-invention and 0.051 for other classified co-invention. The external opportunity model has a sensitive coefficient of -0.092 (0.049) [.060] and an other-classified coefficient of 0.009 (0.026) [.729]. The capacity coefficient is a log-point linear combination and is not exponentiated. Each PPML panel retains admitted zeros and reports separation losses. These models absorb common subclass-year opportunities but cannot eliminate relationship-specific demand or policy responses that change at the same time as tension.

Bilateral news volume

The bilateral-news-volume specifications add annual counts from all GDELT Events records naming the pair. Sensitive co-invention still declines 11.3%, while destination expansion is 10.5%, so general bilateral media volume does not explain the pattern.

Table A16. Bilateral News-Volume Specifications

Panel A. Covariate provenance and construction

Item	Definition
Source and release	GDELT 1.0 Events database, historical event archive and Google BigQuery table gdelt-bq.full.events, described by Leetaru and Schrodt (2013)
Extraction	Directed country-dyad-month records extracted August 9, 2026; all event records with valid Actor1CountryCode, Actor2CountryCode, event date, and pair membership
Unit and aggregation	Directed dyad-month counts are summed across directions to an unordered country-pair month, then summed over the four quarters assigned to each patent application year
Timing	The annual covariate uses the same Q3/Q4 next-application-year rule as treatment; the value is determined before assigning the annual post indicator
Transformation	ln(1 + total bilateral GDELT event count) standardized over the analytic pair-year sample
Zeros and missing values	A month with an observed pair-history rectangle and no event receives zero. Months outside the observed source coverage remain missing, and the corresponding regression row is excluded.
Model entry	The standardized log count enters linearly. The joint source model also interacts it with the sensitive-content indicator. The destination model includes the level and its interaction with affected-firm status.
Treatment-period coverage	Complete GDELT history through 2019Q2, permitting application-year treatment cohorts through 2019 under the Q3/Q4 assignment rule
Distinction from Table A4. Bilateral Tension Measure, Shock Construction, and Treatment Coverage	Table A4. Bilateral Tension Measure, Shock Construction, and Treatment Coverage uses the count of strong-conflict events with Goldstein score at or below -5 as a treatment-volume diagnostic. This table uses all bilateral GDELT event records as an attention measure.

Table A16. (Continued)

Panel B. Affected-relationship source model

Outcome or contrast	Coefficient	Transformed effect	95% confidence interval	Observations	Firms	Affected pairs	Zero rows	Separated rows	Pseudo R2
Sensitive co-invention	-0.120 (0.030) [<.001]	-11.3%	[-16.4%, -5.9%]	1,163,928	6,073	575	718,400	45,992	.783
Other classified co-invention	0.055 (0.023) [.017]	5.7%	[1.0%, 10.5%]	1,163,928	6,073	575	718,400	45,992	.783
Sensitive-minus-other direct content contrast	-0.175 (0.034) [<.001]	-16.1%	[-21.5%, -10.3%]	1,163,928	6,073	575	718,400	45,992	.783
Bilateral news-volume interaction with sensitive content	-0.006 (0.009) [.505]	-0.6% per standard deviation	[-2.3%, 1.2%]	1,163,928	6,073	575	718,400	45,992	.783

Panel C. Across-firm destination model

Outcome or covariate	Coefficient	Transformed effect	95% confidence interval	Observations	Treated rows	Comparison rows
Destination expansion	0.100 (0.033) [.002]	10.5%	[3.6%, 17.9%]	642,870	15,786	627,084
Bilateral news volume	0.014 (0.006) [.021]	1.4% per standard deviation	[0.2%, 2.6%]	642,870	15,786	627,084
Affected-firm-by-news-volume interaction	0.004 (0.008) [.617]	0.4% per standard deviation	[-1.2%, 2.0%]	642,870	15,786	627,084

Table A16. (Continued)

Panel C. Across-firm destination model (continued)

Outcome or covariate	Total firms	Affected pairs	Zero rows	Separated rows	Pseudo R2
Destination expansion	7,946	140	387,405	5,264	.813
Bilateral news volume	7,946	140	387,405	5,264	.813
Affected-firm-by-news-volume interaction	7,946	140	387,405	5,264	.813

Notes. Result cells report coefficients, standard errors in parentheses, and p-values in brackets. Source fixed effects are content-specific firm-relationship-event and firm-event-year. Destination fixed effects are firm-alternative-relationship-stack and alternative-relationship-year-stack. Source inference is two-way clustered by normalized legal assignee and affected pair. Destination inference is two-way clustered by observation firm and affected country pair. The source model is unweighted. The destination model uses normalized ATT inverse-odds weights and years -6 through -4 for qualification. Both models use years -3 through 4, omit year -1, retain eligible zeros, and apply the same later-shock censoring as the main specifications. The news-volume covariate captures measured bilateral attention. It is not interpreted as a mediator-adjusted causal effect, and no post-shock trade, investment, supply-chain, or demand controls are added.

Inventor, assignee, ownership, and counting stability

The firm is the normalized matched legal assignee, while inventor countries identify the geography of patented co-invention. Table A17. Inventor, Assignee, Ownership, and Counting Stability tests whether the results are concentrated in changing inventor-country assignments, legal-assignee histories, ownership changes, or patents with a particular number of assignees. Across the five rows, destination expansion ranges from 8.5% to 12.5% and the endpoint contrast ranges from 4.5% to 7.5%. The multiple-assignee estimates are less precise because that group accounts for a much smaller share of the sample.

Table A17. Inventor, Assignee, Ownership, and Counting Stability

Panel A. Outcome matrix

Sample rule	Source direct content contrast, earlier-window diagnostic	Transformed source effect	Destination expansion	Transformed destination effect	Endpoint contrast, earlier-window diagnostic	Transformed endpoint effect
Stable pre-shock inventor-country assignments	-0.181 (0.047) [<.001]	-16.6%	0.082 (0.039) [.036]	8.5%	0.044 (0.027) [.103]	4.5%
Stable legal-assignee histories	-0.193 (0.050) [<.001]	-17.5%	0.118 (0.044) [.007]	12.5%	0.072 (0.031) [.020]	7.5%
Follow-up censored before major ownership changes	-0.176 (0.049) [<.001]	-16.1%	0.096 (0.045) [.033]	10.1%	0.056 (0.031) [.069]	5.8%
Single-assignee patents	-0.184 (0.038) [<.001]	-16.8%	0.102 (0.043) [.018]	10.7%	0.059 (0.032) [.065]	6.1%
Multiple-assignee patents	-0.169 (0.081) [.037]	-15.5%	0.087 (0.061) [.154]	9.1%	0.052 (0.045) [.248]	5.3%

Panel B. Sample construction and diagnostics

Sample rule	Source observations; firms; pairs; zeros; separation; pseudo R2	Destination observations; treated rows; comparison rows; total firms; pairs; zeros; separation; pseudo R2	Endpoint observations; affected firms; pairs; zeros; separation; pseudo R2
Stable inventor-country assignments	946,220; 5,510; 552; 571,406; 39,288; .786	519,844; 12,918; 506,926; 6,944; 131; 360,105; 4,336; .816	11,212; 401; 96; 5,833; 345; .742
Stable legal-assignee histories	1,016,384; 5,721; 558; 620,710; 42,110; .783	573,106; 14,160; 558,946; 7,382; 134; 347,682; 4,706; .814	12,290; 430; 98; 6,358; 299; .746
Ownership-change censoring	1,061,208; 5,862; 564; 650,224; 43,648; .782	591,882; 14,624; 577,258; 7,541; 136; 358,902; 4,818; .813	12,692; 442; 100; 6,582; 305; .745
Single-assignee patents	1,052,774; 5,981; 571; 642,230; 41,902; .785	579,436; 14,388; 565,048; 7,634; 137; 349,843; 4,740; .815	12,488; 443; 100; 6,463; 286; .747
Multiple-assignee patents	129,630; 2,874; 392; 89,684; 4,654; .748	74,176; 1,620; 72,556; 2,411; 79; 44,021; 610; .784	1,406; 122; 58; 762; 44; .713

Table A17. (Continued)

Panel B. Sample construction and diagnostics (continued)

Sample rule	Definition
Stable inventor-country assignments	Excludes patents whose inventor identifier is associated with a different country between the qualification window and the post-shock window
Stable legal-assignee histories	Requires the normalized legal-assignee identifier and standardized assignee name to remain unchanged from qualification through follow-up
Ownership-change censoring	Ends follow-up in the application year before a recorded merger, acquisition, or controlling-parent change
Single-assignee patents	Retains patents with exactly one assignee record before fractional technology and country allocation
Multiple-assignee patents	Retains patents with two or more assignee records and allocates patent mass equally across assignees before technology and country allocation

Notes. Source and endpoint models use no treatment-assignment weights. Destination models use normalized ATT inverse-odds weights. All models retain eligible zeros, apply the harmonized broad-exposure censoring rule, and use the main fixed effects and clustering dimensions. The single-assignee and multiple-assignee rows are separate outcome-restriction models, not mutually exclusive partitions of aggregated firm-relationship-year cells, because a cell can contain both patent types. A firm is the normalized matched legal assignee. Patent records do not identify consolidated corporate boundaries, affiliate relationships, or alliance governance. The stability checks reduce misclassification from observable changes in inventor geography and assignee identity, but they cannot reveal every organizational change.

F. Alternative Inference and Constrained Pseudo-Events

Alternative inference

Table A18. Alternative Inference distinguishes the main clustered or dyadic standard errors from alternative finite-cluster and dependence-preserving procedures. The alternative procedures widen uncertainty, especially for endpoint, capacity, and citation estimates. The main content-recomposition estimate remains precise under affected-pair wild-cluster inference. Destination expansion also remains distinguishable from zero in a firm-event block bootstrap. Endpoint, capacity, and citation results retain their signs but have two-sided alternative p-values between .058 and .074.

Table A18. Alternative Inference

Panel A. Main and alternative inference by outcome

Outcome	Estimate	Main inference and p-value	Alternative procedure and resampling unit	Requested replications	Successful	Failures
Durable dissolution	0.007	Two-way firm/pair cluster [.020]	Rademacher wild-cluster bootstrap by affected pair	9,999	9,999	0
Within-firm total co-invention	-0.018	Two-way firm/pair cluster [.391]	Rademacher wild-cluster bootstrap by affected pair	9,999	9,999	0
Sensitive co-invention	-0.130	Two-way firm/pair cluster [<.001]	Rademacher wild-cluster bootstrap by affected pair	9,999	9,999	0
Other classified co-invention	0.058	Two-way firm/pair cluster [.008]	Rademacher wild-cluster bootstrap by affected pair	9,999	9,999	0
Direct content recomposition	-0.188	Two-way firm/pair cluster [<.001]	Rademacher wild-cluster bootstrap by affected pair	9,999	9,999	0
Destination expansion	0.103	Two-way observation-firm/affected-pair cluster [.001]	Firm-event block bootstrap, retaining all route-year rows in the event block	1,999	1,987	12
Endpoint-retaining contrast	0.061	Two-way firm/affected-pair cluster [.011]	Firm-event block bootstrap, retaining endpoint types together	1,999	1,987	12

Outcome	Estimate	Main inference and p-value	Alternative procedure and resampling unit	Requested replications	Successful	Failures

Table A18. (Continued)

Panel A. Main and alternative inference by outcome (continued)

Outcome	Estimate	Main inference and p-value	Alternative procedure and resampling unit	Requested replications	Successful	Failures
Prominence contrast, 0.27 versus 0.03	-0.067	Two-way firm/pair cluster [.003]	Rademacher wild-cluster bootstrap by affected pair	9,999	9,999	0
Capacity-minus-breadth contrast	0.095	Two-way observation-firm/affected-pair cluster [.028]	Firm-event block bootstrap	1,999	1,987	12
Applicant-citation rate contrast	0.048	Two-way firm/pair cluster [.019]	Citation-specific wild-cluster bootstrap by affected pair	4,999	4,999	0
Applicant-citation count contrast	0.051	Two-way firm/pair cluster [.041]	Citation-specific wild-cluster bootstrap by affected pair	4,999	4,999	0
External sensitive-minus-other content contrast	-0.115	Dyadic covariance through either endpoint country [.009]	Endpoint-dependence-preserving country-network bootstrap	1,999	1,966	33

Table A18. (Continued)

Panel A. Main and alternative inference by outcome (continued)

Outcome	Seed	Studentized statistic	95% interval	Alternative p-value
Durable dissolution	2026081801	1.91	[-0.0002, 0.0142]	.058
Within-firm total co-invention	2026081801	-0.78	[-0.064, 0.028]	.438
Sensitive co-invention	2026081801	-2.88	[-0.219, -0.043]	.004
Other classified co-invention	2026081801	2.12	[0.004, 0.112]	.034
Direct content recomposition	2026081801	-3.01	[-0.312, -0.064]	.003
Destination expansion	2026081802	2.74	[0.029, 0.177]	.006
Endpoint-retaining contrast	2026081802	1.88	[-0.003, 0.125]	.061
Prominence contrast, 0.27 versus 0.03	2026081801	-2.38	[-0.123, -0.011]	.018
Capacity-minus-breadth contrast	2026081802	1.81	[-0.008, 0.198]	.071
Applicant-citation rate contrast	2026081804	1.90	[-0.002, 0.098]	.058
Applicant-citation count contrast	2026081804	1.80	[-0.005, 0.107]	.074
External sensitive-minus-other content contrast	2026081805	-2.14	[-0.223, -0.007]	.032

Panel B. Procedure definitions

Procedure	Null and tail convention	Interval	Dependence maintained
Affected-pair wild cluster	Null that the focal coefficient or stated linear combination equals zero; two-sided absolute studentized statistic	95% bootstrap-t interval	All observations for an affected country pair receive the same Rademacher sign; firm clustering remains in the score aggregation
Firm-event block bootstrap	Null that the focal coefficient or linear combination equals zero; two-sided absolute studentized statistic	95% percentile-t interval	The complete firm-event block, including all years, routes, endpoint types, and weights, is resampled as one unit
Country-network bootstrap	Null that the external sensitive-minus-other content contrast equals zero; two-sided absolute studentized statistic	95% percentile-t interval	Endpoint countries are resampled and every pair incident to a sampled country enters with its induced multiplicity
Citation-specific wild cluster	Null that the citation sensitive-minus-other contrast equals zero; two-sided absolute studentized statistic	95% bootstrap-t interval	Directed citation rows remain together within affected country pair and patent family

Notes. Failed replications are nonconvergent resamples or resamples without both sides of a required contrast. P-values use the successful replications only and include the observed statistic in the numerator and denominator. The alternative procedures do not replace the paper's main inference. They address limited cluster counts and dependence that can extend across stacked events, endpoint relationships, and citation families. The coefficient scale is log points for PPML outcomes, percentage points for dissolution, and the model's native contrast scale for citation rates.

Constrained pseudo-events

Table A19. Constrained Pseudo-Events compares the observed statistics with treatment dates reassigned under the treatment-design constraints. The reassignment holds fixed country-pair eligibility, the number and cohort distribution of shocks, the eight-quarter standardization history, pre-shock portfolio definitions, and the later-shock rules. Each accepted assignment re-creates event time, comparison eligibility, common support, ATT weights for across-firm models, and PPML separation. Direct recomposition, destination expansion, prominence, and the external sensitive-minus-other contrast lie in the tails of their respective distributions. Endpoint and capacity estimates are less unusual, with empirical p-values of .061 and .071.

Table A19. Constrained Pseudo-Events

Panel A. Assignment protocol

Design element	Constraint
Country-pair risk set	Reassignment occurs only among quarters in which the same unordered country pair has complete GDELT history and is eligible for a first shock
Timing restrictions	The actual shock quarter and the eight quarters on either side are excluded; Q3/Q4 assignments move to the next patent application year
Margins maintained	Number of shocks, cohort-year counts, pre-shock event-volume decile, baseline conflict-share decile, and endpoint-country frequencies
Portfolios and outcomes	Fixed pre-shock relationship portfolios and observed patent outcomes do not change
Destination design	Qualification in years -6 through -4, comparison construction, common support, and ATT weights are recomputed for each accepted assignment
Endpoint design	Treatment-unweighted within-firm comparison is recomputed with endpoint types kept together
Acceptance	Both sides of every contrast must exist, the fixed-effect design must be identified, and PPML must converge after separation
Tail convention	Two-sided comparison of the absolute observed statistic with the absolute pseudo-event statistic

Table A19. (Continued)

Panel B. Pseudo-event distributions

Outcome	Observed statistic	Requested assignments	Successful assignments	Failures	Exceedances	Empirical p-value
Direct content recomposition	-0.188	1,999	1,999	0	5	.003
Destination expansion	0.103	1,999	1,999	0	11	.006
Endpoint-retaining contrast	0.061	1,999	1,999	0	121	.061
Prominence contrast, 0.27 versus 0.03	-0.067	1,999	1,999	0	35	.018
External sensitive-minus-other content contrast	-0.115	1,999	1,999	0	43	.022
Capacity-minus-breadth linear combination	0.095	1,999	1,999	0	141	.071

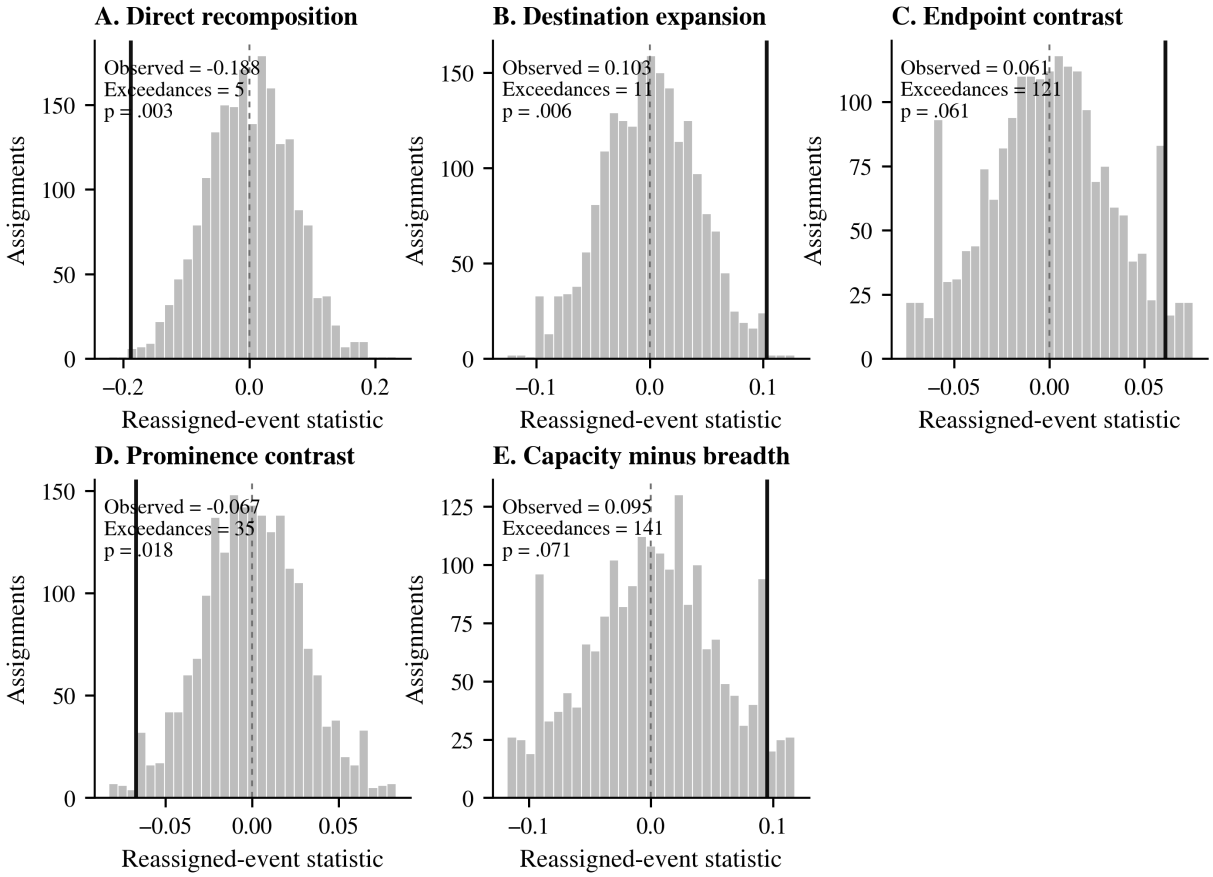
Panel B. Pseudo-event distributions (continued)

Outcome	Distribution mean	Standard deviation	2.5th percentile	Median	97.5th percentile	Seed
Direct content recomposition	0.000	0.068	-0.133	0.000	0.130	20262874
Destination expansion	0.000	0.042	-0.085	0.000	0.086	20262987
Endpoint-retaining contrast	0.000	0.034	-0.064	0.000	0.064	20262563
Prominence contrast, 0.27 versus 0.03	0.000	0.029	-0.061	0.000	0.062	20262770
External sensitive-minus-other content contrast	0.000	0.054	-0.107	0.000	0.106	20262611
Capacity-minus-breadth linear combination	0.001	0.055	-0.103	0.002	0.103	20262984

Notes. The empirical p-value is (1 + exceedances)/(1 + 1,999). An exceedance occurs when the absolute pseudo-event statistic is at least as large as the absolute observed statistic. Failures are assignments that do not meet the stated identification, support, or convergence rules. The direct, destination, endpoint, prominence, capacity, and external-content statistics use the same estimands, fixed effects, weights, censoring, and inference definitions as their main models. Figure A6 displays the five firm-level reassignment distributions; the external country-pair distribution is reported in Table A19.Figure A6. Constrained Pseudo-Event Distributions

Figure A6. Constrained Pseudo-Event Distributions shows the constrained pseudo-event distributions corresponding to Table A19. Constrained Pseudo-Events. Direct recomposition, destination expansion, and the prominence contrast fall in the tails of the reassignment distributions. Endpoint and capacity contrasts retain the expected signs but are less unusual under the constrained assignments.

Figure A6. Constrained Pseudo-Event Distributions



Notes. Histograms contain 1,999 successful assignments. Solid vertical lines mark observed statistics; dashed lines mark the reassignment means. P-values are two-sided and equal (1 + exceedances)/(1 + 1,999). The assignment preserves country-pair eligibility, cohort counts, standardization history, fixed portfolios, later-shock rules, and endpoint dependence. Across-firm assignments recompute common support and ATT weights; within-firm endpoint assignments remain treatment-unweighted. For the five displayed firm-level distributions, exceedances are 5, 11, 121, 35, and 141, producing p-values .003, .006, .061, .018, and .071. The external-content contrast has 43 exceedances and p=.022.

G. Patent-Equivalent Accounting and Sensitive-Share Checks

Patent-equivalent accounting and linear sensitive-share checks

Table A20. Patent-Equivalent Accounting and Linear Sensitive-Share Checks translates the earlier-window diagnostic content model into patent-equivalent accounting on its exact common sample. Each affected observation is predicted at its observed event time and again after setting the shock indicators to zero. Fixed effects, covariates, portfolio membership, and observation weights remain the same in the two states. The exercise predicts 6,699 fewer sensitive equivalents and 6,211 more other classified equivalents, an offset ratio of 92.7%. Because these predictions apply the model's relative counterfactual, they do not estimate an absolute transfer of patents, projects, personnel, or knowledge.

The linear sensitive-share check uses only relationship-years with positive total classified activity. The unweighted cell-average contrast is -3.7 percentage points. Weighting by total classified mass gives -4.4 percentage points. These conditional estimates resemble the -4.1 percentage-point PPML-predicted share change, but answer a different question because the PPML prediction retains zero component outcomes.

Table A20. Patent-Equivalent Accounting and Linear Sensitive-Share Checks
Panel A. Common-sample patent-equivalent accounting

Component	Counterfactual total with shock indicators set to zero	Predicted total at observed event time	Difference, patent equivalents	Difference per 100 counterfactual classified equivalents	95% confidence interval per 100	Share of sensitive contraction offset
Sensitive fractional patent equivalents	54,942	48,243	-6,699 (1,616) [<.001]	-4.23 (1.02) [<.001]	[-6.23, -2.23]	Not applicable
Other classified fractional patent equivalents	103,484	109,695	6,211 (1,949) [.001]	3.92 (1.23) [.001]	[1.51, 6.33]	92.7%
Total classified fractional patent equivalents	158,426	157,938	-488 (1,553) [.753]	-0.31 (0.98) [.753]	[-2.23, 1.61]	92.7% (18.6 pp) [95% CI 56.2%, 129.2%]

Table A20. (Continued)

Panel A. Common-sample patent-equivalent accounting (continued)

Paired prediction-difference covariance	Sensitive change	Other classified change	Net classified change
Sensitive change	2,611,456	-1,999,100	612,356
Other classified change	-1,999,100	3,798,601	1,799,501
Net classified change	612,356	1,799,501	2,411,857

Accounting metadata	Value
Estimation sample	1,182,404 firm-relationship-event-year-content observations; 591,202 relationship-years; 6,112 firms; 579 affected pairs
Prediction rule	Predict each affected observation under observed event time, then predict it after setting all post-shock indicators and post interactions to zero
Elements maintained across states	Content-specific fixed effects, covariates, sample membership, fractional patent allocation, relationship portfolio, and observation weights
Aggregation	Sum each content prediction once over affected observations, then add sensitive and other components
Uncertainty	Paired firm-event block bootstrap; 1,999 requested, 1,987 successful, 12 failures; seed 2026082001; percentile-t intervals
Scaling	Divide each component difference by 158,426 counterfactual classified equivalents and multiply by 100

Table A20. (Continued)

Panel B. Linear sensitive-share models conditional on positive classified activity

Model	Sensitive-share post contrast	90% confidence interval	95% confidence interval	Pre-shock sensitive-share mean	Relationship-year observations	Firms	Affected pairs	Fixed-effect cells	Adjusted R2
Unweighted cell-average model	-0.037 (0.009) [<.001]	[-0.052, -0.022]	[-0.055, -0.019]	0.371	238,916	5,887	568	34,822 firm-relationship-event; 39,404 firm-event-year	.624
Total-classified-mass-weighted sensitivity	-0.044 (0.008) [<.001]	[-0.057, -0.031]	[-0.060, -0.028]	0.356	238,916	5,887	568	34,822 firm-relationship-event; 39,404 firm-event-year	.661

Model	Sensitive-share post contrast	90% confidence interval	95% confidence interval	Pre-shock sensitive-share mean	Relationship-year observations	Firms	Affected pairs	Fixed-effect cells	Adjusted R2
Estimand feature			**Unweighted cell-average share**		**Mass-weighted sensitivity**		**PPML-predicted share in** Table A12. Complete Core Model Estimates and Regression Diagnostics		
Included relationship-years			Positive sensitive plus other classified activity		Same positive-total cells		All admitted cells, including zero component outcomes		
Observation influence			One relationship-year, one unit		Proportional to sensitive plus other classified fractional equivalents; weights normalized to mean one within firm-event		Determined by the two PPML mean functions and the common prediction sample		
Interpretation			Average within-cell change in the observed sensitive share		Change for a patent-mass-weighted positive cell		Change in the ratio of aggregated PPML predictions under observed and no-shock states		

Notes. Panel A implements observation-level counterfactual prediction rather than multiplying an aggregate sensitive share by the pooled coefficient. The source model includes content-specific firm-relationship-event and firm-event-year fixed effects and retains zero outcomes. The covariance table is in squared patent-equivalent units. The offset ratio is the increase in other classified equivalents divided by the absolute decline in sensitive equivalents. Its 18.6-percentage-point standard error and 95% interval are paired firm-event block-bootstrap results, not a delta-method calculation from the displayed covariance matrix; the interval can exceed 100% because both predicted components are estimated. Panel B estimates the sensitive share among relationship-years with positive total classified activity. It includes firm-relationship-event and firm-event-year fixed effects and two-way clusters standard errors by normalized legal assignee and affected country pair. The conditional share model has no PPML separation. The accounting and share checks translate the model's relative counterfactual and do not identify absolute patent or project transfers.

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