Technology Sanctions and Bank Credit Reallocation in China

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Abstract

We study how targeted geopolitical shocks transmit through domestic credit markets. Using a stacked difference-in-differences design based on U.S. technology sanctions on Chinese firms, we show that sanctions reallocate credit across lenders and firms. Commercial banks reduce lending to directly sanctioned firms, while the China Development Bank (CDB) expands credit to the same firms, partially offsetting the contraction in commercial-bank lending. Firms that are not directly sanctioned but operate in sanction-exposed technology domains receive more credit from both lender types. Cross-sectional heterogeneity reveals distinct lending motives: CDB credit responds more strongly to national strategic priorities, whereas commercial-bank lending reflects borrower risk and local financial conditions. These findings show that geopolitical shocks are transmitted not only through trade and technology restrictions, but also through domestic financial institutions that redistribute credit across firms and sectors.

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1 Introduction

Governments increasingly use control over trade, finance, and technology networks as instruments of geopolitical influence (Clayton et al., 2026). A prominent example is the use of technology sanctions and export-control designations to restrict foreign firms' access to strategically important inputs. Unlike conventional trade barriers, these restrictions target specific firms and technologies and limit access to specialized inputs that are difficult to replace. Such shocks can disrupt production, weaken supplier relationships, and force firms to invest in domestic technological adjustment. These margins require external finance precisely when affected firms become riskier borrowers. Firms facing restricted input access may need credit to replace suppliers, expand internal R&D, and sustain investment just as lenders reassess regulatory, compliance, and repayment risk.[1] Beyond directly targeted firms, these shocks may also affect firms operating in related technology domains, where lenders may reassess sector-wide regulatory risk or redirect credit toward potential domestic substitutes.

This paper studies how domestic financial structure shapes the incidence of targeted geopolitical shocks. The central idea is that sanctions affect firms not only by restricting access to foreign inputs, but also by altering the financing conditions under which firms respond to those restrictions. When sanctions raise regulatory, compliance, and repayment risks, market-based lenders may reduce exposure (Ahn and Ludema, 2020; Efing et al., 2023). State-backed lenders, by contrast, may be willing to absorb these risks when affected firms are important for strategic or technological capacity. Domestic finance can therefore become a shock-absorption mechanism. Policy credit may partly insure targeted firms against disruptions in commercial credit, while also reallocating resources toward related firms that can substitute for sanctioned firms. The incidence of sanctions therefore depends not only on the external restriction itself, but also on which domestic intermediaries are willing and able to finance adjustment.

U.S. technology sanctions against Chinese firms provide a setting in which this mechanism can be studied directly. The setting has three useful features. First, U.S. export-control designations generate sharp, externally imposed shocks to firms' access to foreign technology and inputs. Second, China's financial system contains both commercial banks and state-backed policy banks, especially the China Development Bank (CDB). CDB is China's largest policy bank and a major provider of long-term finance for infrastructure and strategic sectors. Its policy mandate allows us to examine whether state-backed credit absorbs geopolitical shocks differently from commercial-bank credit. Third, the

[1] Access to external finance is central to firm investment, innovation, and survival. A large literature shows that shocks to bank credit supply have substantial real effects when borrower fundamentals deteriorate or when intermediaries face capital and funding constraints (Khwaja and Mian, 2008; Chodorow-Reich, 2014; Amiti and Weinstein, 2018).

technology-specific nature of the sanctions allows us to distinguish between firms directly named on U.S. sanction lists and firms that are not sanctioned but operate in related technological domains.

Our empirical analysis combines loan-level borrowing data for Chinese listed firms with U.S. sanction designations and patent-based measures of technology exposure. We define exposure along two margins. Direct exposure is measured by matching firm-level entries on the Bureau of Industry and Security (BIS) Entity List and Military End-User List to Chinese A-share listed firms. Sectoral exposure captures firms that are not directly sanctioned but operate in technology domains linked to sanctioned entities. Following Han et al. (2024), we match BIS-listed entities to invention patents, classify these patents by International Patent Classification (IPC) code, and define each sanctioned entity's core technology category as the IPC class in which its patenting activity is most concentrated. Firms in these IPC categories are technologically proximate to targeted entities and may therefore be affected by changes in perceived regulatory risk, substitution opportunities, and credit reallocation within the same technology space.

A key empirical challenge is to separate the effect of sanctions from pre-existing differences across firms, technologies, and lenders. Sanctioned firms may differ systematically from other firms in ways that also affect borrowing. To address this concern, we exploit variation in the timing of U.S. sanction designations and compare changes in borrowing around these events. We estimate separate stacked difference-in-differences designs for directly sanctioned firms and sectorally exposed firms. The sample covers Chinese A-share listed firms from 2007 to 2024, excluding financial firms and firms without invention patent applications. In both designs, control observations include never-treated firms and not-yet-treated firms before their own exposure, consistent with the stacked event-time design. The specifications include cohort-firm fixed effects and cohort-year-industry-size fixed effects, so identification comes from changes around sanction events among firms in comparable cohort, year, industry, and size cells. To avoid contamination from prior exposure, we exclude firms associated with IPC technologies sanctioned before the sample begins.

The main finding is that state-backed finance partially absorbs the credit-market disruption created by technology sanctions. Among directly sanctioned firms, commercial-bank lending falls by about 72 percent after designation, while CDB lending rises by about 87 percent. In levels, however, the increase in CDB lending only partially offsets the decline in commercial-bank lending. State-backed credit therefore cushions, but does not fully replace, the contraction in commercial-bank credit. For sectorally exposed firms, the pattern is different. Firms that are not directly sanctioned but operate in sanction-exposed technology categories receive more credit from both lender types: CDB lending rises by about 37 percent, while commercial-bank lending rises by about 55 percent. These

results reveal two margins of financial transmission. Direct sanctions trigger a retreat by commercial banks and partial absorption by CDB. Sectoral exposure reallocates credit toward related firms that may benefit from substitution opportunities without bearing direct sanction risk.

The heterogeneity evidence supports the interpretation that lender responses reflect distinct institutional objectives. CDB lending expands more strongly toward firms in strategically important and national-security-related sectors. These patterns are consistent with a policy-bank mandate to support firms and technologies aligned with state priorities. Commercial-bank responses follow a different pattern. Among directly sanctioned firms, commercial-bank lending falls more sharply for younger and less profitable borrowers. Among sectorally exposed firms, commercial-bank lending increases less for younger and less profitable borrowers. Commercial banks also pull back less from directly sanctioned firms, and expand more toward related firms, in regions with deeper financial intermediation and stronger banking competition. These results suggest that policy-bank lending is shaped more by strategic considerations, while commercial-bank lending is shaped more by borrower risk and local credit-market conditions.

We next examine whether this financial absorption is associated with real firm adjustment. Directly targeted firms increase invention patenting and highly cited patenting after sanctions, suggesting an expansion of both innovation quantity and innovation with greater subsequent technological impact. These innovation responses are more strongly associated with CDB lending than with commercial-bank lending. Sectorally exposed firms show a more concentrated response, with gains mainly in high-impact innovation, again more closely associated with CDB lending. Complementary evidence on exploratory patents shows that directly targeted firms also expand innovation outside their familiar technology classes, especially when CDB lending is stronger. We interpret these results as evidence that state-backed credit is associated with technological adjustment under sanctions, not as causal estimates of lending on innovation.

Credit reallocation is also connected to firms' operational adjustment. Technology sanctions restrict access to foreign inputs, so affected firms may need to reorganize supplier relationships. Consistent with this margin, directly targeted firms lose more U.S. suppliers and add more Chinese suppliers after sanctions (Bei et al., 2025). They also broaden their supplier base and experience lower supply-chain stability, indicating that sanctions disrupt existing input relationships while inducing firms to rebuild production networks. These adjustments are more closely associated with CDB lending than with commercial-bank lending: firms receiving greater CDB credit diversify their supplier base more and experience a smaller decline in supply-chain stability. By contrast, sectorally exposed firms show weaker supply-chain responses, suggesting that operational restructuring is concentrated where sanctions directly disrupt supplier relationships.

We provide several exercises to support this interpretation. The first concern is whether BIS designations represent economically meaningful shocks, rather than formal regulatory labels with limited real content. We show that they do. After designation, directly targeted firms discuss sanctions more intensively in annual reports, and firms in sanctioned technology categories do so as well despite not being directly targeted. External assessments move in the same direction: media and investor sentiment deteriorate for directly targeted firms, while news and analyst tone worsen for sectorally exposed firms. Directly targeted firms also lose about 3 percent of market value around BIS announcements. These patterns indicate that sanction exposure changes both firms' own assessment of their operating environment and outside perceptions of their risk. The second concern is whether the lending results reflect differential trends or features of the empirical design. Event-study estimates show no evidence of differential pre-trends, and the results remain similar under sensitivity analyses that allow for moderate deviations from parallel trends (Rambachan and Roth, 2023). The estimates are also stable under conventional difference-in-differences specifications, inverse-probability reweighting based on observable firm characteristics, and alternative estimators for staggered treatment timing and heterogeneous treatment effects (Sun and Abraham, 2021). Finally, placebo exercises that randomly assign sanction exposure and bank-lending variables produce estimates centered around zero and fail to reproduce the baseline patterns.

The paper's central contribution is to identify a domestic financial transmission channel for geopolitical shocks. Existing work has emphasized how sanctions and export controls affect trade flows, input access, firm innovation, and supply-chain restructuring.[2] We show that these shocks also operate through domestic financial institutions. Commercial banks reduce lending to directly sanctioned firms as regulatory and compliance risks rise, while CDB, China's main policy bank for long-term strategic finance, expand lending to the same firms, partly absorbing the financing disruption. At the same time, credit shifts toward technologically related firms that are not directly targeted. The incidence of technology sanctions therefore depends not only on the external restriction itself, but also on the institutional organization of domestic credit markets.

More broadly, the results show that geopolitical fragmentation interacts with domestic financial structure in ways that shape firm adjustment. When lenders differ in objectives, constraints, and tolerance for regulatory risk, the same external shock can generate uneven patterns of financial support. State-linked finance may insure targeted firms against disruptions in commercial credit, but it also reallocates resources toward particular firms and technology areas. Technology sanctions therefore do more than restrict access to foreign inputs. They reshape domestic credit allocation, influence adjustment margins,

[2]Existing work has focused mainly on firms in the country imposing the controls. For example, Crosignani et al. (2026) show that U.S. export controls impose sizable costs on U.S. domestic suppliers through declines in market capitalization and profitability.

and determine how the costs and opportunities created by geopolitical fragmentation are distributed across the economy.

Related Literature. This paper contributes to several strands of literature. First, it adds to the literature on credit supply shocks and bank lending by studying U.S. technology sanctions as an externally imposed source of regulatory risk. A large literature studies credit contractions arising from financial crises, bank balance-sheet shocks, and regulatory changes (Khwaja and Mian, 2008; Chodorow-Reich, 2014; Amiti and Weinstein, 2018). More recent work shows that nonfinancial shocks tied to trade and geopolitics can weaken credit provision. Correa et al. (2023) find that trade-policy uncertainty leads exposed banks to tighten loan terms. Federico et al. (2025) document that trade liberalization can weaken bank balance sheets through higher nonperforming loans. Niepmann and Shen (2025) show that geopolitical risk reduces cross-border lending with spillovers to domestic credit. We complement this literature by showing that sanctions-driven regulatory risk changes not only the amount of credit supplied, but also how credit is reallocated across lenders and firms.

Second, the paper relates to the literature on state banking and government intervention in credit markets. Prior work shows that government-controlled banks expand lending around downturns and policy episodes, with important implications for credit allocation and real activity (La Porta et al., 2002; Sapienza, 2004; Carvalho, 2014; Coleman and Feler, 2015; Eslava and Freixas, 2021). Other studies highlight structural differences between government credit and commercial lending (Hu et al., 2022; Gong et al., 2023). In China, evidence using China Development Bank data suggests that policy-bank credit operates with objectives distinct from commercial lending and can propagate through industry and supply-chain linkages (Ru, 2018; Ru and Yang, 2025). We contribute by showing how policy-bank lending responds to an external geopolitical shock that raises the perceived regulatory risks of lending to sanctioned firms.

Third, the paper relates to a growing literature on the economic effects of geopolitical trade restrictions. One strand examines how state-backed finance responds to geopolitical shocks. For example, Chen et al. (2025) show that government venture capital remained more active than private venture capital in tariff-exposed industries during the U.S.-China tariff escalation. Another strand studies how sanctions and export controls affect targeted firms' adjustment margins (Huang et al., 2024; He and Lyu, 2025). Liu et al. (2025) show that export controls lead exposed firms to reduce imports of controlled inputs while increasing R&D and patenting. Han et al. (2024) document improved production efficiency and higher-quality output among upstream firms in China's sanctioned industries, while Zhang et al. (2026) examine how Entity List designations affect innovation, technology fields, and patents. Sanctions also reshape global production networks.

We contribute by showing that technology sanctions also reshape domestic bank credit allocation, shifting credit across lender types and across firms within sanction-exposed technology domains.

The remainder of the paper proceeds as follows. Section 2 provides institutional background on U.S. export-control designations and China's banking system. Section 3 describes the data and empirical strategy. Section 4 presents the main results on credit reallocation, while Section 5 examines associated firm adjustment. Section 6 presents validation and robustness evidence. Section 7 concludes.

2 Institutional Background

This section describes the institutional setting that motivates our empirical design. Two features are central. First, U.S. export-control measures target specific firms and technologies, creating sharp increases in regulatory and geopolitical risk. Second, China's banking system contains both commercial banks and state-backed policy banks, whose objectives and constraints differ. This combination allows us to study how the same geopolitical shock is transmitted through different domestic financial institutions.

2.1 U.S. Export Control Measures

Geopolitical competition has increasingly moved from broad trade barriers toward targeted regulatory instruments. Our analysis focuses on U.S. export-control policy administered by the Bureau of Industry and Security (BIS) under the Export Administration Regulations (EAR). These controls restrict foreign access to sensitive and dual-use technologies in order to protect U.S. national-security and foreign-policy interests. Recent measures have focused on advanced manufacturing equipment, semiconductors, aerospace components, artificial intelligence, and data-processing technologies. These sectors are central to both economic competitiveness and military modernization. Export controls therefore operate not simply as trade restrictions, but as instruments of strategic competition.

A key feature of BIS export controls is that they operate through firm-level designations rather than economy-wide bans. We focus on two designations codified in 15 CFR Part 744: the Entity List and the Military End-User (MEU) List. Firms placed on either list face legally binding restrictions on the export, re-export, and in-country transfer of U.S.-origin goods, software, and technology. The Entity List applies to firms and institutions viewed as posing risks to U.S. national-security or foreign-policy interests. Placement typically subjects transactions involving U.S.-origin items to licensing

requirements with a presumption of denial, sharply increasing uncertainty over future access to critical inputs. The MEU List applies to firms identified as military end users or as supporting military end uses, including firms that may otherwise operate as commercial entities. Although the two lists differ in scope, both raise regulatory exposure, restrict access to key technologies, and increase compliance risk for counterparties. We therefore treat exposure to either designation as a common sanction shock.

These designations are useful for our analysis because they are imposed for national-security and foreign-policy reasons rather than as responses to firm-level financial distress. They generate discrete changes in regulatory exposure that are plausibly unrelated to short-run changes in firms' borrowing demand or balance-sheet condition. Their effects, however, extend beyond the direct restriction on U.S.-origin inputs. Listing can also signal heightened scrutiny, greater compliance burdens, and an increased likelihood of future escalation. These risks may affect suppliers, customers, investors, and lenders even when the direct legal restriction applies only to a named firm.

The technology-specific nature of these designations is also important. Sanctions may affect not only directly named firms, but also other firms operating in related technology domains. These firms may face greater perceived regulatory risk because they are technologically proximate to sanctioned entities. At the same time, they may benefit if customers, suppliers, or lenders redirect resources toward domestic substitutes for targeted firms. This feature allows us to distinguish direct exposure from sectoral exposure and to examine whether sanctions reallocate credit within exposed technology spaces.

2.2 China's Banking System

China's banking system provides a useful setting for studying the domestic transmission of technology sanctions because it contains lenders with distinct institutional objectives. Policy banks operate alongside commercial banks. Although both provide credit to firms, they differ in mandate, funding structure, and tolerance for regulatory and geopolitical risk. These differences create scope for the same sanction shock to generate different lending responses across institutions.

Policy banks make this distinction especially clear. China has three national policy banks: the China Development Bank (CDB), the Export–Import Bank of China, and the Agricultural Development Bank of China. We focus on CDB because it is the policy bank most directly relevant for corporate credit allocation in the sectors exposed to technology sanctions. Established in 1994, CDB was created to advance national development objectives rather than maximize short-run profits. It is a major provider of long-term finance for infrastructure, industrial upgrading, technological self-reliance, and strategic-sector development. Its funding relies mainly on bond issuance with strong state backing rather

than retail deposits, making it less exposed to deposit withdrawals and local liquidity pressures than commercial banks.

CDB's mandate is closely aligned with the types of adjustment examined in this paper. Unlike the Export–Import Bank of China, whose role is more closely tied to trade finance, or the Agricultural Development Bank of China, whose mandate focuses on agriculture and rural development, CDB is central to long-term investment, infrastructure, and strategic industrial policy. Firms affected by U.S. technology sanctions are often concentrated in sectors such as advanced manufacturing, semiconductors, telecommunications equipment, and defense-related technologies. These are precisely the sectors in which state-backed credit may be used to sustain domestic capacity and reduce dependence on foreign technology.

Commercial banks face different incentives and constraints. China's commercial banking sector includes large state-owned commercial banks, national joint-stock commercial banks, and local city and rural commercial banks. Many commercial banks also have state ownership, so the distinction in this paper is not simply between public and private ownership. Rather, the relevant distinction is between policy mandate and commercial lending discipline. Commercial banks are more directly shaped by prudential regulation, capital requirements, internal risk controls, and performance metrics tied to profitability and balance-sheet quality. They are therefore more sensitive to borrower risk, compliance burdens, and supervisory scrutiny. When firms become subject to U.S. export controls, commercial banks may have stronger incentives to reduce exposure, delay lending, or shift credit toward safer borrowers.

These institutional differences imply that technology sanctions need not produce a uniform contraction in credit. For commercial banks, BIS designations raise regulatory uncertainty, compliance costs, and perceived repayment risk. These forces can reduce lending to directly sanctioned firms, especially those with weaker observable fundamentals. For CDB, the same shock may increase the rationale for continued or expanded lending if affected firms are important for national technological capacity. State-backed credit can therefore partly offset disruptions in commercial credit, while also redirecting resources toward firms and sectors aligned with strategic priorities.

The coexistence of commercial banks and policy banks is thus central to our empirical design. It allows us to ask whether domestic financial structure changes the incidence of geopolitical shocks. If sanctions operate only through borrower risk, both lender types should respond similarly. If lender objectives matter, commercial banks should react more strongly to risk and local financial conditions, while CDB should respond more strongly to strategic-sector considerations. The analysis below tests these predictions by comparing lending responses across lender types, directly sanctioned firms, and sectorally exposed firms.

2.3 Conceptual Framework

We present a simple framework to organize the empirical predictions. Consider a firm that is exposed to a foreign technology sanction. The sanction has two effects. First, it raises the firm's operating risk because access to foreign inputs becomes more uncertain. Second, it raises the firm's strategic value if the firm operates in a technology area that is important for domestic substitution or national industrial policy.

There are two types of lenders. A commercial bank chooses lending based on expected financial returns. A policy bank also values financial repayment, but places additional weight on the firm's strategic value. Let firm i borrow from lender $b \in \{C, P\}$, where C denotes a commercial bank and P denotes a policy bank. The lender's net payoff from lending can be written as

$$\Pi_{ib} = R_i - \lambda_b Risk_i + \theta_b Strategic_i,$$

where R_i is the expected financial return from lending, $Risk_i$ captures default, compliance, and regulatory risk, and $Strategic_i$ captures the firm's strategic value. Commercial banks place little or no weight on strategic value, so $\theta_C \approx 0$. Policy banks place greater weight on strategic value, so $\theta_P > \theta_C$.

A technology sanction increases both risk and strategic value. For commercial banks, the increase in risk dominates because they do not internalize strategic value. Hence, commercial-bank lending should fall for directly sanctioned firms:

$$\frac{\partial Lending_{iC}}{\partial Sanction_i} < 0.$$

For policy banks, the increase in strategic value can offset the increase in risk. Hence, policy-bank lending may rise, especially for firms in strategically important sectors:

$$\frac{\partial Lending_{iP}}{\partial Sanction_i} > 0$$

The same logic extends beyond directly sanctioned firms to firms that operate in related technology domains. These firms do not face the same direct compliance and input-access risk as sanctioned firms, but their strategic value rises because they may serve as domestic substitutes. Therefore, both policy banks and commercial banks may expand lending to these firms, although for different reasons. Policy banks expand lending because strategic value rises. Commercial banks expand lending because these firms may benefit from substitution opportunities without bearing the full direct sanction risk.

In sum, this framework yields three predictions. Direct sanctions should reduce commercial-bank lending but increase policy-bank lending. Policy-bank responses should

be strongest for strategically important firms, while commercial-bank responses should vary more with borrower risk and local credit-market conditions. Sectorally exposed firms should receive additional credit when lenders view them as potential domestic substitutes. These predictions guide the empirical analysis below.

3 Empirical Methodology and Data

This section describes the treatment construction, empirical design, and data. The analysis distinguishes two exposure margins. Direct exposure captures firms that are named on U.S. export-control lists. Sectoral exposure captures firms that are not directly designated but operate in technology domains linked to sanctioned entities. We estimate both margins using a stacked event-study design that compares changes in outcomes around sanction events among treated firms and comparable control firms.

3.1 Treatment Construction and Empirical Strategy

Our sample consists of Chinese A-share publicly traded firms from 2007 to 2024. We impose two sample restrictions. First, we exclude financial firms because their borrowing reflects both their own financing decisions and their role as credit intermediaries. Second, we exclude firms that never filed an invention patent application during the sample period, since these firms cannot be assigned meaningfully to technology domains. The resulting sample should therefore be interpreted as technology-active Chinese listed firms, rather than the full universe of listed firms. Within this sample, exposure is defined along two margins: direct exposure through firm-level BIS designation and sectoral exposure through sanction-exposed technology classes.

Direct Exposure. Treated firms in the direct-exposure analysis are Chinese listed firms, including subsidiaries, that appear on either of two BIS designation lists under the Export Administration Regulations: the Entity List and the Military End-User List. We merge the two lists and match designated entities to Chinese A-share firms. For each matched firm, we record the first date on which the firm or a matched subsidiary appears on either list. Because designations occur at different points in time, these events generate staggered changes in regulatory exposure across firms. Firms matched to first-time BIS designations form the treated group in the direct-exposure analysis.

Sectoral Exposure. Sectoral exposure captures indirect exposure among firms that are not themselves designated but operate in technology domains associated with sanctioned entities. To construct this measure, we link BIS-designated entities to China's patent

universe from the China National Intellectual Property Administration (CNIPA), following Han et al. (2024). Technology domains are defined using the first three digits of the International Patent Classification (IPC) code. Each BIS-designated entity is assigned to a primary IPC three-digit technology class, defined as the class in which its invention patenting activity is most concentrated. These entity-level classes define the set of sanction-exposed technology domains. To avoid conflating repeated designations within the same domain, we define exposure using the first year in which a given IPC three-digit technology class is linked to a sanctioned entity.

Firm-level technology exposure varies over time. In each year, we assign each sample firm to the IPC three-digit class in which it filed the largest number of invention patent applications over the previous five years. This rolling window captures the firm's recent technological focus while smoothing short-run fluctuations in patenting activity. Treated firms in the sectoral-exposure analysis are non-designated firms whose primary IPC three-digit class coincides with the primary technology class of at least one BIS-designated entity.

The sectoral-exposure design is intended to capture firms that may be indirectly affected by sanctions through technological proximity rather than direct legal designation. These firms may face greater perceived regulatory risk because they operate in technology domains associated with sanctioned entities. They may also receive additional credit if lenders redirect resources toward domestic substitutes within exposed technology spaces. We therefore interpret sectoral exposure as a technology-domain shock rather than as a firm-level sanction.

Control groups are defined within the same staggered-adoption framework. In the direct-exposure design, control firms are firms that never appear on the BIS lists, together with firms that have not yet been designated at a given point in time. In the sectoral-exposure design, control firms are firms whose primary technology class is never sanctioned, together with firms whose technology class has not yet been exposed by the relevant event time. In both designs, not-yet-treated firms serve as controls before their own treatment, consistent with the stacked event-time framework.

To ensure that technology-class exposure reflects shocks occurring within the sample period, we exclude firms associated with IPC three-digit technology codes sanctioned before 2007, namely E04, G01, and H01. These classes were sanctioned in 1997 and 2001, so including them would assign exposure on the basis of pre-sample regulatory actions. After these restrictions, the direct-exposure sample contains 143 treated firms and 3,479 control firms. The sectoral-exposure sample contains 1,289 treated firms and 3,221 control firms.

Table A.1 reports descriptive statistics by firm-size quartile for treated and control

firms. Within quartiles, treated and control firms are broadly similar in assets, operating revenue, and operating profit in both the direct- and sectoral-exposure samples. This balance motivates the use of cohort–year–industry–size fixed effects and helps ensure that identification comes from comparisons among firms of similar scale and operating fundamentals.

Empirical Specification. We estimate effects using stacked cohorts within a symmetric event window spanning three years before and three years after each sanction event, from $t-3$ to $t+3$. Events occurring within the same calendar year are grouped into a single cohort. For each cohort, treated firms associated with that event year are matched to the relevant set of control firms. Stacking all cohorts yields the final estimation sample. In the direct-exposure design, cohorts are defined by firm-level designation years. In the sectoral-exposure design, cohorts are defined by the first sanction year for each technology class.

We first estimate dynamic effects and assess pre-trends using the following stacked event-study specification:

$$y_{i,c,t} = \sum_{\tau \neq -1} \beta_\tau \, 1\{t - t_c = \tau\} \times \text{Treat}_{i,c} + \delta_{i,c} + \phi_{cpt} + \varepsilon_{i,c,t}, \tag{1}$$

where i indexes firms, c indexes cohorts, and t indexes calendar years. The indicator $\text{Treat}_{i,c}$ equals one for treated firms in cohort c and zero otherwise. The event year for cohort c is denoted by t_c, and τ indexes event time relative to the sanction year. The omitted reference period is $\tau = -1$. Cohort-firm fixed effects $\delta_{i,c}$ absorb time-invariant differences between treated and control firms within each cohort. Cohort-year-industry-size fixed effects ϕ_{cpt} absorb cohort-specific shocks and common time variation within narrowly defined comparison cells. Industry is based on firms' industry classifications, and size quartiles are constructed each year by sorting firms on total assets. Identification therefore comes from comparisons between treated and control firms within the same cohort, calendar year, industry, and firm-size quartile.

Average post-treatment effects are estimated using the following stacked difference-in-differences specification:

$$y_{i,c,t} = \beta \left(\text{Treat}_{i,c} \times \text{Post}_{c,t} \right) + \delta_{i,c} + \phi_{cpt} + \varepsilon_{i,c,t}, \tag{2}$$

where $\text{Post}_{c,t}$ equals one for years at or after the sanction year of cohort c and zero otherwise. In the direct-exposure design, $\text{Treat}_{i,c} \times \text{Post}_{c,t}$ corresponds to the interaction denoted in the tables as DTreat$\times$DPost. In the sectoral-exposure design, it corresponds to STreat $\times$ SPost. Equation (1) is used for dynamic event-study figures, while Equation (2) is used for baseline average post-treatment estimates. Standard errors are clustered at the

firm level. For count outcomes, we estimate Poisson models using the PPML approach of Correia et al. (2020).

3.2 Outcome Variables and Data Sources

This subsection defines the outcome variables and data sources. Table 1 reports descriptive statistics. Panel A reports the direct-exposure sample, which contains 83,568 firm-year observations. Panel B reports the sectoral-exposure sample, which contains 101,350 firm-year observations. In both panels, the unit of observation is the firm-year.[3]

[Insert Table 1 here]

Credit allocation and loan outcomes. Our main outcomes are new borrowing from policy and commercial banks. We construct these measures from transaction-level borrowing disclosures on CNINFO, the platform designated by the China Securities Regulatory Commission for listed-firm filings and major contract announcements. These disclosures report the contract date, lender identity, and loan amount, allowing us to distinguish policy-bank from commercial-bank borrowing at the transaction level. To build the lending dataset, we scrape the full universe of listed-firm announcements, identify loan-related disclosures using rule-based text filters and large-language-model classification, and manually verify each disclosure to obtain the exact loan amount and lender identity.

We aggregate loan amounts to the firm-year level and construct two variables. *CDB* is new borrowing from the China Development Bank. *CBL* is new borrowing from commercial banks. Both variables are measured in RMB million. Commercial-bank borrowing is substantially larger than CDB borrowing in both samples. In the direct-exposure sample, mean annual borrowing is 27.8 million RMB from CDB and 1,207 million RMB from commercial banks. In the sectoral-exposure sample, the corresponding figures are 32.2 million RMB and 1,165.5 million RMB. These magnitudes show that commercial-bank lending is the dominant source of external bank finance, while CDB lending is smaller in absolute terms but institutionally important for long-term and strategic-sector finance.

Innovation outcomes. Patent data serve two purposes: assigning firms to technology domains in the sectoral-exposure design and measuring innovative activity. Patent application data come from CNIPA, and citation data come from Google Patents. *Invention Patents* measures innovation quantity and is defined as the number of invention patent

[3]The number of observations varies across variables because some accounting and operating items are unavailable for all firm-years.

applications filed by a firm in a year. *High-Cited Patents* measures innovation quality and is defined as the number of invention patent applications whose forward citations rank in the top 10 percent within the same technology class-year, excluding patents with zero citations. *Exploratory Patents* measures innovation outside the firm's existing technology base. It is defined as patent applications outside the firm's familiar IPC-based technology-class pool, where the familiar pool consists of IPC three-digit classes in which the firm had filed patents before the current year.

The descriptive statistics show that firms file, on average, 19.8 invention patent applications per firm-year in the direct-exposure sample and 16.7 in the sectoral-exposure sample. Exploratory patents are less frequent, with means of 0.53 and 0.68, respectively. Highly cited patents are rarer, with means of 0.51 and 0.59.

Supply-chain adjustment. To measure supplier reorganization, we use customer-supplier data from FactSet Revere. Each record includes customer and supplier identifiers, as well as relationship start and end dates. Following Crosignani et al. (2023), we remove duplicate records when a longer relationship exists between the same firm pair and merge multiple relationships into a single continuous relationship when the gap between relationships is shorter than six months.

We construct two firm-year measures of supplier reallocation. *U.S. Supplier Exits* is the number of terminated relationships with U.S. suppliers. *New Chinese Suppliers* is the number of newly added Chinese suppliers. These events are relatively infrequent: the average firm-year has 0.018 U.S. supplier exits and 0.067 new Chinese suppliers in the direct-exposure sample, compared with 0.013 and 0.056 in the sectoral-exposure sample.

We also examine broader changes in supply-chain structure. *Supplier Diversification* measures the breadth of a firm's supplier base, proxied by the number of suppliers in FactSet Revere. *Supply Chain Stability* captures the persistence of major supplier and customer relationships, measured as the average stability of a firm's top-five suppliers and top-five customers from CSMAR. Supplier stability is defined as the share of current top-five suppliers that also appeared in the previous year; customer stability is defined analogously. *Supplier Diversification* averages 1.159 in the direct-exposure sample and 1.094 in the sectoral-exposure sample, while *Supply Chain Stability* averages 0.856 and 0.847, respectively.

Firm fundamentals. We measure firm fundamentals using accounting data from CSMAR. *Asset* is the natural logarithm of total assets. *Income* is the natural logarithm of operating revenue. *Profit* is the natural logarithm of operating profit. The underlying accounting values are measured in RMB million. The two samples are similar along these dimensions.

4 Empirical Results

This section presents the main empirical results. First, we show that U.S. technology sanctions reallocate bank credit across lender types and firms. Directly targeted firms lose commercial-bank credit but receive more CDB credit, while sectorally exposed firms receive more credit from both lender types. We then examine whether these patterns reflect differences in lender objectives by studying heterogeneity across strategic and industrial-policy priorities, as well as borrower risk and local financial conditions.

4.1 Bank Lending Responses

We begin with directly targeted firms. Figure 1 reports the event-study estimates, with Panel A showing CDB lending and Panel B showing commercial-bank lending. The pre-event coefficients are close to zero and statistically insignificant in both panels, providing no evidence of differential pre-trends. The lending responses emerge only after BIS designation, consistent with sanctions operating as discrete shocks to financing conditions. Once firms become subject to the sanctions, CDB lending rises steadily and continues to build through $t = 3$. Commercial-bank lending, by contrast, falls sharply, with the largest contraction around $t = 1$ and only partial recovery thereafter. The dynamic evidence points to a change in the composition of credit, away from commercial banks and toward policy-bank lending, rather than a uniform decline in external finance.

[Insert Figure 1 here]

Table 2 reports the corresponding average post-treatment effects. Columns (1) and (2) show that, after firms are sanctioned, CDB lending to directly targeted firms rises by approximately 87 percent, or 0.626 log points, significant at the 5 percent level. Commercial-bank lending falls by approximately 72 percent, or -1.286 log points, also significant at the 5 percent level. In levels, Online Appendix Table A.2 shows that CDB lending increases by 0.142 billion RMB, while commercial-bank lending declines by 1.174 billion RMB. Thus, the rise in CDB lending partly offsets, but does not fully replace, the contraction in commercial-bank credit. The magnitudes are economically large and indicate substantial substitution from market-based credit toward policy-bank credit once a firm is directly targeted. This pattern is consistent with sanctions raising compliance, enforcement, and reputational risks for commercial lenders, while CDB lending expands to cushion the financing shock.

[Insert Table 2 here]

The pattern differs for firms that are not directly targeted but operate in sanctioned technology categories. Panels C and D of Figure 1 report the event-study estimates for these sectorally exposed firms. The pre-event coefficients again provide no evidence of differential pre-trends. After exposure, borrowing rises from both lender types. CDB lending increases after the event, peaks early, and remains positive at longer horizons. Commercial-bank lending also rises, with effects becoming more pronounced at $t = 2$ and $t = 3$. For sectorally exposed firms, the evidence points to credit expansion rather than tightening.

Columns (3) and (4) of Table 2 confirm this pattern. CDB lending to sectorally exposed firms increases by approximately 37 percent, or 0.312 log points, significant at the 1 percent level. Commercial-bank lending increases by approximately 55 percent, or 0.438 log points, significant at the 10 percent level. In levels, Online Appendix Table A.2 shows that CDB lending increases by 0.033 billion RMB, while commercial-bank lending increases by 0.126 billion RMB. These estimates are difficult to reconcile with a generalized credit contraction across exposed technology domains. Instead, they indicate that credit is redirected toward related firms that may substitute for directly targeted firms without carrying the same direct sanction risk.

4.2 Heterogeneity in Credit Reallocation

The baseline results show that U.S. technology sanctions reallocate credit across lender types and firms. Directly targeted firms lose commercial-bank credit but receive more CDB credit, while firms in sanction-exposed technology domains receive more credit from both lender types. We next ask whether this reallocation reflects distinct lender objectives. If CDB lending is shaped by policy mandates, its response should vary most strongly with firms' strategic importance. If commercial-bank lending is shaped by market-based screening, its response should vary more with borrower risk and local credit-market capacity.

We therefore estimate heterogeneous effects by extending Equation (2) to interact the treatment effect with predetermined firm, industry, and regional characteristics using terms of the form Treat $\times$ Post $\times$ Z_i. The coefficient on the triple interaction captures whether the post-sanction lending response differs systematically across firms with characteristic Z_i. These cross-sectional patterns allow us to assess whether policy-bank and commercial-bank credit respond to sanctions along the dimensions predicted by their institutional objectives.

National strategy. We begin by examining whether lending responses vary with firms' alignment with national strategic priorities. This test is motivated by the institutional

role of CDB. If policy-bank lending reflects state priorities, CDB should respond more strongly when sanctioned or sectorally exposed firms operate in sectors viewed as important for technological upgrading, industrial security, or national resilience. By contrast, if commercial-bank responses are driven mainly by borrower risk and profitability, they need not vary systematically with these strategic classifications.

We use two indicators to capture different dimensions of strategic alignment. The first measure, *Strategic Industry*, captures whether a firm operates in industries prioritized for technological upgrading and long-run industrial competitiveness. These industries are central to China's industrial-policy agenda because they are associated with advanced manufacturing, innovation capacity, and technological self-reliance. Operationally, *Strategic Industry* equals one if a firm belongs to a strategic emerging industry covered by the China Strategic Emerging Industries Composite Index. This index is compiled by the China Securities Index Company (CSI) based on the Chinese government's classification of strategic emerging industries and tracks firms operating in these priority sectors.

The second measure, *National Security*, captures a narrower form of strategic importance: whether a firm's products are linked to national-security-related activities. This measure identifies firms whose operations may be important for defense capacity, critical infrastructure, or strategic resilience. Following Zheng and Zhang (2025), we classify firms as national-security-related using keywords from firms' main-product descriptions, including military, aerospace, electric power, communications, aviation, and shipbuilding. *National Security* equals one for firms classified into these sectors. Together, these two measures allow us to test whether CDB lending responds more strongly to firms whose activities are more closely aligned with state priorities.

Our results support the policy-mandate interpretation. Panel A reports the direct-exposure results. In Columns (1) and (2), the triple interactions between direct exposure and the strategic indicators are positive and statistically significant for CDB lending. The post-sanction increase in CDB lending is 1.385 log points larger for firms in strategic emerging industries and 1.697 log points larger for firms in national-security-related sectors. These effects are economically large and indicate that CDB lending responds especially strongly when directly sanctioned firms are connected to state-priority sectors. In contrast, Columns (3) and (4) show that the corresponding interactions for commercial-bank lending are small and statistically insignificant. Commercial banks therefore do not expand lending differentially toward strategically important directly targeted firms.

[Insert Table 3 here]

Panel B shows a similar pattern for sectoral exposure. Within sanction-exposed technology domains, CDB lending expands more strongly toward firms in strategically important sectors. The interaction between sectoral exposure and *Strategic Industry* is 0.431,

while the interaction with *National Security* is 0.480; both are statistically significant. The corresponding interactions for commercial-bank lending are negative or close to zero and statistically insignificant. Thus, even among firms that are not directly sanctioned, CDB credit is directed more strongly toward firms whose technologies are closer to national strategic priorities.

Online Appendix Table A.3 provides a complementary test using China's industrial-policy priorities. We classify firms by matching their industry classifications to sectors explicitly encouraged or prioritized in China's Eleventh through Fourteenth Five-Year Plans. These classifications capture industries singled out by the state for upgrading, technological development, and policy support. The results reinforce the national-strategy evidence. CDB lending expands more strongly toward firms in policy-prioritized industries, both among directly targeted firms and among sectorally exposed firms. Commercial-bank lending does not exhibit a comparable pattern. These results suggest that CDB credit is allocated in ways that track state-priority considerations, while commercial-bank lending follows a different allocation logic.

Borrower risk. We next examine whether lending responses vary with borrower risk. Table 4 interacts the treatment effect with two firm-level risk indicators. *Low ROA* equals one for firms below the industry-year median return on assets, where ROA is calculated as lagged net profit divided by lagged total assets. *Young* equals one for firms below the industry-year median firm age, measured by years since establishment. These variables capture firms that are likely to appear riskier from the perspective of commercial lenders.

Table 4 shows that commercial-bank lending is substantially more sensitive to borrower risk than CDB lending. Panel A reports the direct-exposure results. For CDB lending, the interactions with *Low ROA* and *Young* are negative but statistically insignificant, suggesting that CDB support does not vary systematically with these risk proxies. Commercial-bank lending shows the opposite pattern. The interaction between direct exposure and *Low ROA* is -1.979, indicating that lending falls substantially more for firms with weaker profitability. Similarly, the interaction with *Young* is -1.797, implying larger contractions for younger firms. Both effects are statistically significant at the 5 percent level.

[Insert Table 4 here]

Panel B shows similar results for sectorally exposed firms. The interactions with *Low ROA* and *Young* remain statistically insignificant for CDB lending. Commercial-bank lending, however, expands significantly less for riskier firms within sanction-exposed technology categories. The interaction with *Low ROA* is -0.826, while the interaction with *Young* is -0.940, both statistically significant at the 5 percent level. These findings

suggest that commercial banks condition their lending responses strongly on borrower risk, whereas CDB lending is comparatively insensitive to these dimensions.

As a further test, we examine whether commercial-bank responses vary with local credit-market strength. Commercial banks should be more willing to absorb sanction-related risk where there is stronger competitive pressure and local markets provide greater lending capacity. Online Appendix Table A.4 interacts the treatment effect with two measures of local credit-market strength. The first is bank competition. Using bank-branch licensing data from the China Banking Regulatory Commission, we calculate each commercial bank's city-year branch count and construct a city-year Herfindahl-Hirschman Index for the commercial banking sector. The second is loan-to-deposit deviation. Following Aguirregabiria et al. (2025), this measure captures whether a city receives more lending than its deposit base would predict, with higher values indicating stronger local credit provision. We therefore expect commercial banks to reduce lending less to directly targeted firms and expand lending more to sectorally exposed firms in stronger local credit markets. By contrast, CDB lending should be less sensitive to these conditions because its funding and mandate are organized at the national level.

The results are consistent with this interpretation. Commercial-bank responses are more favorable in regions with stronger local credit-market conditions: lending contractions to directly targeted firms are weaker, and lending expansions to sectorally exposed firms are stronger. CDB lending, by contrast, does not vary systematically with these local conditions. These patterns further support the interpretation that commercial banks respond to market conditions, while CDB lending is less tied to local financial-market variation.

Overall, the heterogeneity evidence reveals a clear distinction between policy-oriented and commercial-bank lending under U.S. technology sanctions. CDB lending responds more strongly to firms aligned with national strategic and industrial-policy priorities, but does not vary systematically with borrower risk or local financial conditions. Commercial-bank lending displays the opposite pattern. Its responses depend strongly on borrower profitability, firm age, bank competition, and financing support, but not on strategic alignment. These findings support the interpretation that policy-bank and commercial-bank credit allocation follow distinct institutional objectives under geopolitical stress.

5 Real Adjustment and Credit Reallocation

This section examines whether the credit reallocations documented above are accompanied by real firm adjustment. The lending results show that technology sanctions change the composition of credit across lender types: commercial banks reduce lending to directly

targeted firms, while CDB expands lending to directly targeted and sectorally exposed firms. We now ask whether these credit reallocations are associated with changes in the activities through which firms respond to sanctions.

We focus on two adjustment margins that are directly relevant under technology sanctions: innovation and supply-chain restructuring. Innovation reflects firms' efforts to build internal technological capacity when access to foreign inputs becomes restricted. Supply-chain restructuring reflects efforts to replace disrupted input relationships and reorganize production networks. Both activities are likely to require external finance. Innovation involves sustained R&D investment under uncertainty, while supplier substitution requires search, contracting, certification, and retooling costs. If credit reallocation is connected to firm adjustment, firms receiving greater credit after sanctions should exhibit stronger responses along these margins.

The analysis should be interpreted as evidence on associated real adjustment rather than as an isolated causal effect of lending. Credit allocation is itself part of firms' response to sanctions, and lenders may direct credit toward firms with stronger expected adjustment capacity. The goal of this section is therefore not to instrument for lending, but to show whether the credit reallocation documented above is connected to economically meaningful changes in firms' technological and operational behavior.

5.1 Innovation Response to Credit Reallocation

Innovation is a natural adjustment margin under technology sanctions. Restrictions on foreign technology and inputs increase incentives for firms to substitute toward internal R&D and domestic technological upgrading. Whether firms can adjust along these dimensions may depend on financing conditions. We therefore examine whether innovation responses after sanctions vary systematically with the composition of credit.

We use two patent outcomes. *Invention Patents* counts the number of invention patent applications filed by a firm in a year. *High-Cited Patents* captures higher-impact innovation and is defined as invention patent applications whose forward citations rank in the top 10 percent within the same technology class-year. To examine whether innovation responses vary with lending composition, we estimate PPML specifications within the stacked design. We first estimate whether innovation changes after sanction exposure. We then interact sanction exposure with CDB and commercial-bank lending to examine whether the post-sanction innovation response is stronger among firms receiving different types of credit. Table 5 reports the results. Panel A focuses on directly sanctioned firms, while Panel B focuses on firms in sanction-exposed technology domains.

[Insert Table 5 here]

Direct exposure. Directly targeted firms increase both invention patenting and high-impact innovation after sanctions. Columns (1) to (3) show that invention patenting rises following direct exposure. The coefficient on DTreat × DPost ranges from 0.769 to 0.826 across specifications and is statistically significant at the 1 percent level throughout. Interpreted as semi-elasticities in the PPML framework, these estimates imply economically large increases in invention patenting activity after sanctions.

The increase in high-impact innovation is similarly strong. Columns (4) to (6) show that high-cited patents increase by between 0.740 and 0.977 following direct exposure, with all estimates statistically significant. Thus, directly targeted firms do not merely increase patent quantity. They also produce more innovation with high subsequent technological influence. These results indicate that direct sanctions are associated with broad technological upgrading among targeted firms.

The lending interactions show that this innovation response is more closely associated with CDB lending than with commercial-bank lending. In Column (2), the interaction between direct exposure and CDB lending is 0.027 and statistically significant at the 5 percent level. This implies that the increase in invention patenting is larger among firms receiving greater CDB credit after sanctions. The relationship is stronger for high-impact innovation. Column (5) shows that the interaction between direct exposure and CDB lending is 0.082 for high-cited patents, significant at the 5 percent level. These estimates suggest that firms with greater CDB lending exhibit stronger increases in technologically influential innovation after sanctions.

Commercial-bank lending displays a weaker and more selective relationship with innovation adjustment. The interaction between direct exposure and commercial-bank lending is small and statistically insignificant for invention patents in Column (3), with a coefficient of 0.008. For high-cited patents, the interaction is positive and statistically significant. Column (6) reports a coefficient of 0.035, significant at the 5 percent level. This result should be interpreted together with the earlier evidence that commercial-bank lending falls sharply after direct exposure. Firms that retain more commercial-bank credit after sanctions may be stronger borrowers or firms with better innovation prospects, which could help explain why commercial-bank lending is associated with high-impact patenting but not with broader invention patenting. Compared with CDB lending, however, commercial-bank credit does not display a consistent relationship with innovation across both patent outcomes.

Sectoral exposure. The innovation response among sectorally exposed firms is smaller and more concentrated than for directly targeted firms. Invention patenting increases modestly in the baseline specification. Column (1) reports a coefficient of 0.107, statistically significant at the 10 percent level. Once lending interactions are introduced in

Columns (2) and (3), however, the average treatment effect becomes statistically insignificant. This pattern suggests that innovation responses among sectorally exposed firms are more heterogeneous than among directly targeted firms.

The response is stronger for high-impact innovation. Columns (4) to (6) show that high-cited patents increase substantially following sectoral exposure, with coefficients ranging from 0.435 to 0.692. These estimates remain statistically significant, and the coefficient in Column (6) is significant at the 1 percent level. Thus, sectoral exposure is associated less with broad increases in patenting activity than with increases in technologically influential innovation.

CDB lending again appears closely related to this adjustment. Column (2) shows that the interaction between sectoral exposure and CDB lending is 0.009 for invention patents, statistically significant at the 5 percent level. For high-cited patents, the interaction rises to 0.039 in Column (5), significant at the 1 percent level. These results suggest that, among firms operating in sanction-exposed technology domains, CDB lending is associated with stronger substantive and high-impact innovation responses.

Commercial-bank lending displays a different pattern. The interaction between sectoral exposure and commercial-bank lending is close to zero and statistically insignificant for invention patents in Column (3). For high-cited patents, the interaction is negative and statistically significant. Column (6) reports a coefficient of -0.020, significant at the 5 percent level. This pattern is consistent with the idea that commercial-bank lending to sectorally exposed firms is directed more toward safer or shorter-horizon borrowers rather than toward firms undertaking frontier technological adjustment. Because lending is endogenous, this result should be interpreted as a difference in the allocation of credit across firms rather than as evidence that commercial-bank lending reduces innovation.

Online Appendix Table A.5 reports complementary evidence using exploratory patents, defined as patent applications outside a firm's familiar IPC technology classes. The results are broadly consistent with the main innovation evidence. Directly targeted firms expand exploratory innovation after sanctions, and this response is more strongly associated with CDB lending than with commercial-bank lending. This finding reinforces the interpretation that policy-bank credit is associated with technological adjustment under sanctions, especially along margins that require firms to move beyond their existing technology base.

Overall, Table 5 shows that innovation responses under technology sanctions vary systematically with the composition of credit. Directly targeted firms increase both invention and high-cited patenting, while sectorally exposed firms mainly exhibit gains in high-impact innovation. Across both exposure margins, CDB lending is more consistently associated with stronger innovation responses. Commercial-bank lending plays a more

limited and selective role. These patterns should not be interpreted as causal estimates of lending on innovation. Rather, they show that state-backed credit is allocated toward firms undertaking stronger technological adjustment under sanctions.

5.2 Supply-Chain Adjustment to Credit Reallocation

Innovation is one margin of adjustment to technology sanctions. Another is the reorganization of production networks. Export controls can disrupt access to foreign suppliers, forcing firms to replace input relationships and rebuild supplier networks. Online Appendix Table A.6 provides direct evidence on this margin. Directly targeted firms experience more U.S. supplier exits and form more new Chinese supplier relationships after sanctions, consistent with domestic supplier substitution. We use this evidence as motivation for the main analysis below, which examines whether these supplier changes are reflected in broader supply-chain structure and whether this restructuring varies with the composition of bank credit.

Table 6 focuses on two broader measures of production-network adjustment. *Supplier Diversification* measures the breadth of a firm's supplier base, proxied by the number of suppliers. *Supply Chain Stability* measures the persistence of major supplier and customer relationships, defined as the average stability of a firm's top-five suppliers and top-five customers. Panel A presents direct-exposure estimates, while Panel B presents sectoral-exposure estimates. Supplier diversification is estimated using PPML because it is a count outcome, while supply-chain stability is estimated using linear regressions.

[Insert Table 6 here]

The main adjustment is concentrated among directly targeted firms. In Panel A, directly targeted firms increase supplier diversification after sanctions. The baseline coefficient on DTreat $\times$ DPost is 0.288 in Column (1), significant at the 5 percent level. Direct exposure is also associated with lower supply-chain stability. The coefficients in Columns (4) to (6) range from -0.040 to -0.044 and are statistically significant. These patterns indicate that sanctions disrupt existing supplier and customer relationships while inducing firms to broaden their supplier base.

The credit interactions show that CDB lending is closely associated with this restructuring. For supplier diversification, the interaction between direct exposure and Log(CDB) is 0.072 in Column (2), significant at the 1 percent level. For supply-chain stability, the interaction between direct exposure and Log(CDB) is 0.004 in Column (5), significant at the 5 percent level. These estimates imply that directly targeted firms with greater CDB lending diversify their supplier base more and experience a smaller decline

in supply-chain stability after sanctions. Commercial-bank lending does not show comparable interactions for either outcome. Thus, production-network adjustment under direct exposure is more closely associated with policy-bank credit than with commercial-bank credit.

For sectorally exposed firms, supply-chain adjustment is weaker. In Panel B, the coefficients on STreat × SPost are statistically insignificant for both supplier diversification and supply-chain stability. CDB lending also does not significantly moderate either outcome. The only significant interaction is between sectoral exposure and commercial-bank lending in Column (6), where the coefficient is 0.002 for supply-chain stability. This suggests that, among firms exposed through related technology categories, commercial-bank lending is associated with slightly more stable supplier and customer relationships. However, sectoral exposure does not generate the broader production-network restructuring observed among directly targeted firms.

The appendix evidence helps interpret the main results. Online Appendix Table A.6 shows that directly targeted firms experience more U.S. supplier exits, with coefficients ranging from 1.978 to 2.179, and form more new Chinese supplier relationships, with coefficients ranging from 1.072 to 1.568. Both sets of estimates are significant at the 1 percent level. New Chinese supplier formation is also positively associated with CDB lending, with an interaction coefficient of 0.075, significant at the 5 percent level, while commercial-bank lending does not show a comparable association. For sectorally exposed firms, supplier entry and exit responses are statistically insignificant. These patterns indicate that the broader restructuring in Table 6 is concentrated where sanctions directly disrupt supplier relationships.

Taken together, the supply-chain evidence shows that direct sanctions are associated with meaningful operational adjustment. Directly targeted firms lose U.S. suppliers, add Chinese suppliers, broaden their supplier base, and experience disruption in existing supply-chain relationships. CDB lending is associated with domestic supplier formation, stronger supplier diversification, and partial stabilization of supply-chain relationships, while commercial-bank lending plays a more limited role. These results should be interpreted as evidence that CDB credit is allocated toward firms undergoing operational restructuring, not as causal estimates of lending on supply-chain adjustment.

6 Discussion

This section provides evidence on interpretation and robustness. The empirical design requires BIS events to represent economically meaningful shocks rather than purely formal regulatory changes. It also requires the credit reallocation results to be robust to alter-

native specifications and identifying assumptions. We address these issues in two steps. First, we show that sanction exposure changes how firms and outside observers assess affected firms. Second, we show that the main lending results are stable across alternative regression models, placebo exercises, and checks for parallel trends and staggered treatment timing.

6.1 Validation of Sanction Exposure

We begin by validating that BIS designations and category-level sanction events generate detectable changes in perceived regulatory exposure. If these events are economically meaningful, they should affect not only formal legal status, but also firms' own disclosures, external assessments, and market valuations. We examine this prediction using three complementary exercises.

Internal perception. The first exercise examines whether firms discuss U.S. export controls more intensively after sanction exposure. We measure perceived exposure using text from the Management Discussion and Analysis sections of firms' annual reports from CNINFO. Sanction-related language is identified using a Chinese keyword dictionary that captures export controls, technology restrictions, the Entity List, bans, and geopolitical risk. The full dictionary is reported in Online Appendix Table A.7. We construct two measures. *Technology Sanctions Frequency* is defined as $\ln(1+\text{count})$, where count is the number of sanction-related terms in the MD&A. *Technology Sanctions Intensity* scales this count by disclosure length and measures the prominence of sanction-related discussion in the report.[4]

Table 7 reports stacked difference-in-differences estimates using these disclosure measures as dependent variables. The specification follows Equation (2), replacing the lending outcomes with *Technology Sanctions Frequency* and *Technology Sanctions Intensity*. Columns (1) and (2) focus on direct exposure. After BIS designation, directly targeted firms increase *Technology Sanctions Frequency* by 0.092, significant at the 10 percent level, and *Technology Sanctions Intensity* by 0.006, significant at the 5 percent level. The frequency estimate corresponds to roughly a 9.6 percent increase in sanction-related language. These results indicate that direct exposure changes how firms describe their operating environment.

[Insert Table 7 here]

Columns (3) and (4) examine sectoral exposure. Firms operating in sanctioned technology categories increase *Technology Sanctions Frequency* by 0.035 and *Technology Sanc-*

[4]Online Appendix Table A.8 reports summary statistics for the additional disclosure, sentiment, market-reaction, and robustness variables used in the validation exercises.

tions Intensity by 0.002, both significant at the 5 percent level. The smaller magnitudes are consistent with the more indirect nature of category-level exposure. Importantly, however, firms that are not directly targeted still discuss sanction-related risks more intensively once their technology domain becomes exposed. This evidence supports the sectoral-exposure measure by showing that firms selected through technological proximity perceive a change in their regulatory environment.

These results help address a central concern in the sectoral-exposure design. The measure assigns firms to treatment based on technological proximity to BIS-targeted entities, rather than direct legal designation. Such proximity could in principle reflect arbitrary overlap in technology classes. The disclosure results show that this is not merely a mechanical classification: firms in exposed technology domains begin to discuss sanction-related risks more intensively after their domain becomes exposed. Online Appendix Figure A.1 provides a placebo test in which sanction-related disclosure is randomly reassigned across firms and the baseline specification is re-estimated 1,000 times. The placebo estimates are centered around zero and do not resemble the observed coefficients, suggesting that the increase in sanction-related disclosure is unlikely to reflect random variation in annual-report language.

External perception. We next examine whether sanction exposure changes how outside observers assess exposed firms. This test is important because the lending results are interpreted as responses to heightened regulatory, compliance, and cash-flow risk. If external observers also revise their assessments after sanction exposure, the lending response is more plausibly linked to changing perceived risk rather than unrelated contemporaneous shocks.

We measure external perception using three net-negativity outcomes from the China National Research Data Service. *Negative News* is the net share of negative media coverage, defined as negative news minus positive news divided by total news. *Negative Comment* is constructed analogously using stock-forum posts. *Negative Tone* is the net share of negative sentences in analyst reports. These measures are aggregated to the firm-year level and constructed using supervised sentiment classifiers trained on manually labeled corpora.

Table 8 reports the results. Panel A shows that direct exposure worsens public-facing sentiment. After BIS designation, negative media coverage rises by 0.042 and negative investor-forum sentiment rises by 0.019, both significant at the 1 percent level. Analyst tone does not change significantly. This pattern suggests that direct exposure generates an immediate deterioration in public narratives about targeted firms, while analyst language may adjust more gradually or incorporate sanction risk less directly.

[Insert Table 8 here]

Panel B shows that sectoral exposure also worsens external sentiment, though in a different way. Negative news increases by 0.016, significant at the 1 percent level, and negative analyst tone increases by 0.007, significant at the 5 percent level. Negative investor-forum sentiment is small and statistically insignificant. This pattern is consistent with the nature of sectoral exposure: it is less visible to retail investors than a firm-level designation, but it is still recognized in news coverage and professional analysis as a source of regulatory and operating risk. The fact that firms not directly targeted experience a measurable deterioration in sentiment further supports the interpretation that the sectoral-exposure measure captures meaningful indirect exposure.

Online Appendix Figure A.2 reports a corresponding placebo exercise in which external sentiment measures are randomly reassigned across firms and the baseline specification is re-estimated 1,000 times. The placebo distributions do not reproduce the observed deterioration in sentiment, suggesting that the results are not driven by random exposure to negative attention.

Finally, we examine short-window stock-market reactions around BIS announcement dates. Using the Fama–French five-factor model, we compute cumulative abnormal returns over a [-10,20] trading-day window around the first sanction event affecting a firm or its technology category. Online Appendix Figure A.3 shows a sharp negative response for directly targeted firms, with an average market-value loss of about 3 percent over the window. This is consistent with immediate repricing of compliance and cash-flow risk following direct exposure. By contrast, abnormal returns for sectoral exposure are not statistically significant over the same window, consistent with the idea that sectoral exposure is broader, more diffuse, and less tied to a discrete firm-specific announcement.

Taken together, the validation evidence shows that BIS-related events are economically meaningful shocks. Firms discuss sanctions more intensively after exposure, external sentiment deteriorates, and directly targeted firms experience negative market reactions around announcement dates. The evidence also supports the sectoral-exposure design: firms in sanctioned technology domains show greater sanction-related disclosure and more negative external sentiment even when they are not themselves directly targeted.

6.2 Robustness

We next examine whether the baseline lending results are robust to the main identification and specification concerns. We begin with the core identifying assumption, then examine alternative specifications, staggered treatment timing, and placebo exposure tests.

Parallel trends and sensitivity analysis. The event-study design requires treated and control firms to have comparable pre-treatment lending trends. Online Appendix Figure

A.4 shows that the pre-treatment coefficients are small and statistically insignificant. We further conduct sensitivity analyses following Rambachan and Roth (2023), allowing for moderate deviations from strict parallel trends. The conclusions remain similar, suggesting that the lending results are not driven by plausible violations of the identifying trend assumption.

Alternative specifications. We next relax the baseline estimation approach. Online Appendix Figure A.5 reports estimates from a conventional difference-in-differences specification using the original non-stacked sample with firm and year fixed effects. The lending responses remain similar in sign and magnitude, suggesting that the findings do not depend on the stacked event-study construction. We also implement inverse probability weighting to improve treated-control comparability on observables. Propensity scores are estimated using firm size, leverage, age, capital expenditure, and return on assets. Stabilized weights are then used in weighted least squares, with extreme weights winsorized at the 1 percent level. Online Appendix Table A.9 shows that the main results remain stable under this reweighting exercise. Because sectoral exposure requires assigning firms to technology domains, our baseline sample is restricted to firms with invention patent activity. In robustness checks, we also verify that the direct-exposure lending results are similar when the sample is expanded to include listed firms without invention patents.

Staggered treatment timing. We then address the possibility that staggered treatment timing and heterogeneous treatment effects affect the estimates. Because sanction timing varies across firms and technology categories, some two-way fixed-effects comparisons may place inappropriate weight on already-treated units. We therefore re-estimate the baseline effects using alternative difference-in-differences estimators following Sun and Abraham (2021). Online Appendix Figure A.6 shows that the estimates remain quantitatively similar and statistically significant, with no evidence of differential pre-trends.

Placebo exposure tests. Finally, we ask whether similar patterns arise when exposure is assigned at random. We randomly assign sanction exposure and bank-lending variables and re-estimate the baseline specification 1,000 times. Online Appendix Figures A.7 and A.8 show that the placebo estimates are centered around zero and do not reproduce the baseline effects. This evidence suggests that the results are unlikely to reflect chance correlations between sanction timing and lending outcomes.

Overall, these exercises strengthen the interpretation of the baseline lending results. The estimates show no evidence of differential pre-trends, remain similar under sensitivity checks for trend violations and staggered-treatment estimators, are stable across alternative specifications and reweighting, and are not reproduced by placebo exposure

assignments. Together with the validation evidence above, these results support the interpretation that U.S. technology sanctions induce systematic credit reallocation across lender types and firms.

7 Conclusion

This paper studies how domestic financial institutions shape the transmission of geopolitical shocks. Using U.S. technology sanctions on Chinese firms, we show that credit reallocation differs sharply across lender types. Commercial banks reduce lending to directly targeted firms, consistent with heightened regulatory, compliance, and repayment risk. By contrast, the China Development Bank expands lending to directly targeted firms and to firms operating in sanctioned technology domains. These responses are stronger for firms and industries aligned with national strategic priorities, consistent with state-directed credit allocation rather than conventional market-based screening.

The results highlight how the effects of geopolitical fragmentation depend on the structure of domestic financial intermediation. The same external shock can generate different adjustment dynamics depending on which financial institutions absorb risk and how credit is allocated across firms. In financial systems where lending is primarily market-oriented, geopolitical shocks may propagate through tighter financing conditions and reduced credit supply. In systems with large state-directed financial institutions, policy credit may partially offset these forces and redirect resources toward strategically important firms and sectors.

Understanding the transmission of geopolitical shocks therefore requires looking beyond firms' direct exposure to sanctions. It also requires examining the incentives, constraints, and objectives of the intermediaries that finance adjustment. As governments increasingly use trade, technology, and financial restrictions as instruments of strategic competition, financial intermediation becomes an important channel through which these restrictions affect domestic economies. Our evidence shows that credit allocation is shaped not only by profitability and borrower risk, but also by geopolitical considerations and state priorities. Domestic credit markets therefore play a central role in determining how economies adapt to technological decoupling and strategic competition.

References

Aguirregabiria, V., R. Clark, and H. Wang (2025): "The geographic flow of bank funding and access to credit: Branch networks, synergies, and local competition," *American Economic Review*, 115, 1818–1856.

Ahn, D. P. and R. D. Ludema (2020): "The sword and the shield: The economics of targeted sanctions," *European Economic Review*, 130, 103587.

Amiti, M. and D. E. Weinstein (2018): "How much do idiosyncratic bank shocks affect investment? Evidence from matched bank-firm loan data," *Journal of Political Economy*, 126, 525–587.

Bei, Z., Y. Qi, J. Wu, and Y. Zhou (2025): "Navigating Geopolitical Risk: How do Sanctions Shape Global Supply Chains?" *Available at SSRN 5493927*.

Carvalho, D. (2014): "The real effects of government-owned banks: Evidence from an emerging market," *The Journal of Finance*, 69, 577–609.

Chen, Y. J., R. K. Gong, and J. Li (2025): "Industrial policy in a new era: Government venture capital in the US–China trade war," *Journal of Development Economics*, 103599.

Chodorow-Reich, G. (2014): "The employment effects of credit market disruptions: Firm-level evidence from the 2008–9 financial crisis," *The Quarterly Journal of Economics*, 129, 1–59.

Clayton, C., M. Maggiori, and J. Schreger (2026): "A framework for geoeconomics," *Econometrica*, 94, 105–136.

Coleman, N. and L. Feler (2015): "Bank ownership, lending, and local economic performance during the 2008–2009 financial crisis," *Journal of Monetary Economics*, 71, 50–66.

Correa, R., J. Di Giovanni, L. S. Goldberg, and C. Minoiu (2023): *Trade uncertainty and US bank lending*, vol. 31860, National Bureau of Economic Research.

Correia, S., P. Guimarães, and T. Zylkin (2020): "Fast Poisson estimation with high-dimensional fixed effects," *The Stata Journal*, 20, 95–115.

Crosignani, M., L. Han, M. Macchiavelli, and A. F. Silva (2026): "Securing technological leadership? the cost of export controls on firms," *Journal of Financial Economics*, 175, 104192.

Crosignani, M., M. Macchiavelli, and A. F. Silva (2023): "Pirates without borders: The propagation of cyberattacks through firms' supply chains," *Journal of Financial Economics*, 147, 432–448.

Efing, M., S. Goldbach, and V. Nitsch (2023): "Freeze! Financial sanctions and bank responses," *The Review of Financial Studies*, 36, 4417–4459.

Eslava, M. and X. Freixas (2021): "Public development banks and credit market imperfections," *Journal of Money, Credit and Banking*, 53, 1121–1149.

Federico, S., F. Hassan, and V. Rappoport (2025): "Trade shocks and credit reallocation," *American Economic Review*, 115, 1142–1169.

Gong, D., J. Xu, and J. Yan (2023): "National development banks and loan contract terms: Evidence from syndicated loans," *Journal of International Money and Finance*, 130, 102763.

Han, P., W. Jiang, and D. Mei (2024): "Mapping US–China technology decoupling: Policies, innovation, and firm performance," *Management Science*, 70, 8386–8413.

He, Y. and J. Lyu (2025): "Export controls and innovation transfer within Chinese business groups: Evidence from the US entity list," *Research Policy*, 54, 105311.

Hu, B., A. Schclarek, J. Xu, and J. Yan (2022): "Long-term finance provision: National development banks vs commercial banks," *World Development*, 158, 105973.

Huang, K. G., N. Jia, and Y. Ge (2024): "Forced to innovate? Consequences of United States' anti-dumping sanctions on innovations of Chinese exporters," *Research Policy*, 53, 104899.

Khwaja, A. I. and A. Mian (2008): "Tracing the impact of bank liquidity shocks: Evidence from an emerging market," *American Economic Review*, 98, 1413–1442.

La Porta, R., F. Lopez-de Silanes, and A. Shleifer (2002): "Government ownership of banks," *The Journal of Finance*, 57, 265–301.

Liu, X., Y. Liu, A. Makarin, et al. (2025): "Export Controls and Innovation in Sanctioned Countries," *Available at SSRN 5476786*.

Niepmann, F. and L. S. Shen (2025): "Geopolitical risk and global banking," Tech. rep., Federal Reserve Bank of Boston.

Rambachan, A. and J. Roth (2023): "A more credible approach to parallel trends," *Review of Economic Studies*, 90, 2555–2591.

Ru, H. (2018): "Government credit, a double-edged sword: Evidence from the China Development Bank," *The Journal of Finance*, 73, 275–316.

Ru, H. and E. Yang (2025): "Government Credit and International Trade," *Journal of Financial and Quantitative Analysis*, 60, 2398–2430.

Sapienza, P. (2004): "The effects of government ownership on bank lending," *Journal of Financial Economics*, 72, 357–384.

Sun, L. and S. Abraham (2021): "Estimating dynamic treatment effects in event studies with heterogeneous treatment effects," *Journal of Econometrics*, 225, 175–199.

Zhang, J., C. Liu, and R. Liu (2026): "The Dual Effects of Technology Decoupling: US Export Controls and Innovation in China," *Available at SSRN 6210408*.

Zheng, S. and R. Zhang (2025): "Industry Chain Risks and Breakthroughs in Indigenous Innovation by Chinese Enterprises," *Social Sciences in China*, 46, 4–25.

Table 1: Summary Statistics

	Direct Exposure			**Sectoral Exposure**		
Variable	N	Mean	SD	N	Mean	SD
	(1)	(2)	(3)	(4)	(5)	(6)
CDB	83568	27.784	369.317	101350	32.208	477.678
CBL	83568	1207.023	6281.696	101350	1165.526	5807.409
Invention Patents	83568	19.779	193.811	101350	16.694	175.385
Exploratory Patents	83568	0.530	4.188	101350	0.680	5.088
High-Cited Patents	83568	0.510	9.252	101350	0.590	9.988
U.S. Supplier Exits	83568	0.018	0.192	101350	0.013	0.158
New Chinese Suppliers	83568	0.067	0.418	101350	0.056	0.368
Supplier Diversification	83568	1.159	3.572	101350	1.094	3.217
Supply Chain Stability	83563	0.856	0.312	101340	0.847	0.314

Notes: This table reports descriptive statistics for the main variables used in the analysis. *CDB* is new borrowing from the China Development Bank, and *CBL* is new borrowing from commercial banks; both are measured in RMB million. *Invention Patents* is the number of invention patent applications. *Exploratory Patents* is the number of invention patent applications outside a firm's familiar technology classes. *High-Cited Patents* is the number of invention patent applications whose forward citations rank in the top 10 percent within the same technology class-year, excluding patents with zero citations. *U.S. Supplier Exits* is the number of terminated relationships with U.S. suppliers, and *New Chinese Suppliers* is the number of newly added Chinese suppliers. *Supplier Diversification* is the number of suppliers. *Supply Chain Stability* measures the persistence of major supply-chain relationships and is defined as the average of supplier and customer stability.

Table 2: Bank Lending Responses to U.S. Technology Sanctions

	Log(CDB)	Log(CBL)	Log(CDB)	Log(CBL)
	(1)	(2)	(3)	(4)
DTreat × DPost	0.626**	-1.286**		
	(0.316)	(0.529)		
STreat × SPost			0.312***	0.438*
			(0.118)	(0.266)
Cohort-Firm FE	Y	Y	Y	Y
Cohort-Year-Industry-Size FE	Y	Y	Y	Y
N	83568	83568	101350	101350
Adj. R^2	0.213	0.532	0.237	0.510

Notes: This table reports stacked difference-in-differences estimates of the effect of U.S. technology sanctions on Chinese firms' annual bank lending. The dependent variables are *Log(CDB)*, defined as the natural logarithm of China Development Bank lending plus one, and *Log(CBL)*, defined as the natural logarithm of commercial-bank lending plus one. Columns (1)–(2) report estimates for directly exposed firms, defined as firms directly listed on U.S. export-control sanction lists. Columns (3)–(4) report estimates for sectorally exposed firms, defined as firms operating in the same technology categories as sanctioned entities. DTreat × DPost equals one for directly exposed firms in and after the sanction year. STreat × SPost equals one for sectorally exposed firms in and after the category-level sanction year. All specifications include cohort-firm fixed effects and cohort-year-industry-size fixed effects. Standard errors are clustered at the firm level and reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

Table 3: State Priorities and Bank Lending Responses to U.S. Technology Sanctions

Panel A: Direct Exposure				
	Log(CDB)	Log(CDB)	Log(CBL)	Log(CBL)
	(1)	(2)	(3)	(4)
DTreat × DPost	-0.334	-0.145	-1.619**	-1.344**
	(0.304)	(0.321)	(0.716)	(0.674)
DTreat × DPost × Strategic Industry	1.385***		0.480	
	(0.517)		(0.943)	
DTreat × DPost × National Security		1.697**		0.126
		(0.692)		(0.891)
Cohort-Firm FE	Y	Y	Y	Y
Cohort-Year-Industry-Size FE	Y	Y	Y	Y
N	83568	83568	83568	83568
Adj. R^2	0.213	0.213	0.532	0.532
Panel B: Sectoral Exposure				
	Log(CDB)	Log(CDB)	Log(CBL)	Log(CBL)
	(1)	(2)	(3)	(4)
STreat × SPost	0.125	0.160	0.690**	0.670**
	(0.147)	(0.131)	(0.326)	(0.306)
STreat × SPost × Strategic Industry	0.431**		-0.583	
	(0.206)		(0.440)	
STreat × SPost × National Security		0.480**		-0.737
		(0.232)		(0.482)
Cohort-Firm FE	Y	Y	Y	Y
Cohort-Year-Industry-Size FE	Y	Y	Y	Y
N	101350	101350	101350	101350
Adj. R^2	0.237	0.237	0.510	0.510

Notes: This table reports heterogeneous bank lending responses to U.S. technology sanctions by alignment with national-strategy. Panel A reports estimates for directly exposed firms, defined as firms directly listed on U.S. export-control sanction lists. Panel B reports estimates for sectorally exposed firms, defined as firms operating in the same technology categories as sanctioned entities. The dependent variables are *Log(CDB)*, defined as the natural logarithm of China Development Bank lending plus one, and *Log(CBL)*, defined as the natural logarithm of commercial-bank lending plus one. The key regressors interact the treatment variables with two firm characteristics: *Strategic Industry*, which equals one if a firm belongs to a strategic emerging industry covered by the China Strategic Emerging Industries Composite Index, and *National Security*, which equals one if a firm operates in national-security-related sectors identified from principal-product descriptions using keywords such as military, aerospace, electric power, communications, aviation, and shipbuilding, following Zheng and Zhang (2025). DTreat × DPost equals one for directly exposed firms in and after the sanction year. STreat × SPost equals one for sectorally exposed firms in and after the category-level sanction year. All specifications include cohort-firm fixed effects and cohort-year-industry-size fixed effects. Standard errors are clustered at the firm level and reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels. Because *Strategic Industry* and *National Security* are time-invariant, their main effects are absorbed by fixed effects and not reported.

Table 4: Borrower Risk and Bank Lending Responses to U.S. Technology Sanctions

Panel A: Direct Exposure				
	Log(CDB)	Log(CDB)	Log(CBL)	Log(CBL)
	(1)	(2)	(3)	(4)
DTreat × DPost	0.940*	0.859**	0.164	-0.619
	(0.487)	(0.435)	(0.875)	(0.612)
DTreat × DPost × Low ROA	-0.555		-1.979**	
	(0.473)		(0.902)	
Low ROA	0.027		0.191	
	(0.083)		(0.193)	
DTreat × DPost × Young		-0.631		-1.797**
		(0.503)		(0.886)
Young		-0.223*		-0.748**
		(0.132)		(0.380)
Cohort-Firm FE	Y	Y	Y	Y
Cohort-Year-Industry-Size FE	Y	Y	Y	Y
N	69774	83568	69774	83568
Adj. R^2	0.207	0.213	0.550	0.532
Panel B: Sectoral Exposure				
	Log(CDB)	Log(CDB)	Log(CBL)	Log(CBL)
	(1)	(2)	(3)	(4)
STreat × SPost	0.509***	0.388**	1.000***	0.943**
	(0.184)	(0.178)	(0.381)	(0.367)
STreat × SPost × Low ROA	-0.232		-0.826**	
	(0.187)		(0.394)	
Low ROA	0.048		0.464***	
	(0.072)		(0.163)	
STreat × SPost × Young		-0.141		-0.940**
		(0.190)		(0.446)
Young		0.006		0.752**
		(0.136)		(0.328)
Cohort-Firm FE	Y	Y	Y	Y
Cohort-Year-Industry-Size FE	Y	Y	Y	Y
N	84881	101350	84881	101350
Adj. R^2	0.228	0.237	0.533	0.510

Notes: This table reports heterogeneous bank lending responses to U.S. technology sanctions by borrower risk. Panel A reports estimates for directly exposed firms, defined as firms directly listed on U.S. export-control sanction lists. Panel B reports estimates for sectorally exposed firms, defined as firms operating in the same technology categories as sanctioned entities. The dependent variables are *Log(CDB)*, defined as the natural logarithm of China Development Bank lending plus one, and *Log(CBL)*, defined as the natural logarithm of commercial-bank lending plus one. The key regressors interact the treatment variables with *Low ROA* and *Young*. *Low ROA* equals one for firms below the industry-year median ROA, where ROA is calculated as lagged net profit divided by lagged total assets. *Young* equals one for firms below the industry-year median firm age, measured by years since establishment. DTreat × DPost equals one for directly exposed firms in and after the sanction year. STreat × SPost equals one for sectorally exposed firms in and after the category-level sanction year. All specifications include cohort-firm fixed effects and cohort-year-industry-size fixed effects. Standard errors are clustered at the firm level and reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels. Because *Low ROA* uses lagged financial information, missing lagged data reduce the sample size in columns (1) and (3).

Table 5: Innovation Responses to U.S. Technology Sanctions and Bank Lending

Panel A: Direct Exposure						
	Inv. Pat.	Inv. Pat.	Inv. Pat.	High-Cit. Pat.	High-Cit. Pat.	High-Cit. Pat.
	(1)	(2)	(3)	(4)	(5)	(6)
DTreat × DPost	0.826***	0.808***	0.769***	0.977***	0.938***	0.740*
	(0.162)	(0.167)	(0.195)	(0.343)	(0.353)	(0.416)
DTreat × DPost × Log(CDB)		0.027**			0.082**	
		(0.014)			(0.041)	
Log(CDB)		-0.004			0.001	
		(0.005)			(0.010)	
DTreat × DPost × Log(CBL)			0.008			0.035**
			(0.010)			(0.016)
Log(CBL)			-0.001			0.000
			(0.002)			(0.006)
Cohort-Firm FE	Y	Y	Y	Y	Y	Y
Cohort-Year-Industry-Size FE	Y	Y	Y	Y	Y	Y
N	57590	57590	57590	5403	5403	5403
Panel B: Sectoral Exposure						
	Inv. Pat.	Inv. Pat.	Inv. Pat.	High-Cit. Pat.	High-Cit. Pat.	High-Cit. Pat.
	(1)	(2)	(3)	(4)	(5)	(6)
STreat × SPost	0.107*	0.091	0.092	0.475*	0.435*	0.692***
	(0.057)	(0.057)	(0.057)	(0.243)	(0.242)	(0.268)
STreat × SPost × Log(CDB)		0.009**			0.039***	
		(0.004)			(0.011)	
Log(CDB)		-0.009**			0.004	
		(0.004)			(0.008)	
STreat × SPost × Log(CBL)			0.002			-0.020**
			(0.003)			(0.009)
Log(CBL)			-0.001			0.006
			(0.002)			(0.005)
Cohort-Firm FE	Y	Y	Y	Y	Y	Y
Cohort-Year-Industry-Size FE	Y	Y	Y	Y	Y	Y
N	92340	92340	92340	6146	6146	6146

Notes: This table reports innovation responses to U.S. technology sanctions. Panel A reports estimates for directly exposed firms, defined as firms directly listed on U.S. export-control sanction lists. Panel B reports estimates for sectorally exposed firms, defined as firms operating in the same technology categories as sanctioned entities. The dependent variables are *Invention Patents*, defined as the number of invention patent applications, and *High-Cited Patents*, defined as invention patents whose forward citations rank in the top 10 percent within the same technology class-year. Columns (2), (3), (5), and (6) interact the exposure indicators with *Log(CDB)* and *Log(CBL)* to examine whether innovation responses vary with bank lending. All specifications are estimated using Poisson pseudo-maximum likelihood and include cohort-firm fixed effects and cohort-year-industry-size fixed effects. Standard errors are clustered at the firm level and reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels. Patent data are from the China National Intellectual Property Administration, and citation data are from Google Patents.

Table 6: Supply Chain Responses to U.S. Technology Sanctions and Bank Lending

Panel A: Direct Exposure						
	Supplier Diversification	Supplier Diversification	Supplier Diversification	Supply Chain Stability	Supply Chain Stability	Supply Chain Stability
	(1)	(2)	(3)	(4)	(5)	(6)
DTreat × DPost	0.288**	0.152	0.308*	-0.040**	-0.044**	-0.040*
	(0.144)	(0.140)	(0.168)	(0.018)	(0.018)	(0.022)
DTreat × DPost × Log(CDB)		0.072***			0.004**	
		(0.014)			(0.002)	
Log(CDB)		-0.007			-0.001	
		(0.005)			(0.001)	
DTreat × DPost × Log(CBL)			-0.002			-0.000
			(0.008)			(0.001)
Log(CBL)			0.006***			-0.001***
			(0.002)			(0.000)
Cohort-Firm FE	Y	Y	Y	Y	Y	Y
Cohort-Year-Industry-Size FE	Y	Y	Y	Y	Y	Y
N	36968	36968	36968	83568	83568	83568
Adj. R^2				0.307	0.307	0.307
Panel B: Sectoral Exposure						
	Supplier Diversification	Supplier Diversification	Supplier Diversification	Supply Chain Stability	Supply Chain Stability	Supply Chain Stability
	(1)	(2)	(3)	(4)	(5)	(6)
STreat × SPost	-0.017	-0.021	0.011	0.016	0.017	-0.004
	(0.084)	(0.084)	(0.103)	(0.010)	(0.010)	(0.012)
STreat × SPost × Log(CDB)		0.006			-0.001	
		(0.014)			(0.002)	
Log(CDB)		-0.008**			-0.001	
		(0.003)			(0.001)	
STreat × SPost × Log(CBL)			-0.003			0.002***
			(0.005)			(0.001)
Log(CBL)			(0.002)			(0.000)
Cohort-Firm FE	Y	Y	Y	Y	Y	Y
Cohort-Year-Industry-Size FE	Y	Y	Y	Y	Y	Y
N	42249	42249	42249	101350	101350	101350
Adj. R^2				0.324	0.324	0.325

Notes: This table reports supply chain responses to U.S. technology sanctions and examines whether these responses vary with bank lending. Panel A reports estimates for directly exposed firms, defined as firms directly listed on U.S. export-control sanction lists. Panel B reports estimates for sectorally exposed firms, defined as firms operating in the same technology categories as sanctioned entities. The dependent variables are *Supplier Diversification* and *Supply Chain Stability*. *Supplier Diversification* is measured by the number of suppliers and is constructed from FactSet Revere. Because it is a count variable, columns (1)–(3) are estimated using Poisson pseudo-maximum likelihood. *Supply Chain Stability* is the average of supplier stability and customer stability, where supplier stability is the share of current top-five suppliers that also appeared in the previous year and customer stability is defined analogously. Columns (4)–(6) are estimated using linear regressions. The key regressors interact the exposure indicators with *Log(CDB)* and *Log(CBL)*. DTreat × DPost equals one for directly exposed firms in and after the sanction year. STreat × SPost equals one for sectorally exposed firms in and after the category-level sanction year. All specifications include cohort-firm fixed effects and cohort-year-industry-size fixed effects. Standard errors are clustered at the firm level and reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels. Supplier diversification data are from FactSet Revere, and supply chain stability data are from CSMAR.

Table 7: Firm Disclosure Responses to U.S. Technology Sanctions

	TSF	TSI	TSF	TSI
	(1)	(2)	(3)	(4)
DTreat × DPost	0.092*	0.006**		
	(0.052)	(0.002)		
STreat × SPost			0.035**	0.002**
			(0.015)	(0.001)
Cohort-Firm FE	Y	Y	Y	Y
Cohort-Year-Industry-Size FE	Y	Y	Y	Y
N	83568	83568	101350	101350
Adj. R^2	0.626	0.556	0.613	0.540

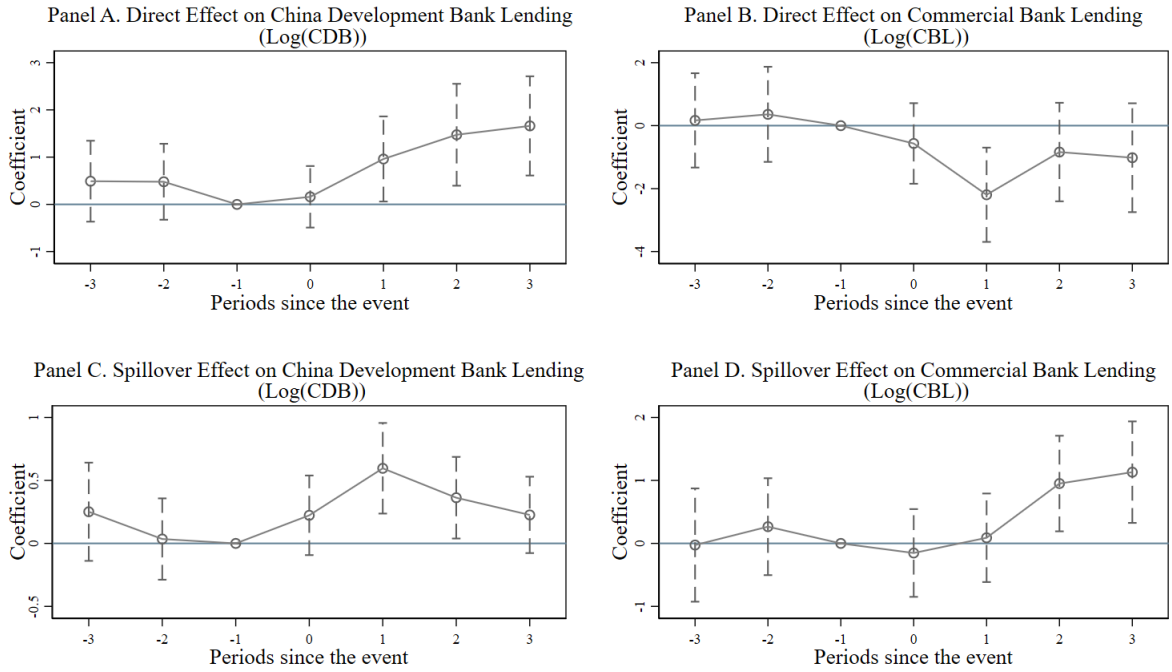
Notes: This table reports firm disclosure responses to U.S. technology sanctions, estimated using a stacked difference-in-differences design. The dependent variables are *Technology Sanction Frequency* (*TSF*) and *Technology Sanction Intensity* (*TSI*), constructed from firms' Management Discussion and Analysis (MD&A) sections. *TSF* is defined as the natural logarithm of the number of technology-sanction-related terms in the MD&A section plus one. *TSI* is defined as the ratio of technology-sanction-related terms to the total word count in the MD&A section. Technology-sanction-related terms are identified using a Chinese keyword dictionary covering U.S. export controls and technology restrictions, including terms such as 技术制裁 (technology sanctions), 出口管制 (export controls), 实体清单 (Entity List), 禁令 (ban), and 地缘政治 (geopolitical risk). The full dictionary is reported in Online Appendix Table A.7. Columns (1)–(2) report estimates for directly exposed firms, defined as firms directly listed on U.S. export-control sanction lists. Columns (3)–(4) report estimates for sectorally exposed firms, defined as firms operating in the same technology categories as sanctioned entities. DTreat × DPost equals one for directly exposed firms in and after the sanction year. STreat × SPost equals one for sectorally exposed firms in and after the category-level sanction year. All specifications include cohort-firm fixed effects and cohort-year-industry-size fixed effects. Standard errors are clustered at the firm level and reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

Table 8: External Sentiment Responses to U.S. Technology Sanctions

Panel A: Direct Exposure			
	Negative news	Negative comment	Negative tone
	(1)	(2)	(3)
DTreat × DPost	0.042***	0.019***	-0.004
	(0.014)	(0.005)	(0.007)
Cohort-Firm FE	Y	Y	Y
Cohort-Year-Industry-Size FE	Y	Y	Y
N	83568	83568	83568
Adj. R^2	0.437	0.622	0.411
Panel B: Sectoral Exposure			
	Negative news	Negative comment	Negative tone
	(1)	(2)	(3)
STreat × SPost	0.016***	0.002	0.007**
	(0.006)	(0.002)	(0.003)
Cohort-Firm FE	Y	Y	Y
Cohort-Year-Industry-Size FE	Y	Y	Y
N	101350	101350	101350
Adj. R^2	0.420	0.590	0.443

Notes: This table reports external sentiment responses to U.S. technology sanctions, estimated using a stacked difference-in-differences design. Panel A reports estimates for directly exposed firms. Panel B reports estimates for sectorally exposed firms. The dependent variables capture sentiment from three external sources. *Negative News* is the net share of negative news coverage, defined as the difference between the number of negative and positive news articles divided by the total number of news articles. *Negative Comment* is the net share of negative stock-forum comments, defined analogously using investor posts. *Negative Tone* is the net share of negative sentences in analyst reports, defined as the difference between the number of negative and positive sentences divided by the total number of sentences. All sentiment measures are constructed using data from the China National Research Data Service (CNRDS). DTreat × DPost equals one for directly exposed firms in and after the sanction year. STreat × SPost equals one for sectorally exposed firms in and after the category-level sanction year. All specifications include cohort-firm fixed effects and cohort-year-industry-size fixed effects. Standard errors are clustered at the firm level and reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

Figure 1. Event Study Estimates of Bank Lending Responses to U.S. Technology Sanctions



Notes: This figure presents event-study estimates of bank lending responses to U.S. technology sanctions, based on the stacked difference-in-differences framework in Equation (1). The outcome variables are *Log(CDB)*, defined as the natural logarithm of China Development Bank lending plus one, and *Log(CBL)*, defined as the natural logarithm of commercial-bank lending plus one. Panels A and B report estimates for directly exposed firms, defined as firms directly listed on U.S. export-control sanction lists. Panels C and D report estimates for sectorally exposed firms, defined as firms operating in the same technology categories as sanctioned entities. Coefficients are plotted by event year relative to the sanction year, with the year immediately preceding the sanction normalized to zero. All specifications include cohort-firm fixed effects and cohort-year-industry-size fixed effects. Standard errors are clustered at the firm level. Vertical bars denote 95 percent confidence intervals.

Internet Appendix

Not Intended for Publication

A Additional Tables and Graphs

Table A.1: Firm Characteristics by Firm Size Quartile and Exposure Type

Panel A: Direct Exposure									
		Size Q1		Size Q2		Size Q3		Size Q4	
Variable	Stat.	Treated	Control	Treated	Control	Treated	Control	Treated	Control
N	Tot.	41	20044	75	21158	222	20944	359	20725
Asset	Mean	6.837	6.603	7.667	7.626	8.447	8.437	10.337	10.005
	Median	6.920	6.773	7.718	7.632	8.432	8.427	10.072	9.744
	SD	0.283	0.558	0.224	0.215	0.265	0.271	1.107	0.935
Income	Mean	5.968	5.934	6.751	6.879	7.609	7.753	9.624	9.311
	Median	6.070	5.984	6.950	6.914	7.683	7.785	9.522	9.153
	SD	0.611	0.683	0.757	0.633	0.615	0.665	1.278	1.075
Profit	Mean	3.415	3.843	4.007	4.548	4.977	5.318	6.866	6.820
	Median	3.949	3.954	4.127	4.687	5.117	5.466	6.802	6.830
	SD	1.164	0.879	1.090	0.936	1.043	1.019	1.531	1.313
Panel B: Sectoral Exposure									
		Size Q1		Size Q2		Size Q3		Size Q4	
Variable	Stat.	Treated	Control	Treated	Control	Treated	Control	Treated	Control
N	Tot.	1573	23207	1722	23635	1921	23752	2012	23528
Asset	Mean	6.678	6.574	7.653	7.631	8.429	8.436	10.056	10.000
	Median	6.827	6.759	7.656	7.636	8.414	8.422	9.802	9.754
	SD	0.525	0.602	0.215	0.214	0.269	0.268	0.927	0.908
Income	Mean	5.981	5.947	6.879	6.933	7.684	7.794	9.348	9.341
	Median	6.020	6.017	6.909	6.962	7.674	7.844	9.170	9.213
	SD	0.623	0.744	0.610	0.662	0.666	0.716	1.149	1.115
Profit	Mean	3.895	3.772	4.612	4.530	5.310	5.312	6.900	6.792
	Median	4.030	3.904	4.774	4.692	5.428	5.467	6.889	6.829
	SD	0.840	0.922	0.913	0.976	0.993	1.044	1.309	1.315

Notes: This table reports summary statistics by firm-size quartiles and exposure type. Panel A reports the direct-exposure sample, consisting of firms directly listed on U.S. export-control sanction lists and their matched controls. Panel B reports the sectoral-exposure sample, consisting of firms operating in the same technology categories as sanctioned entities and their matched controls. Firms are divided into four size quartiles, from Size Q1 (smallest firms) to Size Q4 (largest firms), based on firm size. Within each quartile, statistics are reported separately for treated and control firms. *Asset* is the natural logarithm of total assets. *Income* is the natural logarithm of operating revenue. *Profit* is the natural logarithm of operating profit. The table reports the number of firms, mean, median, and standard deviation for each variable.

Table A.2: Bank Lending Responses to U.S. Technology Sanctions (in billion RMB)

	CDB	CBL	CDB	CBL
	(1)	(2)	(3)	(4)
DTreat × DPost	0.142***	-1.174**		
	(0.048)	(0.570)		
STreat × SPost			0.033**	0.126*
			(0.015)	(0.068)
Cohort-Firm FE	Y	Y	Y	Y
Cohort-Year-Industry-Size FE	Y	Y	Y	Y
N	83568	83568	101350	101350
Adj. R^2	0.097	0.584	0.203	0.667

Notes: This table reports stacked difference-in-differences estimates of the effect of U.S. technology sanctions on Chinese firms' annual bank lending in levels. The dependent variables are *CDB*, defined as China Development Bank lending in billion RMB, and *CBL*, defined as commercial-bank lending in billion RMB. Columns (1)–(2) report estimates for directly exposed firms, defined as firms directly listed on U.S. export-control sanction lists. Columns (3)–(4) report estimates for sectorally exposed firms, defined as firms operating in the same technology categories as sanctioned entities. DTreat × DPost equals one for directly exposed firms in and after the sanction year. STreat × SPost equals one for sectorally exposed firms in and after the category-level sanction year. All specifications include cohort-firm fixed effects and cohort-year-industry-size fixed effects. Standard errors are clustered at the firm level and reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

Table A.3: Industrial Policy and Bank Lending Responses to U.S. Technology Sanctions

Panel A: Direct Exposure				
	Log(CDB)	Log(CDB)	Log(CBL)	Log(CBL)
	(1)	(2)	(3)	(4)
DTreat × DPost	-0.320	-0.633	-2.770**	-2.687**
	(0.356)	(0.398)	(1.291)	(1.253)
DTreat × DPost × Policy Priority	1.080**		1.627	
	(0.438)		(1.376)	
EI	-0.211		1.882**	
	(0.680)		(0.907)	
DTreat × DPost × Key Sector		1.481***		1.513
		(0.567)		(1.318)
KI		0.264		2.305**
		(0.704)		(0.914)
Cohort-Firm FE	Y	Y	Y	Y
Cohort-Year-Industry-Size FE	Y	Y	Y	Y
N	83568	83568	83568	83568
Adj. R^2	0.213	0.213	0.532	0.532
Panel B: Sectoral Exposure				
	Log(CDB)	Log(CDB)	Log(CBL)	Log(CBL)
	(1)	(2)	(3)	(4)
STreat × SPost	-0.051	0.022	0.900**	0.867**
	(0.179)	(0.180)	(0.417)	(0.393)
STreat × SPost × Policy Priority	0.524**		-0.685	
	(0.228)		(0.486)	
EI	0.032		0.687	
	(0.407)		(0.673)	
STreat × SPost × Key Sector		0.469**		-0.745
		(0.236)		(0.489)
KI		0.419		1.353*
		(0.475)		(0.733)
Cohort-Firm FE	Y	Y	Y	Y
Cohort-Year-Industry-Size FE	Y	Y	Y	Y
N	101350	101350	101350	101350
Adj. R^2	0.237	0.237	0.510	0.510

Notes: This table reports heterogeneous bank lending responses to U.S. technology sanctions by industrial-policy status. Panel A reports estimates for directly exposed firms, defined as firms directly listed on U.S. export-control sanction lists. Panel B reports estimates for sectorally exposed firms, defined as firms operating in the same technology categories as sanctioned entities. The dependent variables are *Log(CDB)*, defined as the natural logarithm of China Development Bank lending plus one, and *Log(CBL)*, defined as the natural logarithm of commercial-bank lending plus one. The key regressors interact the exposure indicators with two measures of industrial-policy status. *Policy Priority* identifies firms in industries encouraged by national industrial policy, and *Key Sector* identifies firms in industries receiving key support. These measures are constructed by matching firms' industry classifications to industries encouraged or prioritized in China's Eleventh, Twelfth, Thirteenth, and Fourteenth Five-Year Plans. DTreat × DPost equals one for directly exposed firms in and after the sanction year. STreat × SPost equals one for sectorally exposed firms in and after the category-level sanction year. All specifications include cohort-firm fixed effects and cohort-year-industry-size fixed effects. Standard errors are clustered at the firm level and reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

Table A.4: Regional Financial Conditions and Bank Lending Responses to U.S. Technology Sanctions

Panel A: Direct Exposure				
	Log(CDB)	Log(CDB)	Log(CBL)	Log(CBL)
	(1)	(2)	(3)	(4)
DTreat × DPost	2.370**	1.115**	-4.437***	-2.311***
	(1.184)	(0.546)	(1.321)	(0.660)
DTreat × DPost × Bank Competition	-1.961		3.536***	
	(1.207)		(1.359)	
BC	0.133		-0.199	
	(0.109)		(0.299)	
DTreat × DPost × Credit Support		-0.957		1.970**
		(0.602)		(0.961)
II		0.042		0.569*
		(0.118)		(0.305)
Cohort-Firm FE	Y	Y	Y	Y
Cohort-Year-Industry-Size FE	Y	Y	Y	Y
N	83568	83568	83568	83568
Adj. R^2	0.213	0.213	0.532	0.532
Panel B: Sectoral Exposure				
	Log(CDB)	Log(CDB)	Log(CBL)	Log(CBL)
	(1)	(2)	(3)	(4)
STreat × SPost	0.400**	0.359**	0.008	0.001
	(0.162)	(0.143)	(0.348)	(0.334)
STreat × SPost × Bank Competition	-0.150		0.755**	
	(0.176)		(0.382)	
BC	0.092		-0.182	
	(0.077)		(0.210)	
STreat × SPost × Credit Support		-0.102		0.897**
		(0.179)		(0.404)
II		-0.093		0.182
		(0.099)		(0.254)
Cohort-Firm FE	Y	Y	Y	Y
Cohort-Year-Industry-Size FE	Y	Y	Y	Y
N	101350	101350	101350	101350
Adj. R^2	0.237	0.237	0.510	0.510

Notes: This table reports heterogeneous bank lending responses to U.S. technology sanctions by regional financial conditions. Panel A reports estimates for directly exposed firms, defined as firms directly listed on U.S. export-control sanction lists. Panel B reports estimates for sectorally exposed firms, defined as firms operating in the same technology categories as sanctioned entities. The dependent variables are *Log(CDB)*, defined as the natural logarithm of China Development Bank lending plus one, and *Log(CBL)*, defined as the natural logarithm of commercial-bank lending plus one. The key regressors interact the exposure indicators with two measures of regional financial conditions: *Bank Competition* and *Credit Support*. Using bank-branch licensing data from the China Banking Regulatory Commission, we construct a city-year Herfindahl-Hirschman Index for commercial-bank branches. *Bank Competition* equals one for cities with above-median bank competition. Following Aguirregabiria et al. (2025), *Credit Support* is based on the loan-to-deposit deviation, defined as the difference between a city's national share of year-end financial institution loans and its national share of deposits. *Credit Support* equals one for cities with above-median loan-to-deposit deviation. DTreat × DPost equals one for directly exposed firms in and after the sanction year. STreat × SPost equals one for sectorally exposed firms in and after the category-level sanction year. All specifications include cohort-firm fixed effects and cohort-year-industry-

Table A.5: Exploratory Innovation Responses to U.S. Technology Sanctions

Panel A: Direct Exposure			
	Exp. Pat.	Exp. Pat.	Exp. Pat.
	(1)	(2)	(3)
DTreat × DPost	1.102***	0.633*	1.502***
	(0.351)	(0.370)	(0.545)
DTreat × DPost × Log(CDB)		0.205***	
		(0.037)	
Log(CDB)		-0.004	
		(0.012)	
DTreat × DPost × Log(CBL)			-0.037
			(0.029)
Log(CBL)			0.003
			(0.004)
Cohort-Firm FE	Y	Y	Y
Cohort-Year-Industry-Size FE	Y	Y	Y
N	38041	38041	38041
Panel B: Sectoral Exposure			
	Exp. Pat.	Exp. Pat.	Exp. Pat.
	(1)	(2)	(3)
STreat × SPost	-0.013	-0.023	0.021
	(0.100)	(0.107)	(0.123)
STreat × SPost × Log(CDB)		0.005	
		(0.015)	
Log(CDB)		0.006	
		(0.008)	
STreat × SPost × Log(CBL)			-0.003
			(0.006)
Log(CBL)			0.002
			(0.003)
Cohort-Firm FE	Y	Y	Y
Cohort-Year-Industry-Size FE	Y	Y	Y
N	43994	43994	43994

Notes: This table reports exploratory innovation responses to U.S. technology sanctions. The dependent variable is *Exploratory Patents*, defined as patent applications outside a firm's familiar IPC-based technology classes. Panel A reports direct-exposure estimates for firms directly targeted by U.S. export controls. Panel B reports sectoral-exposure estimates for firms operating in sanction-exposed technology categories. All specifications are estimated using Poisson Pseudo Maximum Likelihood (PPML) and include cohort–firm fixed effects and cohort–year–industry–size fixed effects. Standard errors are clustered at the firm level and reported in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Table A.6: Supplier Entry and Exit Responses to U.S. Technology Sanctions

Panel A: Direct Exposure						
	U.S. Supplier Exits	U.S. Supplier Exits	U.S. Supplier Exits	New Chinese Suppliers	New Chinese Suppliers	New Chinese Suppliers
	(1)	(2)	(3)	(4)	(5)	(6)
DTreat × DPost	1.978***	1.990***	2.179***	1.237***	1.072***	1.568***
	(0.590)	(0.602)	(0.649)	(0.381)	(0.378)	(0.420)
DTreat × DPost × Log(CDB)		0.012			0.075**	
		(0.050)			(0.031)	
Log(CDB)		-0.041			0.012	
		(0.043)			(0.018)	
DTreat × DPost × Log(CBL)			-0.026			-0.034
			(0.049)			(0.022)
Log(CBL)			-0.036*			0.003
			(0.020)			(0.007)
Cohort-Firm FE	Y	Y	Y	Y	Y	Y
Cohort-Year-Industry-Size FE	Y	Y	Y	Y	Y	Y
N	2202	2202	2202	10909	10909	10909
Panel B: Sectoral Exposure						
	U.S. Supplier Exits	U.S. Supplier Exits	U.S. Supplier Exits	New Chinese Suppliers	New Chinese Suppliers	New Chinese Suppliers
	(1)	(2)	(3)	(4)	(5)	(6)
STreat × SPost	0.675	0.599	-0.310	-0.102	-0.117	-0.489
	(0.586)	(0.593)	(0.888)	(0.254)	(0.257)	(0.315)
STreat × SPost × Log(CDB)		0.130			0.013	
		(0.088)			(0.040)	
Log(CDB)		-0.002			-0.007	
		(0.066)			(0.019)	
STreat × SPost × Log(CBL)			0.060			0.030
			(0.043)			(0.018)
Log(CBL)			-0.007			-0.004
			(0.026)			(0.007)
Cohort-Firm FE	Y	Y	Y	Y	Y	Y
Cohort-Year-Industry-Size FE	Y	Y	Y	Y	Y	Y
N	1303	1303	1303	8843	8843	8843

Notes: This table examines whether bank lending shapes the entry and exit of supplier relationships following U.S. technology sanctions. Panel A reports direct effects for firms directly designated under U.S. export controls, while Panel B reports sectoral exposure effects for firms exposed through sanction-affected technology categories. The dependent variables are *U.S. Supplier Exits* and *New Chinese Suppliers*. *U.S. Supplier Exits* is the number of terminated supplier relationships with U.S. firms, and *New Chinese Suppliers* is the number of newly established supplier relationships with Chinese firms. The key regressors interact treatment indicators with lending from the China Development Bank and commercial banks. DTreat × DPost equals one for directly sanctioned firms in years at or after the sanction year, and STreat × SPost equals one for firms in sanctioned technology categories in years at or after the category-level sanction year. All specifications include cohort-firm fixed effects and cohort-year-industry-size fixed effects. Standard errors are clustered at the firm level and reported in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. The supplier relationship data are from FactSet Revere.

Table A.7: Technology Sanctions Keyword Dictionary

中文关键词	English Translation	中文关键词	English Translation
技术封锁	technology blockade	保护主义	protectionism
技术制裁	technology sanction	贸易壁垒	trade barrier
技术管制	technology control	关税壁垒	tariff barrier
技术受限	restricted access to technology	贸易摩擦	trade tension
出口管制	export control	反倾销	anti-dumping measure
实体清单	Entity List	外汇管制	foreign exchange control
军事清单	military end-user list	合规风险	compliance risk
禁运	embargo	高端芯片	advanced chip
禁令	ban	国产替代	import substitution
单边制裁	unilateral sanction	自主可控	self-sufficiency in key technologies
国际制裁	international sanction	供应链重构	supply chain restructuring
经济制裁	economic sanction	供应链安全	supply chain security
地缘政治	geopolitical risk	半导体供应	semiconductor supply

Notes: This table describes the construction of the technology-sanctions text measures. To identify discussion of U.S. technology sanctions in firm disclosures, we build a keyword dictionary and apply text analysis to the "Management Discussion and Analysis" (MD&A) section of listed firms' annual reports obtained from CNINFO. The dictionary covers terms related to technology blockades and sanctions (e.g., technology blockade, technology sanctions, export controls, Entity List, military end-user list, embargo/ban), broader policy and trade restrictions (e.g., unilateral/international/economic sanctions, geopolitical risk, trade barriers, tariff barriers, trade tensions, anti-dumping measures, foreign exchange controls, compliance risk), and technology supply-chain topics (e.g., advanced chips, import substitution, self-sufficiency in key technologies, supply chain restructuring/security, semiconductor supply). The Chinese terms and their English equivalents used to build the dictionary are reported above.

Table A.8: Summary Statistics for Disclosure and Sentiment Measures

Variable	Panel A			Panel B		
	N	Mean	SD	N	Mean	SD
	(1)	(2)	(3)	(4)	(5)	(6)
TSF	83568	0.548	0.715	101350	0.384	0.620
TSI	83568	0.016	0.028	101350	0.012	0.025
Negative news	83568	-0.194	0.227	101350	-0.167	0.227
Negative comment	83568	-0.065	0.101	101350	-0.066	0.093
Negative tone	83568	-0.093	0.110	101350	-0.1	0.110

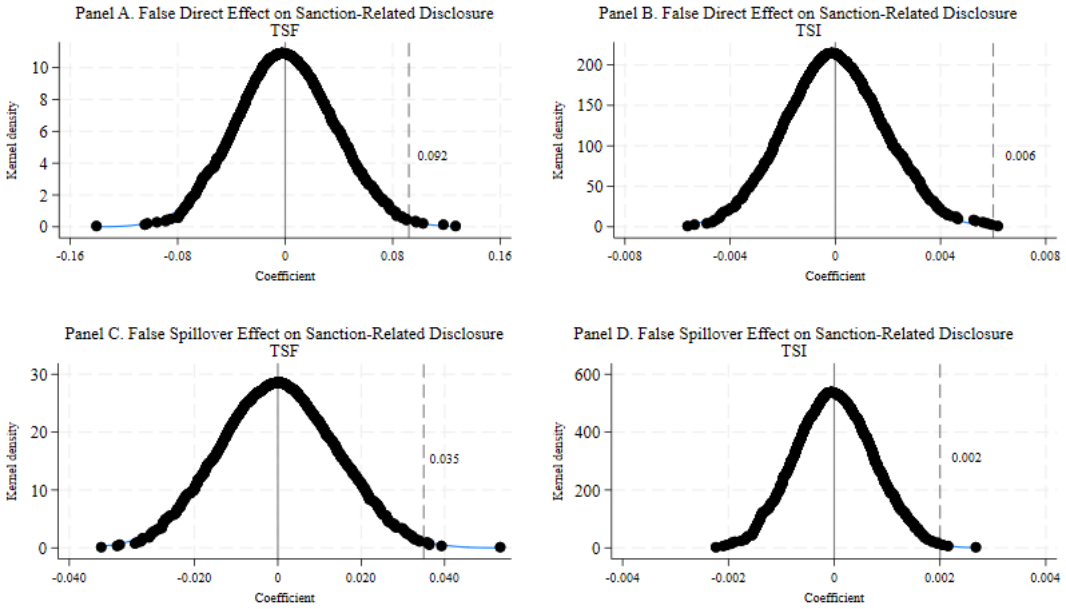
Notes: This table reports descriptive statistics for additional variables used in our analysis. Panel A covers the direct sanctions (list-based) sample, while Panel B covers the sectoral-exposure (technology-class) sample. *TSF* measures the frequency of perceived technology sanctions, defined as the natural logarithm of (the count of technology-sanctions-related terms in the "Management Discussion and Analysis" section of a listed firm's annual report +1). *TSI* measures the intensity of perceived technology sanctions, defined as the ratio of the frequency of technology-sanctions-related terms to total word count in the same section. *Negative news* is the net share of negative news, defined as (number of negative news articles − number of positive news articles) divided by total news articles. *Negative comment* is the net share of negative stock-forum comments, defined as (number of negative posts − number of positive posts) divided by total posts. *Negative tone* is the net share of analysts' negative tone, defined as (number of negative sentences − number of positive sentences) divided by total sentences in analyst reports.

Table A.9: Bank Lending Responses to U.S. Technology Sanctions: Inverse Probability Weighting

	Log(CDB)	Log(CBL)	Log(CDB)	Log(CBL)
	(1)	(2)	(3)	(4)
DTreat × DPost	0.499*	-1.279**		
	(0.291)	(0.563)		
STreat × SPost			0.296**	0.558**
			(0.117)	(0.270)
Cohort-Firm FE	Y	Y	Y	Y
Cohort-Year-Industry-Size FE	Y	Y	Y	Y
N	82991	82991	100594	100594
Adj. R^2	0.212	0.533	0.237	0.512

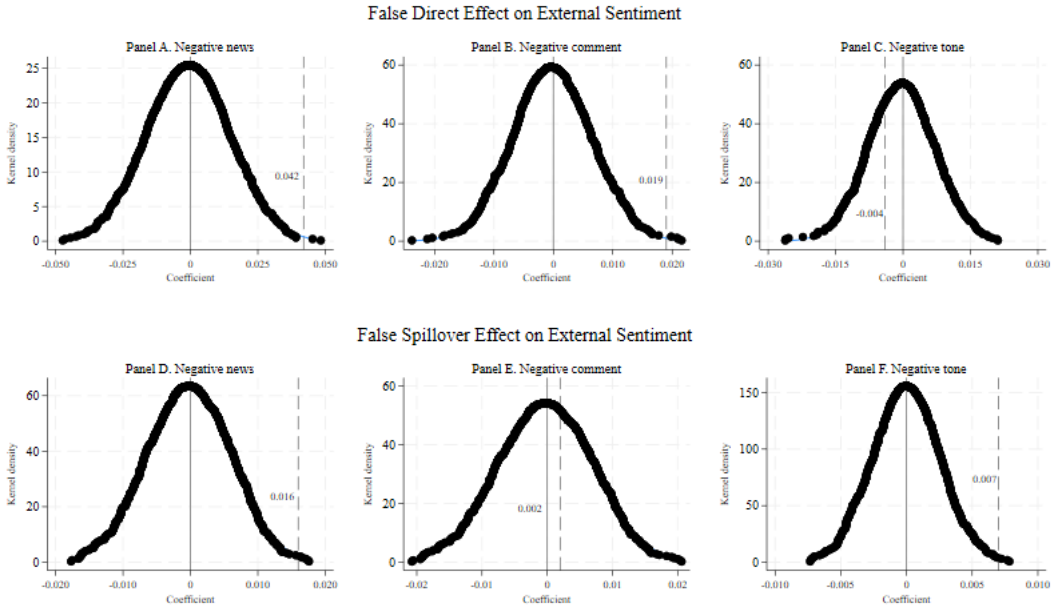
Notes: This table reports stacked difference-in-differences estimates of bank lending responses to U.S. technology sanctions using inverse probability weighting. The dependent variables are *Log(CDB)*, defined as the natural logarithm of China Development Bank lending plus one, and *Log(CBL)*, defined as the natural logarithm of commercial-bank lending plus one. Columns (1)–(2) report estimates for directly exposed firms, defined as firms directly listed on U.S. export-control sanction lists. Columns (3)–(4) report estimates for sectorally exposed firms, defined as firms operating in the same technology categories as sanctioned entities. Propensity scores are estimated using a logit model with firm size, leverage, age, capital expenditure, and return on assets as covariates. Stabilized inverse probability weights are constructed from the estimated propensity scores and winsorized at the 1% level. DTreat × DPost equals one for directly exposed firms in and after the sanction year. STreat × SPost equals one for sectorally exposed firms in and after the category-level sanction year. All specifications include cohort-firm fixed effects and cohort-year-industry-size fixed effects. Standard errors are clustered at the firm level and reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

Figure A.1: Placebo Test: Random Reassignment of Sanctions-Related Disclosure



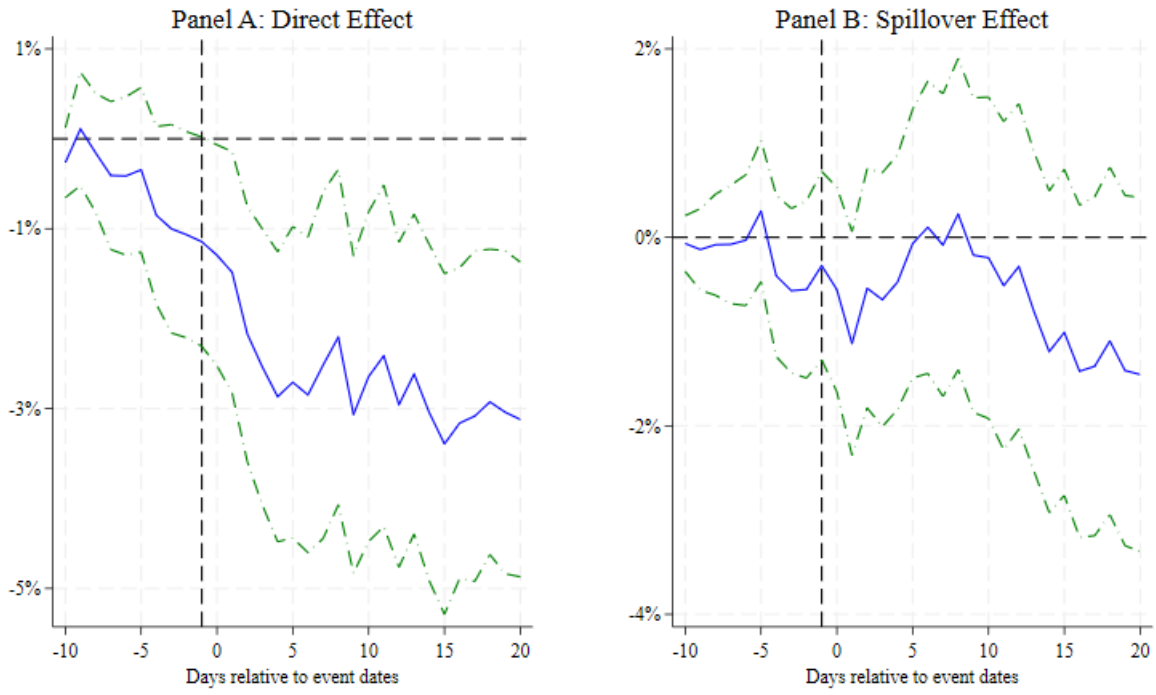
Notes: This figure reports a randomization placebo test for sanctions-related disclosure. We randomly reassign the disclosure measure across firms and re-estimate the baseline specification 1,000 times. The figure plots the distribution of placebo coefficients. The vertical line denotes the baseline estimate from the actual data. The placebo distribution is centered near zero and does not reproduce the baseline estimate, suggesting that the disclosure result is unlikely to be driven by random variation in sanctions-related disclosure.

Figure A.2: Placebo Test: Random Reassignment of External Sentiment



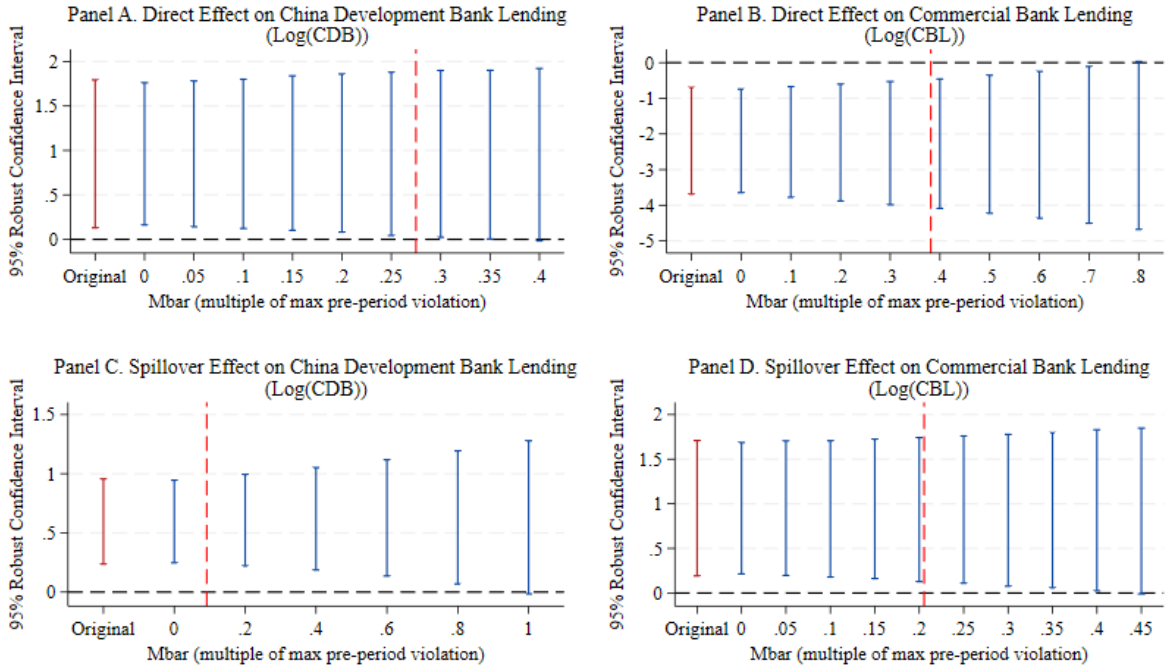
Notes: This figure reports a randomization placebo test for external sentiment. We randomly reassign the external sentiment measures across firms and re-estimate the baseline specification 1,000 times. The figure plots the distribution of placebo coefficients. The vertical line denotes the baseline estimate from the actual data. The placebo distributions are centered near zero and generally do not reproduce the baseline estimates, suggesting that the sentiment results are unlikely to be driven by random variation in external sentiment. Panels C and E correspond to outcomes with insignificant baseline estimates; their placebo distributions are therefore interpreted relative to these null baseline effects.

Figure A.3: Stock-Market Reactions to Technology Sanction Events



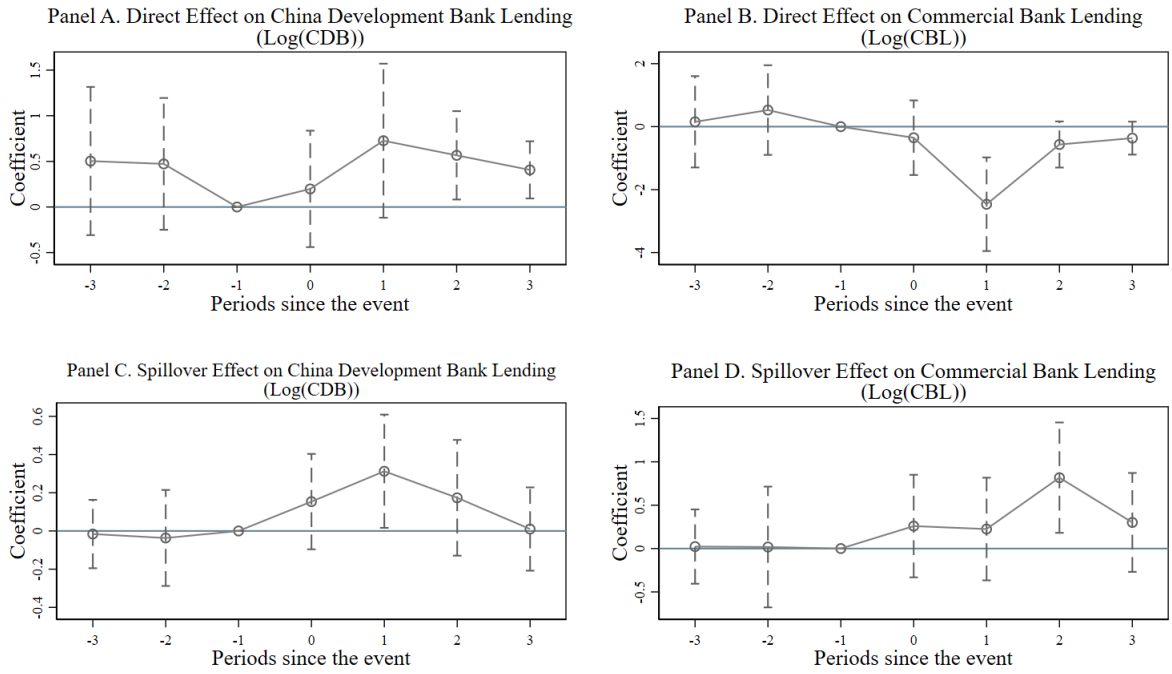
Notes: This figure plots cumulative abnormal returns (CARs) for Chinese listed firms around U.S. BIS export-control announcements. The event window runs from 10 trading days before to 20 trading days after the announcement date. CARs are estimated using the Fama-French five-factor model. For firms or technology categories with multiple designation events, we use the first relevant designation. Panel A reports estimates for directly exposed firms, defined as firms explicitly added to a BIS list, including the Entity List or MEU List. Panel B reports estimates for sectorally exposed firms, defined as firms not directly listed but operating in technology categories affected by BIS restrictions. The vertical dashed line marks the trading day before the announcement. The solid line plots the mean CAR across events, and the dashed lines report 95% confidence intervals.

Figure A.4: Sensitivity to Deviations from Parallel Trends



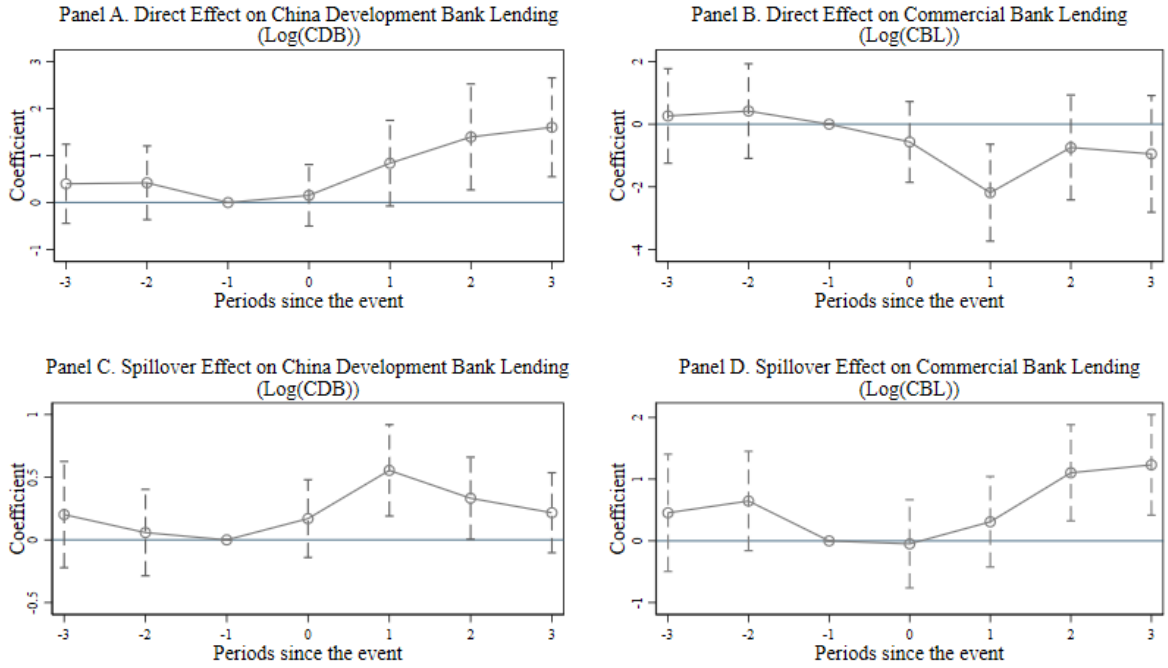
Notes: This figure reports sensitivity analysis for the event-study estimates of bank lending responses to U.S. technology sanctions, following Rambachan and Roth (2023). The analysis assesses how robust the estimated treatment effects are to violations of parallel trends. The horizontal axis reports the sensitivity parameter M, which governs the maximum allowable change in the slope of the underlying trend between consecutive periods. The vertical axis reports the estimated treatment effect on bank lending. Results correspond to the dynamic estimates in Panels A–D of Figure 1. The vertical dashed line marks the benchmark value $\hat{M}$, defined as 0.5 times the standard error of the event-time coefficient with the largest t-statistic. Panels report results separately for directly exposed firms and sectorally exposed firms, and for two outcomes: *Log(CDB)*, defined as the natural logarithm of China Development Bank lending plus one, and *Log(CBL)*, defined as the natural logarithm of commercial-bank lending plus one.

Figure A.5: TWFE Event Study Estimates of Bank Lending Responses to U.S. Technology Sanctions



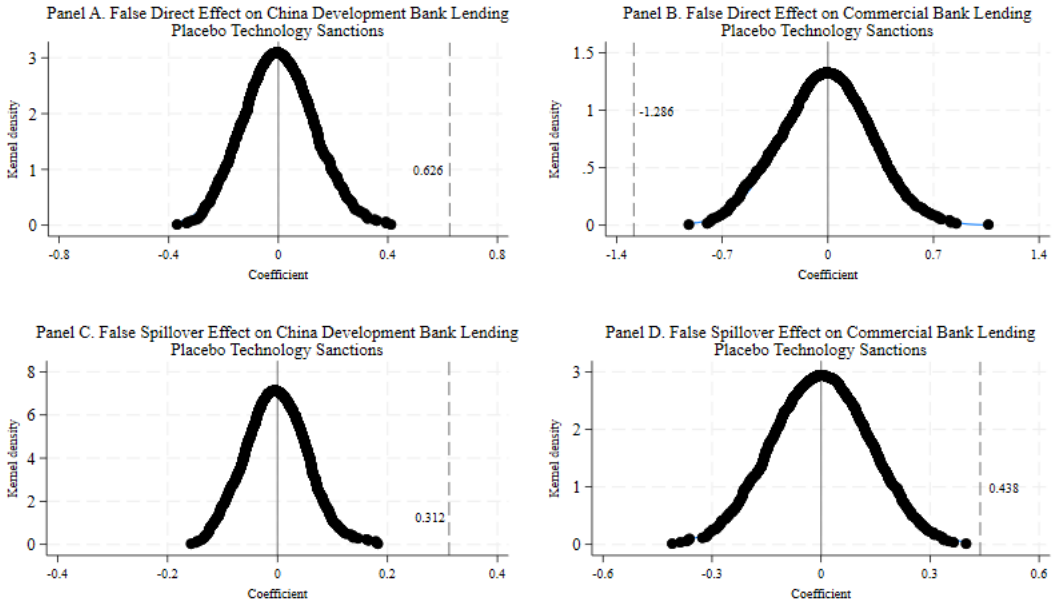
Notes: This figure presents two-way fixed effects event-study estimates of bank lending responses to U.S. technology sanctions. The outcome variables are *Log(CDB)*, defined as the natural logarithm of China Development Bank lending plus one, and *Log(CBL)*, defined as the natural logarithm of commercial-bank lending plus one. Panels A and B report estimates for directly exposed firms, defined as firms directly listed on U.S. export-control sanction lists. Panels C and D report estimates for sectorally exposed firms, defined as firms operating in the same technology categories as sanctioned entities. Coefficients are plotted by event year relative to the sanction year, with the year immediately preceding the sanction normalized to zero. All specifications include firm fixed effects and year fixed effects. Standard errors are clustered at the firm level. Vertical bars denote 95 percent confidence intervals.

Figure A.6: Alternative Event Study: Sun and Abraham (2021)



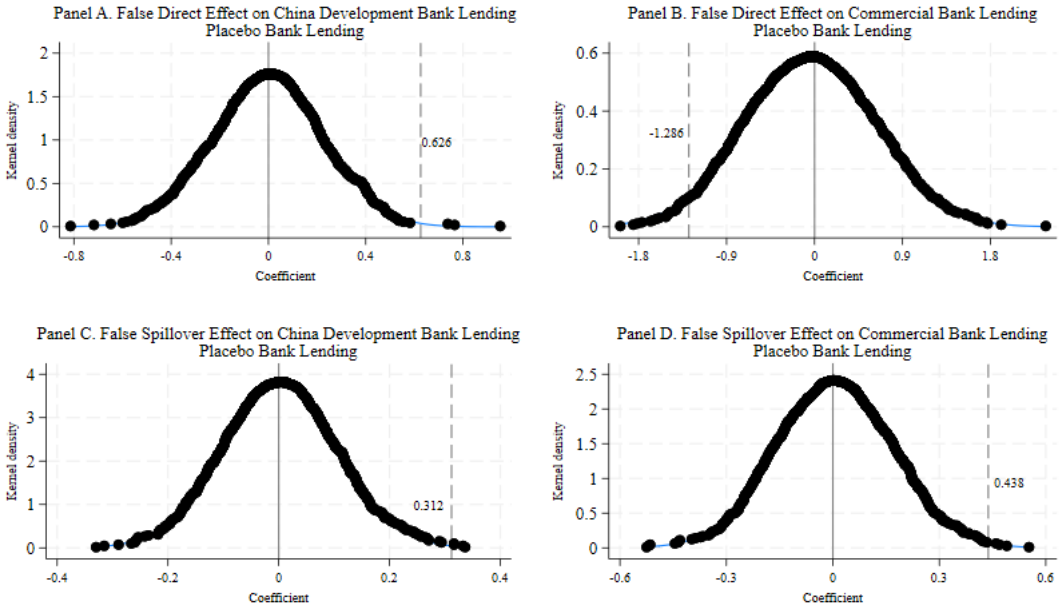
Notes: This figure reports event-study estimates of bank lending responses to U.S. technology sanctions using the interaction-weighted estimator of Sun and Abraham (2021). The estimator allows treatment effects to vary across cohorts and event time, estimates cohort-specific average treatment effects on the treated, and aggregates them by relative time. The outcome variables are *Log(CDB)*, defined as the natural logarithm of China Development Bank lending plus one, and *Log(CBL)*, defined as the natural logarithm of commercial-bank lending plus one. Panels A and B report estimates for directly exposed firms, defined as firms directly listed on U.S. export-control sanction lists. Panels C and D report estimates for sectorally exposed firms, defined as firms operating in the same technology categories as sanctioned entities. Coefficients are plotted by event year relative to the sanction year, with the year immediately preceding the sanction normalized to zero. Standard errors are clustered at the firm level. Vertical bars denote 95% confidence intervals.

Figure A.7: Placebo Test: Random Reassignment of Technology Sanctions



Notes: This figure reports a randomization placebo test for technology-sanction exposure. We randomly reassign the sanction-exposure variable across firms and re-estimate the baseline specification 1,000 times. The figure plots the distribution of placebo coefficients. The vertical line denotes the baseline estimate from the actual data. The placebo distribution is centered near zero and does not reproduce the baseline estimate, suggesting that the main lending results are unlikely to be driven by random assignment of sanction exposure.

Figure A.8: Placebo Test: Random Reassignment of Bank Lending



Notes: This figure reports a randomization placebo test for bank lending. We randomly reassign the bank lending variable across firms and re-estimate the baseline specification 1,000 times. The figure plots the distribution of placebo coefficients. The vertical line denotes the baseline estimate from the actual data. The placebo distribution is centered near zero and does not reproduce the baseline estimate, suggesting that the main lending results are unlikely to be driven by random variation in bank lending.