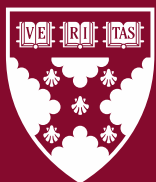


Working Paper 25-004

The Consequences of Export Controls in Target Countries

Xueyue Liu
Yu Liu
Jaya Wen



**Harvard
Business
School**

The Consequences of Export Controls in Target Countries

Xueyue Liu
Fudan University

Yu Liu
Fudan University

Jaya Wen
Harvard Business School

Working Paper 25-004

Copyright © 2024 by Xueyue Liu, Yu Liu, and Jaya Wen.

Working papers are in draft form. This working paper is distributed for purposes of comment and discussion only. It may not be reproduced without permission of the copyright holder. Copies of working papers are available from the author.

Funding for this research was provided in part by Harvard Business School.

The Consequences of Export Controls in Target Countries

Xueyue Liu*

Yu Liu†

Jaya Wen‡

August 19, 2024

Abstract

Export controls are a common instrument of national security, but their economic consequences are not well understood. This paper evaluates how these controls affect firm performance and adaptation in targeted countries. We use variation in a 2007 US policy, commonly called the “China Rule”, that restricted Chinese imports of products with military end-uses. We find a substantial, persistent decrease in Chinese imports of these products from the United States, which are not replaced by imports from the rest of the world. Exposed firms exhibit decreased profits and productivity. Furthermore, exposed firms show signs of adaptation: they are more likely to have positive R&D expenditures and more likely to hold any patent. However, firms do not appear to adapt by substituting to other import partners.

JEL Classification: F13, F14, D22

*School of Economics, Fudan University. Email: liuxueyue@fudan.edu.cn

†School of Economics, Fudan University. Email: yu_liu@fudan.edu.cn

‡Harvard Business School. Email: jwen@hbs.edu

1 Introduction

Sanctions are a crucial instrument of foreign policy for many countries. One category of sanction, export controls, are often implemented to prevent geopolitical rivals from obtaining goods and technologies with military applications. Export controls are common - for example, as of 2023, the US controlled exports to 156 countries for national security reasons,¹ and 42 countries participated in the Wassenaar Arrangement, a multilateral organization that coordinates export controls for thousands of products, from conventional arms to dual-use goods and technologies.

Despite their widespread use, the effectiveness of export controls is not well understood. While they are designed to disrupt the supply of specific products, targeted countries may respond by seeking alternative international sources, fostering domestic production, or innovating to overcome the absence of the restricted goods. Hence, the extent to which export controls achieve their intended effects remains unclear.

This paper studies the economic consequences of a 2007 US policy, known as the “China Military Catch All Rule”, or “China Rule”, that restricted US exports to China of specific products with military applications. We leverage a natural experiment created by the implementation of the policy, which initially targeted 47 product categories that were later reduced to 31. We focus on three questions: whether the policy limited China’s imports of the controlled goods, how the policy affected Chinese firms, and whether Chinese firms and supply chains adapted in response.

Our analysis proceeds in several stages. First, we test whether the China Rule decreased Chinese imports of controlled products using a difference-in-differences approach. Using a firm-product-year dataset, we compare imports of treated six-digit Harmonized System (HS) products relative to untreated six-digit HS products within the same broader four-digit HS category, before and after 2007. We find a decrease in imports of treated products, especially on the extensive margin. Firms were 5.1 percentage points less likely to import any treated product after the policy, relative to untreated products.

Second, we test whether the policy affected firm performance. To do so, we compare firm outcomes among treated and untreated firms, before and after the reform. We define firm-level exposure as an indicator of whether a given firm imported any restricted HS6 product before 2007. We find a statistically significant decline in firm profits and productivity, as well as weakly falling sales and capital stocks. These results suggest that the China Rule hampered the performance of affected manufacturing firms.

Third, we investigate whether Chinese firms invested in adaptation strategies. Using the same difference-in-difference specification as we do for firm outcomes, we find that treated firms were

¹Bureau of Industry and Security (2023) “Commerce Country Chart”. The figure includes all countries with NS 2 export restrictions.

more likely to have positive research and development expenditures and positive patents after the reform. These results suggest that firms sought to adjust to sanctions by developing new production methods. On the other hand, firms did not appear to adapt by switching to new trading partners: we find that imports of controlled products from all non-US countries and non-US allies, fell after the policy.

Overall, these results suggest that the China Rule was effective and restricting the supply of sanctioned goods to Chinese firms. Additionally, in the medium run, the sanctions depressed Chinese firm performance, despite additional innovative activity.

This paper is the first to provide empirical evidence on the economic consequences of export controls for target countries. To date, most work on export controls has been qualitative (Chapman, 2013; Macdonald, 2015; Bown, 2019), and the empirical studies that do exist focus on consequences of export controls for the issuing country. For example, Crosignani et al. (2024) find that US export controls led to decoupling between US and Chinese firms, and US suppliers experienced a drop in stock returns, bank lending, profitability, and employment. Relatedly, Wiggernhorn et al. (2014) find evidence that US-listed firms found in violation of export controls suffer lower stock returns. By offering causal estimates of the impact of export controls on target countries, our paper advances the ability of scholars and policymakers to evaluate the efficacy and unintended consequences of such policies.

Our work also contributes to the economics literature on sanctions, including (Keerati, 2022), which studies financial sanctions on Russia and finds that, due to state protection, the sanctions inadvertently strengthened targeted firms relative to their peers. (Bachmann et al., 2022; Sturm et al., 2022) assess restrictions on Russian energy imports, estimating costs for European countries and the optimal tariff levels, respectively. Ghasseminejad and Jahan-Parvar (2021); Draca et al. (2019) analyze sanctions on Iran and find that they depressed Iranian stock returns and firm profitability, while Kim et al. (2023) finds that trade sanctions on North Korea decreased aggregate output and real income.²

The remainder of the paper is organized as follows: Section 2 presents background information. Section 3 discusses our empirical strategy and data. Section 4 presents results. Finally, Section 5 concludes.

2 Background

In this section, we outline the broader context surrounding the 2007 China Rule and discuss specifics of its implementation.

²We also note a longstanding literature in political science on the efficacy and incidence of sanctions (Hufbauer et al., 1990; Morgan and Schwebach, 1997; Pape, 1997; Baldwin, 1999).

Historically, the United States has at times restricted exports to geopolitical rivals of “dual-use” goods: products that have both military and civilian applications. The first major example of this policy took place in World War I, when the US banned exports of arms, transportation components, and other goods that could aid enemy force. During the Cold War, the US participated in the Coordinating Committee for the Control of Multinational Trade (CoCom), a multilateral organization that limited exports of strategic goods and technology to communist countries (Chapman, 2013).

In the 1990s, after the fall of the Soviet Union, the United States eased dual-use export controls. The period of liberalization endured until September 11, 2001, when the US underwent a significant policy shift, and national security became a top priority. During this period, the Bush administration emphasized the role of economic policies in protecting national security.

During the 2000s, US leadership became increasingly concerned about China’s rapidly expanding military capabilities and announced that it would hedge against China’s military buildup. It was against this backdrop that a new policy was announced.

The 2007 China Rule. On June 19th, 2007, the United States Bureau of Industry and Security (BIS) issued a policy that amended export policies toward China: “Revisions and Clarification of Export and Reexport Controls for the People’s Republic of China (PRC)”, commonly referred to as the “China Military Catch All Rule”, or the “China Rule” (Padilla, 2007a). The rule updated the Export Administration Regulations, which are the implementation mechanism of the Export Administration Act of 1979 (Diamond, 2008). Under this act, the executive branch had the authority to regulate foreign commerce, including creating lists of controlled products for export to particular destinations.

The purpose of the China Rule was to protect United States national security by restricting flows of products and technologies that could contribute to China’s military capabilities. It focused on “dual-use” goods, or those that had both civilian and military applications. The policy was motivated by US concerns about Chinese military expenditures, which have been rising steadily for several decades, at a time of tense relations between the two nations. The rule was also designed to facilitate commercial trade for civilian purposes.

The policy had three major components. First, it placed restrictions on the export, re-export, or transfer of specific products “that would make a direct and significant contribution to China’s military” and changed how export licenses for those products were granted. Second, it created a “Validated End-User” program that allowed Chinese entities to apply for pre-approval and import restricted products. Third, it updated the rules governing End-User Statements, which US exporters sometimes obtain from China’s Ministry of Commerce. In Appendix Section A, we provide excerpts from the original policy document with more details.

The policy’s enforcement mechanism expanded the liability of US exporters, stating that they needed to obtain a license whenever they had “knowledge” that their products were destined for

"military end-uses" in China. Because the rule defined "knowledge" broadly, exporters could be liable in situations when they "should have been aware" of a violation, even if they did not have direct evidence (Corr, 2002). As a result, after the policy, US exporters needed to implement extensive due diligence about each transaction to China or risk harsh penalties, including fines and legal action.

In a draft rule disclosed in July 2006, 26 physical goods under the Export Control Classification Number (ECCN) system were slated for inclusion under export controls. However, addressing concerns voiced in public comments, BIS conducted a thorough military and economic impact review. This review employed three criteria to determine whether a product should be controlled. In order of their importance, the criteria were: the military applicability of each item, the extent of US exports of the item, and the availability of the item from other countries. After deliberation, 9 ECCN goods were removed from the list, resulting in 17 ECCN goods classifications that were subject to final export controls.³

Experts anticipated that the policy would decrease Chinese imports of controlled products. One factor was firm uncertainty around whether they were in violation of the policy. US exporters, especially small and medium firms, had difficulty analyzing the complex ties between Chinese enterprises and the military, as ownership structures and ties with the state are often opaque. As a result, many firms avoided any transactions that might expose them to legal risk. Furthermore, though VEU program theoretically allowed qualified Chinese firms to obtain pre-approval to buy restricted products, the requirements were extremely stringent. To illustrate, only 5 firms were part of the VEU program in 2008, and this number had increased to just 12 by 2016.

Overall, policymakers viewed the rule as "one of the most important changes to export control policy in many years" (Padilla, 2007b). There was, however, disagreement as to whether the policy would achieve its intended effects. Critics argued that China would eventually source controlled goods from other countries or manufacture them domestically. They also reasoned that the rule would hurt US businesses and drive adaptation and innovation in China (Diamond, 2008). We use data to test these competing hypotheses.

3 Empirical Strategy

Imports. Our analysis proceeds in several steps. First, we estimate the impact of the *China Rule* on Chinese firm imports from the United States. To do so, we compare the 17 final treated ECCN goods from the 9 ECCN products that were selected and later removed. To implement this comparison, we use a crosswalk to map ECCN codes to six-digit Harmonized System (HS)

³The initial list also contained 21 software and technology products, whereas the final list also contained 14 software and technology products. Due to the coverage of our data, we do not study these items.

codes, resulting in 59 treated HS six-digit products and 18 control HS six-digit products. Using a firm-product-year-level dataset, we estimate:

$$y_{f,hs6,t} = \beta Treat_{hs6} \times \mathbb{I}_{t \geq 2007} + \theta_f + \theta_{hs6} + \theta_{hs4} \times t + \varepsilon_{f,hs6,t}, \quad (1)$$

where f indexes firms, $hs6$ indexes six-digit HS products, $hs4$ indexes four-digit HS products, and t indexes years. Each observation is at the firm, six-digit product, and year level. $Treat_{hs6}$ is a indicator that equals one if the six-digit HS product was ever subject to an export control and zero if it was initially listed as a controlled item but removed during deliberations. $\mathbb{I}_{t \geq 2007}$ is an indicator that equals one if the year is 2007 or later and zero otherwise.

We will focus on two outcome variables, $y_{f,hs6,t}$, whether a firm imported a given HS6 product in a given year, and the natural log of a firm's import value of a given HS6 product in a given year. The specification controls for firm fixed effects, θ_f , six-digit HS product fixed effects, θ_{hs6} , and four-digit HS product-specific time trends, $\theta_{hs4} \times t$. The firm fixed effects absorb average differences in imports by firm. The six-digit HS product fixed effects address the possibility that some six-digit products are always imported more. Finally, the four-digit HS product-time trends ensure that we control for differences in imports over time by broad product group. We cluster standard errors at the six-digit HS level, as that is the unit targeted by export controls.

The coefficient β captures the relative increase in US imports of treated six-digit products relative to dropped products. Ex ante, we expect the export controls to have decreased imports from the US of treated goods after 2007, such that $\beta < 0$.

In addition to the average treatment W of β , it is useful to understand the dynamic effects of treatment. To this end, we estimate:

$$y_{f,hs6,t} = \sum_{j=2001}^{2013} \beta_j Treat_{hs6} \times \mathbb{I}_{t=j} + \theta_f + \theta_{hs6} + \theta_{hs4} \times t + \varepsilon_{f,hs6,t}. \quad (2)$$

This equation produces separate estimates for each year. $\mathbb{I}_{t=j}$ is an indicator variable for year j . Fixed effects and clustering remain the same as in Equation 1. The coefficients β_j capture the difference in imports during year j for treated six-digit HS products relative to untreated six-digit products in the same four-digit HS category. Ex ante, we expect $\beta_j < 0$ for $j \geq 2007$. We set 2006, the year prior to treatment, as the omitted category.

Firm Outcomes. Next, we analyze whether the export controls affected the behavior and outcomes of Chinese firms, again comparing the 17 final treated ECCN products from the 9 ECCN products that were selected and later removed. We estimate the following using a firm-year-level dataset:

$$y_{fscf} = \beta Treat_f \times \mathbb{I}_{t \geq 2007} + \theta_f + \theta_s \times t + \theta_c \times \tau_t + \varepsilon_{fscf}, \quad (3)$$

where f indexes firms, s indexes four-digit CIC industries, c indexes counties, and t indexes years. Each firm is assigned to one industry. $Treat_f$ is a firm-level indicator that equals one if the firm imported any restricted HS6 product before 2007 and zero if it imported a removed HS6 product before 2007.

We will use firm variables including sales, profits, inputs, and productivity as outcomes $y_{fsc,t}$. We also control for firm fixed effects, θ_f , industry-specific trends, $\theta_s \times t$ and county-by-year fixed effects, $\theta_c \times \tau_t$. The firm fixed effects remove any constant differences in these outcomes across firms over time, while the industry-specific trends remove differences in industry growth rates and demand trends. The county-by-year fixed effects remove average differences in firm outcomes across different places in China, due for example to regional exposure to shocks. We cluster standard errors at the firm level.

The coefficient β captures the difference in outcomes among firms that imported any exposed products relative to firms that imported control products, before and after the sanctions. Ex ante, we expect the export controls to have generally harmed firm performance, such that $\beta < 0$ for outcomes like sales and profits.

Analogously to the import results, we also estimate a year-by-year version of Equation 3 to assess pre-trends and dynamic effects. We interact the firm treatment variable with indicators for each year of the sample, $\mathbb{I}_{t=j}$, treating 2006 as the omitted group. Coefficients β_j capture the year-by-year difference in the outcome $y_{f,hs6,t}$ among treated and untreated firms.

$$y_{fsc,t} = \sum_{j=2001}^{2013} \beta_j Treat_f \times \mathbb{I}_{t=j} + \theta_f + \theta_s \times t + \theta_c \times \tau_t + \varepsilon_{fsc,t}. \quad (4)$$

3.1 Data

Sanctioned Products. The *China Rule* was implemented using Export Control Classification Numbers (ECCN), a product classification code used by BIS. We match these codes to six-digit Harmonized System 1996 (HS6) products using a crosswalk from the E.U. Council.⁴ We match these codes to four-digit Chinese Industrial Code (CIC4) industries using the crosswalk from Brandt et al. (2017).

Chinese Trade Flows. We measure Chinese trade flows using transaction-level *Chinese Customs Data*, which are available from 2000 to 2016. For all import and export transactions, we observe total value, item quantity, product code⁵, and source or destination country. We also observe characteristics of the importing or exporting firm, including its name, location, and ownership

⁴Source: Directorate-General for Financial Stability, Financial Services and Capital Markets Union, “Export-Related Restrictions for Dual-Use Goods and Advanced Technologies”, 2023. URL: https://finance.ec.europa.eu/publications/export-related-restrictions-dual-use-goods-and-advanced-technologies_en

⁵Products are recorded using eight-digit Harmonized System (HS) codes.

category. We use these data to construct several variables, including whether a given firm imported a given HS6 product in a given year, and the value that they imported.

Chinese Firm Outcomes. We obtain firm balance sheets and income statements from the *Annual Survey of Industrial Production* (ASIP), 1998-2013. The ASIP is conducted each year by the National Bureau of Statistics (NBS). These data cover large manufacturing firms with annual revenues above 5 million RMB (603,865 USD). Because of documented data quality issues with the 2010 survey, we omit it from our sample (Brandt et al., 2023, 2020). We also note that firm value-added and intermediate inputs are no longer reported in ASIP starting 2009. We calculate those variables following the process in Brandt et al. (2020) for 2011-2013.⁶ Unfortunately, the necessary inputs for that calculation are also not available for 2009.

The data contain a rich set of variables related to firm production, including sales, profits, value-added, capital, employment, and intermediate inputs. We use these variables estimate firm productivity, following the procedure of De Loecker and Warzynski (2012). To link firm outcomes to trade flows, we merge the Customs and ASIP data using firm names.⁷ The resulting merge covers 182,293 out of 791,574 unique ASIP firms and out of 629,424 unique Customs firms. This match rate is comparable to that of Yu (2015).⁸

We obtain information on firm patents from the China National Intellectual Property Administration (CNIPA). We obtain firm-level research and development expenditures from ASIP for 2000-2007 and directly from the National Bureau of Statistics (NBS) for 2008-2013.⁹ The variable is computed and reported in the same way for the entire time period.

Given the temporal coverage of the Customs data and firm data, our final regression sample includes 2000 through 2013.

4 Results

Imports. To understand whether the China Rule achieved its central target of decreasing Chinese imports of controlled goods from the United States, we estimate Equation 1. We use two different outcome variables: an indicator for greater than zero imports of a given product from a given firm, and the natural log of total import value. We consider two different samples: the full Customs

⁶We describe this process in Appendix C.

⁷We match three set firm-level data by firm name. To improve matching efficiency, we first clean firms' names as follows: (1) we delete spaces, punctuation marks, and other symbols; (2) we standardize all letters in firm and applicant names in capital form in English style; (3) we single out five high-frequency general terms by statistical analysis and drop them: "limited," "liability," "stock," "company," "factory;" and (4) we delete general terms for regions: "province," "autonomous region," "city," "district," "county." Then we match import data and patent data with ASIP data, year by year.

⁸Yu (2015) matched firms using exactly identical company names and exactly identical postal codes and phone numbers for years 2000 to 2006.

⁹Specifically, we use Table 107-2 for all available firms from 2008-2013.

sample, as well as the sample for which we have both Customs and ASIP data, which we call the “matched sample”. Table 1 reports the results.

Table 1: Imports from the US

	(1)	(2)	(3)	(4)
	Customs Sample		Customs-ASIP Matched Sample	
	I(Imports > 0)	Ln(Imports)	I(Imports > 0)	Ln(Imports)
<i>Pre-2007 Mean</i>	0.240	9.280	0.260	9.280
Treat x Post-2007	-0.030** (0.012)	-0.025 (0.072)	-0.051*** (0.014)	-0.027 (0.074)
Observations	346,899	74,362	262,906	57,222
R-squared	0.142	0.426	0.125	0.408

Notes: Observations are at the firm-HS6-year level. The data cover 2001-2013 except 2010. All regressions include firm fixed effects, HS6 product fixed effects, and HS4 product-specific time trends. Standard errors are clustered at the HS6 product level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Column (1) shows that, in the full Customs sample, firms were 3.0 percentage points less likely to import treated HS6 products relative to untreated HS6 products within the same HS4 category. The coefficient is statistically significant at the $p < 0.05$ level. Column (2) shows that, conditional on having positive imports in a given product, treated products were not imported at different amounts relative to untreated products.

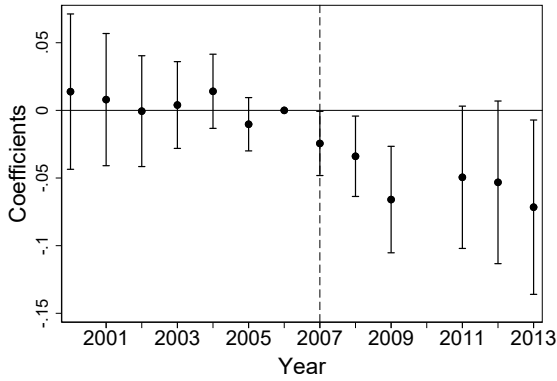
Next, we produce the same results for the Customs-ASIP matched sample. The total firm-HS6-year observations decrease from 346,899 to 262,906 million, a decline of 24%. In column (3), we find that treated HS6 products were 5.1 percentage points less likely to be imported at all relative to products in the same HS4 category with $p < 0.01$. In column (4), we again find that, conditional on having positive import values, firms did not import different amounts of treated products relative to untreated products.

These results indicate that export controls decreased Chinese imports of treated goods through the extensive margin. Additionally, the comparison between the first and last two columns show that focusing on the matched sample does not qualitatively change the results.

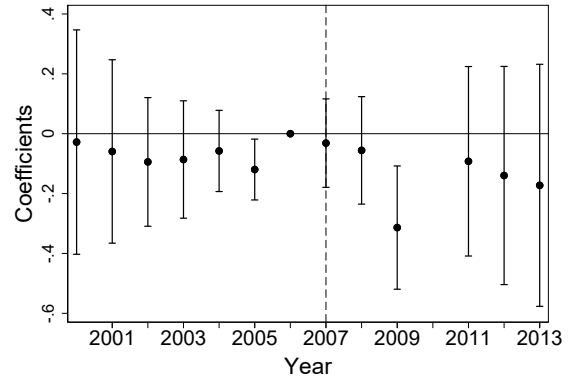
Now, we examine pre-trends and dynamic effects for these import results. Figure 1 display coefficients β_j from Equation 2. Across all four subfigures, we observe no evidence of pre-trends. In Subfigures (a) and (c), the treatment effect is negative and persistent in the six years after treatment. Subfigures (b) and (d) corroborate that export controls primarily affected the extensive margin, rather than intensive margin, of product imports.

Figure 1: Imports from the US: Dynamic Effects

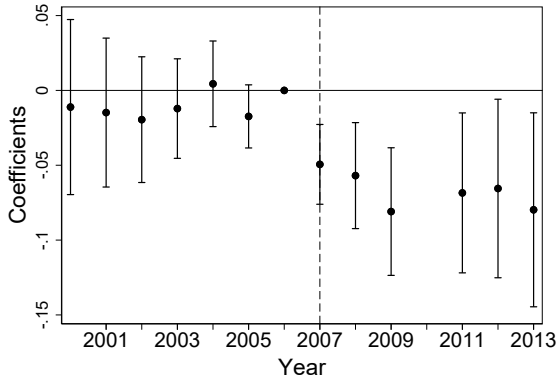
(a) Any Imports from the US - Customs Sample



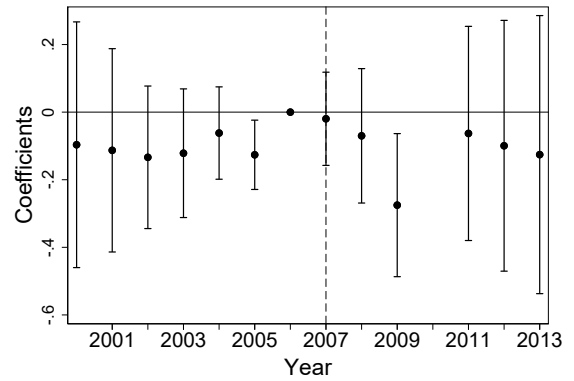
(b) Ln Imports from the US - Customs Sample



(c) Any Imports from the US - Matched Sample



(d) Ln Imports from the US - Matched Sample



Firm Outcomes. Next, we assess whether and how the China Rule export controls affected treated Chinese firms by estimating Equation 3. We consider the natural log of the following outcomes: total sales, total profits, capital (fixed assets), employment, intermediate inputs, and value added. We also compute total factor productivity of revenue using the value-added method from De Loecker and Warzynski (2012). Note that we do not consider the extensive for these variables as, except for profits, they are all strictly positive.

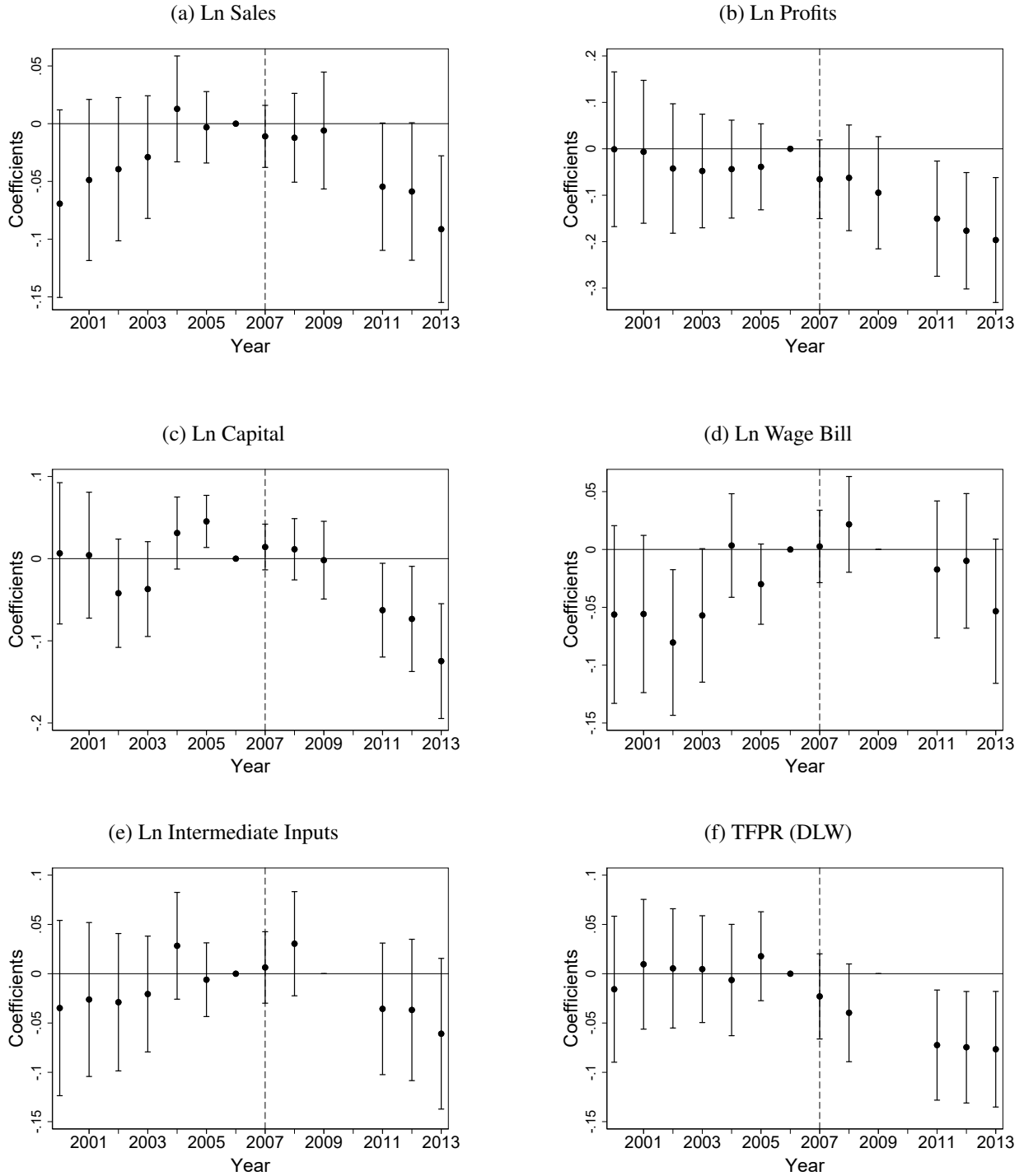
Table 2 reports the results. We find that, relative to untreated firms, treated firms had lower sales, profits, capital, value added, and TFPR after 2007. Column (1) shows that sales of treated firms weakly declined by $e^{0.019} - 1 = 1.9\%$ after 2007, though the coefficient is not statistically significant. Column (2) shows that profits of treated firms were $e^{0.086} - 1 = 9.0\%$ lower after 2007. The coefficient is statistically significant at the $p < 0.05$ level. Firm inputs of capital, wage bills, and intermediate inputs did not respond in a statistically significant way. Finally, among treated firms after 2007, TFPR was $e^{0.053} - 1 = 5.4\%$ lower.

We then analyze the pre-trends and dynamic effects of these firm results using Equation 4. Note

that we omit the 2010 survey for data quality issues and that intermediate input and productivity data are missing for 2009. Figure 2 displays the results. We find that logged sales, profits, capital, and productivity all decline over time. The decrease is gradual, with the first two years after the reform displaying smaller treatment effects than 2011-2013. The pre-trends for sales, profits, capital, and productivity do not appear to drive the post-treatment decline. We note an increasing pre-trend in log wage bill, so we interpret it with caution.

Overall, the firm results suggest that US export controls depressed the performance of exposed Chinese firms. The effects were muted at first and increased in the medium-term, and had economically relevant magnitudes.

Figure 2: Firm Performance



Military Firms. Because the stated policy objective of the export control was to limit China's military capacity, we next investigate the differential response of firm manufacturing military goods relative to all other firms. In China, there are twelve military conglomerates, all of which are

managed by the State-owned Assets Supervision and Administration Commission (SASAC).¹⁰ Using data from the State Administration of Industry and Commerce, we then identify the names of all subsidiaries of these corporations up to ten layers of ownership. Finally, we match this list of names with firm names in our main firm dataset, ASIP. We identify 118 unique military firms in our baseline sample.

We create an indicator for military firms, $Military_f$, and estimate the following variation of Equation 3:

$$y_{fsc} = \beta_{military} Treat_f \times \mathbb{I}_{t \geq 2007} \times Military_f + \beta Treat_f \times \mathbb{I}_{t \geq 2007} + \gamma \mathbb{I}_{t \geq 2007} \times Military_f + \theta_f + \theta_s \times t + \theta_c \times \tau_t + \varepsilon_{fsc}, \quad (5)$$

Table 3 displays the coefficients $\beta_{military}$ and β for each of the main firm outcomes. The row labeled “Treat x Post-2007” reports β and, unsurprisingly given the small number of military firms, the values are nearly identical to those in Table 2. The row of coefficients above it reports $\beta_{military}$ for each firm outcome, and can be interpreted as the differential effect of treatment among military firms. Though none of the coefficients are statistically significant, likely due to the small number of military firms, we find that they are predominantly negative. For example, in column (2), we find that military firms had -0.453 log points lower profits, for a total treatment effect equaling a $e^{(0.082+0.453)} - 1 = 70.7\%$ decline in profits. Similarly, in column (6), we find that military firms’ productivity declined slightly more than those of all other firms, by $e^{(0.053+0.006)} - 1 = 6.1\%$ on average.

These results suggest that the China Rule decreased the performance of military firms, an intended consequence of the policy. Furthermore, the decline in performance among military firms was weakly larger than those of other manufacturing firms, though statistical power is limited by a small sample size.

Firm Adaptation. Once certain products are controlled, Chinese firms may try to adapt in a variety of ways. Here, we test a few key channels: innovation and substitution to other partner countries.

Did affected firms adapt to export controls by innovating? We measure innovation using research and development (R&D) expenditures and total patents. Table 4 displays the results. In Panel A, we explore the extensive margin of these innovation behaviors, and in Panel B, we explore the intensive margin. Column (1) shows that treated firms were 2.9 percentage points more

¹⁰The twelve conglomerates are: the China National Nuclear Corporation, the China Nuclear Engineering & Construction Corporation, the China Aerospace Science and Technology Group Corporation, the China Aerospace Science And Industry Corporation, the Aviation Industry Corporation Of China, the China Aircraft Engine Group Corporation, the China Shipbuilding Industry Corporation, the China Shipbuilding Industry Corporation, the China North Industries Group Corporation, the China Weapon Equipment Group Corporation, the China Electronics Technology Group Corporation, and the China Electronics Corporation.

Table 2: Firm Outcomes

	(1)	(2)	(3)	(4)	(5)	(6)
	Ln(Sales)	Ln(Profits)	Ln(Capital)	Ln(Wage Bill)	Ln(Inter. Inputs)	TFPR (DLW)
<i>Pre-2007 Mean</i>	11.77	8.980	10.56	8.930	11.45	-0.170
Treat x Post-2007	-0.019 (0.022)	-0.086** (0.041)	-0.036 (0.024)	0.021 (0.021)	-0.007 (0.025)	-0.053*** (0.018)
Observations	76,324	59,900	76,324	70,334	69,792	63,903
R-squared	0.907	0.784	0.920	0.882	0.883	0.559

Notes: Observations are at the firm-year level and include firms matched in the Customs and ASIP. The data cover 2001-2013, except 2010. Columns 4-6 are missing for the year 2009. All regressions include firm fixed effects, county-by-year fixed effects, and industry-specific time trends. Standard errors are clustered at the firm level. *** p<0.01, ** p<0.05, * p<0.1.

Table 3: Military Firm Outcomes

	(1)	(2)	(3)	(4)	(5)	(6)
	Ln(Sales)	Ln(Profits)	Ln(Capital)	Ln(Wage Bill)	Ln(Inter. Inputs)	TFPR (DLW)
<i>Pre-2007 Mean</i>	11.77	8.980	10.56	8.930	11.45	-0.170
Treat x Post-2007 x Military	-0.152 (0.158)	-0.453 (0.362)	0.007 (0.217)	-0.252 (0.191)	-0.058 (0.242)	-0.006 (0.205)
Treat x Post-2007	-0.018 (0.022)	-0.082** (0.041)	-0.036 (0.024)	0.023 (0.021)	-0.006 (0.025)	-0.053*** (0.018)
Observations	76,324	59,900	76,324	70,334	69,792	63,903
Observations, Military	933	766	933	876	870	745
R-squared	0.907	0.784	0.920	0.882	0.883	0.559

Notes: Observations are at the firm-year level and include firms matched in the Customs and ASIP. The data cover 2001-2013, except 2010. Columns 4-6 are missing for the year 2009. All regressions include firm fixed effects, county-by-year fixed effects, and industry-specific time trends. Standard errors are clustered at the firm level. *** p<0.01, ** p<0.05, * p<0.1.

likely to have positive R&D expenditures, with a coefficient statistically significant at the $p < 0.01$ level. Column (2) shows that treated firms were 1.8 percentage points more likely to have any patent, with a coefficient statistically significant at the $p < 0.05$ level, and that their logged number of patents increased by $e^{0.182} - 1 = 20.0\%$.

Table 4: Firm Adaptation

	(1)	(2)	(3)	(4)	(5)
			Imports of Controlled Products from:		
	R&D Expenditures	Total Patents	Non-U.S. Countries	Non-U.S. Allies	U.S.
Panel A: I(Outcome > 0)					
<i>Pre-2007 Mean</i>	<i>0.280</i>	<i>0.140</i>	<i>0.400</i>	<i>0.270</i>	<i>0.280</i>
Treat x Post-2007	0.029*** (0.010)	0.018** (0.008)	-0.043*** (0.010)	-0.016* (0.008)	-0.198*** (0.007)
Observations	69,205	76,324	76,324	76,324	76,324
R-squared	0.613	0.575	0.579	0.575	0.494
Panel B: Ln(Outcome)					
<i>Pre-2007 Mean</i>	<i>7.120</i>	<i>1.490</i>	<i>11.47</i>	<i>10.97</i>	<i>10.07</i>
Treat x Post-2007	-0.035 (0.079)	0.182** (0.084)	-0.014 (0.115)	-0.077 (0.179)	- -
Observations	22,162	12,923	26,853	17,005	
R-squared	0.841	0.772	0.754	0.721	

Notes: Observations are at the firm-year level and include firms matched in the Customs and ASIP. The data cover 2001-2013, except 2010. All regressions include firm fixed effects, county-by-year fixed effects, and industry-specific time trends. Standard errors are clustered at the firm level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

In Figure 3, Subfigures (a), (b), and (c), we test whether pre-trends drive the results for any R&D, any patents, and the natural log of total patents. We do not observe pre-trends for the first two variables. The omitted group is 2006, and data for R&D expenditures was not available for 2004. We note that the increase in R&D expenditures is concentrated in the first two years after treatment, whereas the point estimate for having any patents is positive and steady from 2008 to 2013. In Subfigure (c), we observe a positive pre-trend leading up to the treatment year. As a result, we interpret this result with caution.

Next, we consider whether affected firms adapted by importing controlled goods from other countries. We consider two sets of partners: all countries outside of the United States, and countries that are not US allies.¹¹ In Panel A, column (3), we find that firms were 4.3 percentage points less

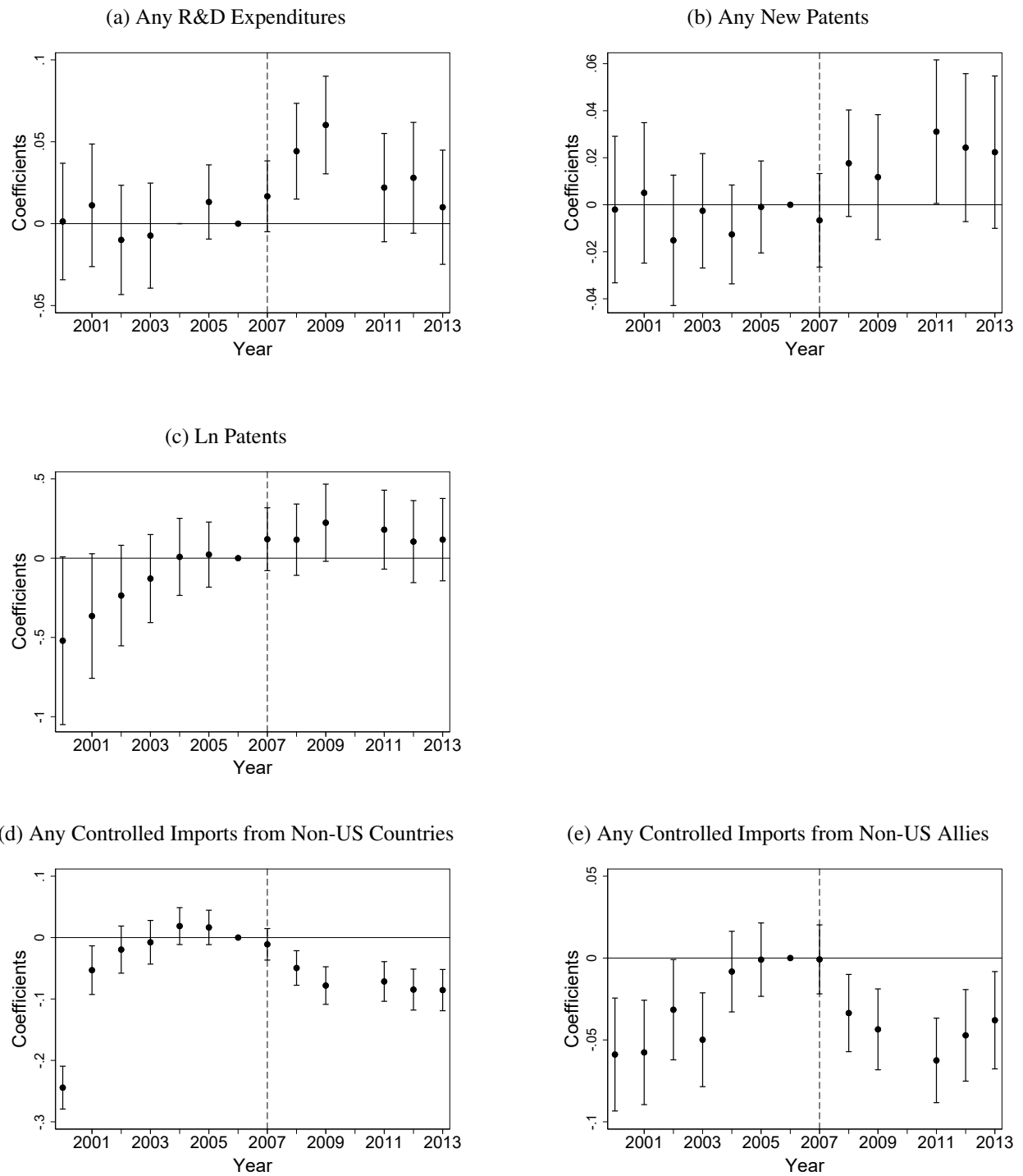
¹¹We use alliance definitions from Kleinman et al. (2024).

likely to have any imports of controlled products from countries other than the United States. This result suggests that Chinese firms were not able to substitute toward other trading partners for controlled goods, and that countries around the world may have acted in concert with US policy. In Panel A, column (4), we perform the same exercise for non-US allies, with the idea that non-allies may have been less likely to go along with US policies. We find that treated Chinese firms were 1.6 percentage points less likely to import controlled goods from non-US allies. Again, this result suggests that firms were not able to make up for imports of controlled goods by turning to other trading partners. In Panel B, we find no intensive-margin effects for imports from either group.

For comparison, we run the same regression for imports of controlled products from the United States in column (5). We find that treated firms were 20 percentage points less likely to import any controlled products from the United States (on a pre-period mean of 28 percentage points). This metric demonstrates that the decline in imports of controlled goods from the US was much larger than the decline from other countries and from non-US allies. We also note that, due to the definition of the treatment variable, we cannot estimate the intensive margin for US imports of controlled goods, as the control group definitionally has zero import flows (and thus missing log import flows).

In Figure 3, Subfigures (d) and (e), we examine pre-trends and dynamic effects. We find that there may be a slightly positive pre-trend on both import indicators. These pre-trends would tend to go against our finding of a decline. Overall, the decline in controlled imports from non-US countries is quite steady. The decline in controlled imports from non-US allies is smaller in magnitude, and may attenuate slightly by 2013.

Figure 3: Firm Adaptation



5 Conclusion

Export controls are globally widespread and generally used to limit the access of geopolitical rivals to critical goods and technologies. However, some policymakers have raised questions about the efficacy of export controls and their consequences for targeted countries. First, they have debated whether such controls truly decrease China's overall access to restricted products, or if targets are able to find substitute suppliers elsewhere around the world. They also raise the possibility that such sanctions spur domestic innovation.

In this paper, we provide direct empirical evidence on these issues. We find that in the short- and medium-run, US export controls successfully decreased Chinese imports of controlled products, both from the US and from the entire world. Chinese firms were not able to make up for the shortfall from other countries including non-US allies. Furthermore, we find that exposed firms suffered negative performance consequences, despite additional investments in adaptation. Whether this is desirable from a policy perspective is open to debate. The manufacturing firms in our sample operate in non-military sectors, and may be considered unintended targets of the policy. Additionally, in the long run, firm investments in R&D and new patents could lead to domestic substitutes for controlled goods. Overall, we seek to shed light on an urgent policy debate.

References

- Bachmann, Rüdiger, David Baqaee, Christian Bayer, Moritz Kuhn, Andreas Löschel, Benjamin Moll, Andreas Peichl, Karen Pittel, and Moritz Schularick**, “What if Germany is cut off from Russian energy?,” *VoxEU.org*, 2022, 25.
- Baldwin, David A**, “The sanctions debate and the logic of choice,” *International security*, 1999, 24 (3), 80–107.
- Bown, Chad P**, “Export controls: America’s other national security threat,” *Duke J. Comp. & Int’l L.*, 2019, 30, 283.
- Brandt, Loren, Johannes Van Biesebroeck, and Yifan Zhang**, “Creative accounting or creative destruction? Firm-level productivity growth in Chinese manufacturing,” *Journal of development economics*, 2012, 97 (2), 339–351.
- , —, **Luhang Wang, and Yifan Zhang**, “WTO accession and performance of Chinese manufacturing firms,” *American Economic Review*, 2017, 107 (9), 2784–2820.
- , —, **Yifan Zhang, and Luhang Wang**, “Where has all the dynamism gone? Productivity growth in China’s manufacturing sector, 1998-2013,” 2023.
- , **John Litwack, Elitza Mileva, Luhang Wang, Yifan Zhang, and Luan Zhao**, “China’s productivity slowdown and future growth potential,” 2020.
- Chapman, Bert**, *Export controls: a contemporary history*, University Press of America, 2013.
- Corr, Christopher F**, “The Wall Still Stands: Complying with Export Controls on Technology Transfers in the Post-Cold War, Post-9/11 Era,” *Houston Journal of International Law*, 2002, 25, 441.
- Crosignani, Matteo, Lina Han, Marco Macchiavelli, and André F Silva**, “Geopolitical Risk and Decoupling: Evidence from US Export Controls,” *FRB of New York Staff Report*, 2024, (1096).
- Diamond, Andrew F**, “Dueling over Dual-Use Goods: The US Department of Commerce’s Misguided Attempt to Promote US Security and Trade with China through Restrictive Export Controls,” *Brooklyn Journal of Corporate, Financial & Commercial Law*, 2008, 3, 153.
- Draca, Mirko, Jason Garred, Leanne Stickland, and Nele Warrinnie**, “On target? The incidence of sanctions across listed firms in Iran,” Technical Report, LICOS Discussion Paper 2019.

- Ghasseminejad, Saeed and Mohammad R Jahan-Parvar**, “The impact of financial sanctions: The case of Iran,” *Journal of Policy Modeling*, 2021, 43 (3), 601–621.
- Hufbauer, Gary Clyde, Jeffrey J Schott, and Kimberly Ann Elliott**, *Economic sanctions re-considered: History and current policy*, Vol. 1, Peterson Institute, 1990.
- Keerati, Ritt**, “The unintended consequences of financial sanctions,” *Available at SSRN 4049281*, 2022.
- Kim, Jihee, Kyoochul Kim, Sangyoon Park, and Chang Sun**, “The economic costs of trade sanctions: Evidence from North Korea,” *Journal of International Economics*, 2023, 145, 103813.
- Kleinman, Benny, Ernest Liu, and Stephen J Redding**, “International Friends and Enemies,” *American Economic Journal: Macroeconomics*, 2024, *Forthcoming*.
- Loecker, Jan De and Frederic Warzynski**, “Markups and firm-level export status,” *The American Economic Review*, 2012, 102 (6), 2437–2471.
- Macdonald, Stuart**, *Technology and the tyranny of export controls*, Springer, 2015.
- Morgan, T Clifton and Valerie L Schwebach**, “Fools suffer gladly: The use of economic sanctions in international crises,” *International Studies Quarterly*, 1997, 41 (1), 27–50.
- Padilla, Christopher**, “Revisions and Clarifications of Export and Reexport Controls for the People’s Republic of China (PRC); New Authorization Validated End-User; Revision of Import Certificate and PRC End-User Statement Requirements,” *Federal Register*, July 2007, 72 (117), 38313.
- Padilla, Christopher A.**, “The Future of U.S. Export Controls on Trade with China,” STATES NEWS SERVICE January 2007. [hereinafter Padilla 1/29/07].
- Pape, Robert A**, “Why economic sanctions do not work,” *International security*, 1997, 22 (2), 90–136.
- Sturm, John, Kai Menzel, and Jan Schmitz**, “The simple economics of optimal sanctions: The case of eu-russia energy trade,” *Available at SSRN 4084754*, 2022.
- Wiggenhorn, Joan, Kimberly Gleason, and Manoharlal Sukhwani**, “An exploratory examination of export control act violations,” *International Business Research*, 2014, 7 (4).
- Yu, Miaojie**, “Processing trade, tariff reductions and firm productivity: Evidence from Chinese firms,” *The Economic Journal*, 2015, 125, 943–988.

Online Appendix

A Excerpts from the 2007 China Rule

In this appendix, we present excerpts from the final version of the China Rule (Padilla, 2007a) for reference. The passage below provides a summary of the rule itself.

In this final rule, the Bureau of Industry and Security (BIS) amends the Export Administration Regulations (EAR) to revise and clarify US licensing requirements and licensing policy on exports and reexports of items to the People's Republic of China (PRC). BIS published a revised policy and related amendments in proposed form in the Federal Register with a request for comments.

This final rule establishes a control, based on knowledge of a "military end-use," on exports and reexports to the PRC of certain items on the Commerce Control List (CCL) that otherwise do not require a license to the PRC. It also includes a revision to the license application review policy for items destined for the PRC that are controlled on the CCL for reasons of national security and revises the license review policy for items controlled for reasons of chemical and biological weapons proliferation, nuclear non-proliferation, and missile technology for export to the PRC, requiring that applications involving such items be reviewed in conjunction with the revised national security licensing policy.

This rule also creates a new authorization for "validated end-users" to which specified items may be exported or reexported without a license. Validated end-users will be placed on a list in the EAR after review and approval by the United States Government. The process for such review is also set forth in this final rule.

This rule also revises the circumstances in which End-User Statements, issued by the PRC Ministry of Commerce (MOFCOM), must be obtained, requiring them for transactions that both require a license to the PRC for any reason and (for most exports) exceed a total value of \$50,000.

This final rule also includes other minor corrections and conforming amendments.

The next passage explains the intended purpose of the rule as well as major events during the rule's proposal and revision process.

It is the policy of the United States Government to facilitate US exports to legitimate civilian end-users in the People's Republic of China (PRC), while preventing exports

that would enhance the military capability of the PRC. Consistent with this policy, the Bureau of Industry and Security (BIS) is amending the Export Administration Regulations (EAR) by revising and clarifying United States licensing requirements and licensing policy on exports and reexports of goods and technology to the PRC. As the PRC has increased its participation in the global economy, bilateral trade has grown rapidly, and the PRC has emerged as a major market for US exports and investment. This greatly expanded economic relationship is beneficial for both nations, and has increased the prosperity of both the American and Chinese people. The United States therefore seeks to encourage and facilitate exports to legitimate civil end-users in the PRC. At the same time, the United States has a longstanding policy of not permitting exports that would make a direct and significant contribution to the PRC's military capability. Moreover, the United States has an interest in restricting exports of certain dual-use products and technologies that would not otherwise need an export license, if those items are destined for a "military end-use" in the PRC. BIS is therefore amending the EAR to revise and clarify US licensing requirements and licensing policy on exports and reexports of items to the PRC, and to establish a new authorization that is intended to facilitate exports to validated civilian end-users in the PRC. On July 6, 2006, BIS published a proposed rule and requested public comments (71 FR 38313). On October 19, 2006, the original comment period deadline of November 3, 2006 was extended until December 4, 2006 (71 FR 61692). The detailed rationale for the proposed rule's provisions is provided in the preamble to the proposed rule and is not repeated here. In general, however, this rule proposes certain revisions and clarifications to licensing requirements and policies with regard to the PRC to more precisely reflect US foreign policy and national security interests.

This passage then details the three major components of the policy: updated licensing requirements, the Validated End-User program, and updated end-user statement requirements.

Revision of Licensing Review Policy and License Requirements

To strengthen efforts to prevent US exports to the PRC that would enhance the PRC's military capabilities, this rule revises the licensing review policy for items controlled on the Commerce Control List for reasons of national security. Specifically, this rule amends section 742.4(b)(7) to make clear that the overall policy of the United States for exports to the PRC of these items is to approve exports for civil end-uses but generally to deny exports that will make a direct and significant contribution to Chinese military capabilities. BIS makes further revisions to the EAR to clarify that it will review license applications to export or reexport to the PRC items controlled for

chemical and biological weapons proliferation, nuclear nonproliferation, and missile technology under sections 742.2, 742.3 and 742.5, respectively, of the EAR, in accordance with the licensing policies in both paragraph (b) of the applicable section and with the revised licensing policy in paragraph 742.4(b)(7) of the EAR, which provides a presumption of denial for license applications to export, reexport, or transfer items that would make a direct and significant contribution to the PRC's military capabilities such as, but not limited to, the major weapons systems described in new Supplement No. 7 to Part 742 of the EAR. This rule also implements a new control on exports to the PRC of certain CCL items that otherwise do not require a license to the PRC when the exporter has knowledge, as defined in section 772.1 of the EAR, that such items are destined for "military end-use" in the PRC or is informed that such items are destined for such an end-use. The list of items subject to this "military end-use" restriction covers approximately 20 products and associated technologies, as described in the entries of 31 full or partial Export Control Classification Numbers (ECCNs). The list was based on a review of public comments and a careful interagency review of items listed on the CCL that currently do not require a license for export to the PRC but have the potential to advance the military capabilities of the PRC. Applications to export, reexport, or transfer items controlled pursuant to the "military end-use" control will be reviewed on a case-by-case basis to determine whether the export, reexport, or transfer will make a material contribution to the military capabilities of the PRC and would result in advancing the country's military activities contrary to the national security interests of the United States. Other end-use controls in part 744 of the EAR continue to apply.

New Authorization Validated End-User (VEU)

To facilitate legitimate exports to civilian end-users, BIS establishes in this rule a new authorization Validated End-User. The authorization will allow the export, reexport, and transfer of eligible items to specified end-users in an eligible destination, initially the PRC. Validated end-users will be those entities that meet a number of criteria, including a demonstrated record of engaging only in civil end-use activities. This rule outlines clear procedures to request Validated End-User authorization, the procedures and timelines to be used by an interagency committee established to consider such requests, and the criteria for evaluating requests.

Revision of End-User Statement Requirements

To strengthen implementation of the April 2004 end-use visit understanding between the Vice Minister of Commerce of the PRC and the US Under Secretary of Commerce

for Industry and Security, this rule requires exporters to obtain PRC End-User Statements from the Ministry of Commerce of the PRC for all exports of items on the CCL requiring a license to the PRC over a specific value, which for most exports will be a new, higher threshold of \$50,000. BIS anticipates that this change will facilitate BIS's ability to conduct end-use checks on exports or reexports of controlled goods and technologies to the PRC, consistent with the existing end-use visit understanding with the Government of the PRC, without resulting in an overall annual increase in the number of such statements required from US exporters. The facilitation of end-use checks should, in turn, facilitate increased US exports to the PRC.

B Responses of China's Ministry of Commerce on June 19, 2007

The US Department of Commerce has recently announced "Revisions and Interpretations of Export and Re-export Control Policies of the People's Republic of China; New Verified End-User System; Amendments to Import Certification and China End-User Description Requirements." In response, on June 19, 2007, Yao Shenhong, spokesperson of the Ministry of Commerce, issued a statement expressing China's concerns over the new regulations. According to Yao Shenhong, these regulations expand the scope of export control licensed goods to China, requiring the Chinese Ministry of Commerce to issue end-user instructions and increasing the scope of high-tech and strategic trade between the two countries. This heightened cost severely impacts the confidence of enterprises from both nations engaging in high-tech trade.

China believes that the US's insistence on announcing the new regulations without fully considering the Chinese side's opinions goes against the spirit of cooperation between the two countries. The imposed unreasonable obstacles and additional preconditions on normal trade between China and the US do not serve the interests of companies on both sides. Instead, they hinder China's efforts to expand imports from the United States and impede the balanced development of Sino-US trade. As a result, the negative consequences of these new regulations on bilateral high-tech trade should be fully attributed to the United States. China retains the right to provide further comments on the new regulations and take corresponding measures.

China hopes that the US will prioritize safeguarding the long-term interests of both countries, consider the actual interests of enterprises, and take constructive measures to actively promote the development of bilateral high-tech trade. Creating conditions to ease the Sino-US trade imbalance and fostering a healthy and comprehensive economic and trade relationship between the two nations should be the ultimate goal.

C Data Appendix

To calculate value-added and intermediate inputs for 2011, 2012, and 2013, we use data from the ASIP for the years 2004 to 2007 to construct a four-digit CIC industry-level multiplier. This multiplier is defined as the average ratio of firms' total labor costs (which include wage bills, employment insurance, welfare, pensions, and housing funds) to the wage bill alone. Subsequently, we apply this multiplier to the wage bill values from 2011 to 2013 to ascertain their total labor costs. Next, we estimate each firm's total production cost as follows: total production cost = total output * (sales cost/sales revenue). We then calculate intermediate input, which is derived by subtracting total labor costs and depreciation from the total production cost, and value-added, which is calculated as total output minus intermediate input plus value-added tax. Following this, we utilize sector-level price deflators (for output, input, and capital) sourced from Brandt et al. (2012) to adjust these figures to real output, input, and capital values. Lastly, we employ the DLW (De Loecker and Warzynski, 2012) methodology to estimate Total Factor Productivity (TFP). Due to the absence of value-added, intermediate inputs, and labor inputs in the ASIP data for 2009, we are unable to estimate the firms' TFP levels for that year.