Working Paper Series

WP 13-5 JUNE 2013

Peers and Tiers and US High-Tech Export Controls: A New Approach to Estimating Export Shortfalls

Asha Sundaram and J. David Richardson

Abstract

In this study, we employ a difference-in-difference, gravity-equation approach to quantifying the trade impact of high-technology export controls that are motivated by national security. We estimate the effect of controls on high-tech export performance of the United States, of its traditional rival (peer) exporters, and of emerging exporters. Using an 11-year panel of seven high-tech sectors from 1994 through 2004, we find that the United States under-exports to "high-threat" importers. We find, more surprisingly, that the United States over-exports to "medium-threat" importers and to a large "trusted" group of importers, both relative to a norm (default group) of importers. We find that traditional peer exporters under-export to the trusted group of importers, and along with emerging exporters, under-export to most medium-threat importers. These findings, robust in a comparable dataset ending in 2011, suggest high substitutability between export suppliers and export markets for high-tech products. The same peer exporters over-export to high-threat importers, suggesting their less stringent enforcement of multilateral export controls and also undermining to a certain extent, the security objective of the very strictest of these controls. Overall, importers deemed security threats import only half of their high-tech potential from the 10 exporters on which we focus. Our study underlines the importance of current American efforts to reform the export control regime to make it more target-effective.

JEL Classification: F13, F14, F52

Keywords: US Trade Policy, US National Security, Competitiveness, Emerging High-Technology Exporters, Gravity Model, Difference-in-Difference Estimation

Asha Sundaram is senior lecturer of economics at the University of Cape Town, South Africa, with research interests in the areas of international trade and development economics. **J. David Richardson** is senior fellow emeritus at the Peterson Institute for International Economics, professor of economics and international relations emeritus at Syracuse University, and research associate of the National Bureau of Economic Research.

Authors' Note: We thank the Peterson Institute of International Economics for funding and support. We also thank the participants of the two seminars at the Peterson Institute for International Economics for their invaluable comments. We especially thank Gary Hufbauer, Xuepeng Liu, Dean DeRosa, and Arvind Subramanian. We benefited tremendously from discussions with Chris Rohlfs. All errors and omissions remain our own.

Peterson Institute for International Economics

1750 Massachusetts Avenue, NW Washington, DC 20036-1903
Tel: (202) 328-9000 Fax: (202) 659-3225 www.piie.com

1. INTRODUCTION AND OVERVIEW

In the early 1990s, as the Cold War ended, US export controls that aimed to keep high-tech goods and technologies out of the hands of enemies deterred between $15 billion and $25 billion of such exports, roughly 5 percent (Richardson 1993). Recent US export controls, aimed at a different set of enemies, and only modestly changed in administrative structure, have been criticized widely for their unwieldy imprecision and ineffectiveness, especially as the capability to export high-tech products has spread from traditional western exporters to those in emerging countries.[1] Both Congress and the administration committed in 2010 to a radical restructuring of export controls aimed at improving their threat deterrence and at preserving American technological momentum.[2] That restructuring effort is still under way.

Below the surface of the important policy discussion and reform effort lie several mysteries. Using the same techniques as in Richardson (1993), aggregate estimated shortfalls from US national security controls seem to have *fallen* from roughly 5 percent of high-tech exports to roughly 1 percent in the mid-2000s, and even less by 2011. US exports to destinations that still face heavy controls, especially China[3] but also Russia, seem no longer to reveal the uniform shortfalls that one might casually suspect and that were prominent in estimates for the early 1990s.

In this working paper, we aim to unpack these mysteries and use modern statistical techniques to replace the judgmental forensics involved in the 1993 study. Both studies employ the so-called gravity-equation approach to trade data to establish normal or expected levels of US exports in various sectors and to various trading partners.[4] Over- and under-exports are then identified with unexplained residuals. In this paper, we add a formal statistical technique called difference-in-difference estimation to estimate export shortfalls and unexpected export intensity over sectors, trading partners, and time. The 1993 study, by contrast, relied on sensible-yet-subjective judgments about gravity-equation residuals that differed between low-tech and high-tech sectors, between "trusted" and "targeted" trading partners, and between US exports and that of a group of peer exporters who did not always observe the same controls (some controls were multilateral, others unilateral). We also expand the peer-exporter group to relevant

1. See, for a trenchant and recent sample, Hsu (2010), NRC (2009a and 2009b), and Wallerstein (2009).

2. Since early 2010, the US administration has been implementing plans to streamline export controls, perhaps under the jurisdiction of a single, integrated agency, and to reclassify more items from "munitions" categories into "dual use" (civilian and military) categories. The Congress and technical advisory groups have been actively serving as discussion forums. The European Union is conducting a very similar review (EC 2011).

3. Chinese critics continue to complain about the way US controls deny China the benefits of high-tech exports that they claim pose minimal security threat.

4. These approaches have been widely used for similar norm-setting purposes by Peterson Institute researchers: Frankel (1997), DeRosa (2004, 2007, 2008, and 2009), DeRosa and Gilbert (2006), Elliott et al. (2007), and Hufbauer (2010).

emerging-economy exporters, consistent with the modern diffusion of technology. Our present study also relies on a panel of 11 years of data,[5] whereas the 1993 study employed only two cross sections of data.

We look for statistical evidence of US export shortfalls in seven high-tech sectors to countries that were targets of national security motivated export controls during 1994 through 2004. We employ a difference-in-difference estimation approach.[6] We look at differential high-tech exports by the United States to importing countries classified as security threats, relative to exports to all other importers, as predicted by a standardized gravity model of trade. Our estimate of US export shortfalls to security threats gives us our first difference between security threats and our norm. We then look at this difference before and after these countries were classified as threats, giving us an estimate of changing shortfalls from time-changing control intensity, our second difference. The time period we focus on, 1994 through 2004, spans many shifts in the export control regime in the United States, thereby providing us with variation in the status of countries as threats from previous Cold War opponents to more recent states classified as terrorist threats or as proliferation threats, which we exploit to further identify the impact of export controls on trade.

Additionally, we are able to factor in a third difference, associated with the frequently used term foreign availability—for the ability of rival exporters to supply high-tech goods to security threats when their own export controls are looser or nonexistent. The third difference looks at exports in high-tech products from traditional "peer" exporters of the United States—France, Germany, the United Kingdom, and Japan—to targeted importers before and after classification, relative to US exports. It allows us to get at estimates of an important type of trade diversion as a result of the US export control regime.[7] Finally,

---

5. We test for robustness of our results in a panel extending to 2011. Results, summarized briefly below, are surprisingly comparable, at a high level of statistical significance.

6. Difference-in-difference (DID) estimation is an econometric tool that can be used to analyze the impact of a policy, implemented at a particular point in time, on outcomes of interest. Very simply, DID involves defining a treatment group, to which the policy applies, and a control group, that is as similar as possible to the treatment group, but to which the policy does not apply. The impact of the policy is then estimated as the difference of the mean of the outcome variable of interest before, or pre-policy, and after, or post-policy, in the treatment compared to the same pre over post difference in the control group. This analysis can also be performed in a regression framework, with the outcome regressed on a constant, a dummy for the post period, a dummy for the treatment group, and an interaction of the post and treatment dummies. Here, the coefficient on the interaction gives the DID estimate. The advantage of the regression framework is that it allows us to control for other observable factors (in our framework, the gravity variables like distance) that drive the outcome variable of interest. DID estimation has been used in several studies, including and not restricted to Card and Krueger (1994) and Hanson and Xiang (2004), who use DID estimation with a gravity model of trade to study the home-market effect.

7. This specification, though inspired by a triple-difference estimation framework (Gruber 1994), is not a full-fledged triple-difference specification. The latter would include a set of peer-by-importer effects to "difference out" differential exports by peers over the United States, thus only exploiting the importer switches between tiers over time to identify the effect of export controls on differential export patterns of US over peer exports. This controls for any unobserved heterogeneity in differential export patterns of the United States to target importers relative to peer exporters over the time period.

we are able to compare export behavior of the United States and its traditional peers under the export control regime to that of emerging exporters of high-tech products, including Brazil, China, India, Israel, and Mexico, and thereby explore trends in substitution by importing country markets from traditional exporters to emerging suppliers of high-tech products.

We argue that our difference-in-difference estimation procedure contributes precision to previous studies that estimate the impact of US export controls (Richardson 1993) and more broadly, of economic sanctions on trade (Hufbauer et al. 1997 and Elliot et al. 2007, for example). In addition, we are able to measure trade diversion and substitution of markets among rival exporters. Besides, the estimation procedure allows us to control for some of the unobserved shocks in export patterns that may be correlated with changes in importer threat status under the export control regime. It also controls for trends in high-tech export competitiveness that are common across all importing partners, such as intrinsic comparative advantage. Similarly, the difference-in-difference estimation would control for import demand shocks if they affect all exporters similarly (e.g., global business cycles among Organization for Economic Cooperation and Development [OECD] countries).

We find, as we did in the 1993 study, that the United States under-exports to high-threat countries. If an importer were to switch to high-threat status from a default status (defined below), US exports would almost vanish—to about 3 percent of the norm for default importers. However, since high-threat countries account for less than 1 percent of US high-tech exports, we argue that any gains resulting from promoting these countries to a better importer status under the regime would be negligible. Results also indicate that the United States over-exports to economically large moderate-threat importers and to trusted industrialized countries relative to its peers.

However, we also find a high degree of substitutability between export destinations and export suppliers. Lost US exports to high-threat importers and over-exports to industrialized and moderate-threat importers are typically compensated by peer and emerging-exporter over-exports and under-exports, respectively, to the same destinations. For example, though we find that the United States over-exports to medium- to high-threat importers that include large countries like China, India, and Russia, (except in the key electrical machinery sector), many US rivals under-export to the same group. We also find that these broad patterns hold when we extend our analysis to look at data from 1994 through 2011, results for which are presented in appendix A.

For a full-fledged triple-difference analysis of US export controls, see Sundaram (2011). However, our alternate specification, detailed in subsequent paragraphs, controls for such unobserved heterogeneity. In fact, in a sense, it is even more demanding than a triple-difference specification since it includes dummies for each exporter-importer pair and not just peer pairs. This means that average exports from every exporter to each importer (over time) are differenced out, helping us control for unobserved country-*pair* specific factors driving export flows.

We conclude that our study undergirds the need for a reevaluation of the US export control regime and the resources dedicated by regulators and firms to administer and abide by it. The regime targets marginal importers successfully. But because of substitutability between export destinations and suppliers, it does not seem to go a long way towards attaining its objective of keeping harmful technology from potential sources of threat to national security. Our results further suggest significant refinement of the multilateral export control regime to ensure its objectives are met.

2. THE US EXPORT CONTROL REGIME AND ITS SECURITY-THREAT TIERS

Export controls in the interests of national security were targeted towards the Soviet Bloc countries during the Cold War. The United States negotiated multilateral export controls with its allies, the Western Bloc countries. As the Cold War ended, revisions to the export control regime were undertaken in 1993 and subsequently in 1996 with new targets now focused on countries posing terrorist or proliferation threats and on states that tolerated terrorist activities. The Wassenaar Arrangements emerged in 1996 with the United States and other industrialized nations (most members of the OECD) negotiating multilateral export controls to prevent dual-use technologies (those with both civilian and military use) falling into enemy hands. Though all signatories agreed to multilateral export controls and on lists of classified products, enforcement of these multilateral controls was largely left to each signatory under the Wassenaar Arrangements. The United States was historically seen as being a more stringent enforcer of export controls than its peer exporters (Richardson 1993).

Table 1a provides the complete list of importers and their respective tiers at each point in time. Documentation on country tiers was obtained primarily from the website of the Bureau of Industry and Security, which also contains foreign policy reports from 1995 through 2005. Importing countries are classified into tiers for export controls on high performance computers.[8] For tier 1 countries, though exporters are required to maintain records of shipments and sometimes forward information to the government as requested, most exports are allowed to proceed without prior government review (license exception). Most OECD importers fall under this category and we refer to tier 1 as trusted importers.

For tier 2 countries, which are countries with a low risk profile, no prior government review is required for exports of most product categories, though certain sensitive product sub-categories require an export license. Most importers fall under this category and we conceive this as our default tier, as detailed

8. Technically, the tier classification system applies only to categories of high performance computers. Biological and chemical agents and associated equipment and software, missile technology, communication technology, and satellites and encryption are other major categories of high-tech exports where controls apply but are not strictly governed by the tier system. Nevertheless, the importing countries to which export controls apply in these categories conform very closely to countries designated as tier 3 and tier 4 countries in the high performance computers tier classification system. We hence use this classification for all the sector groups we consider.

more precisely below. Tier 3 countries are countries that pose proliferation, diversion, or other security risks, and exports to these countries hence require an export license for most product categories. We refer to these as medium- to high-threat importers. In the case of tier 4 countries, exports in most product categories are denied. We hence refer to tier 4 countries as high-threat importers. In table 1b we list the signatories of the Wassenaar Arrangement and its predecessor, the agreement on controls against the Soviet Bloc countries, both multilateral agreements on high-tech export controls.

3. EMPIRICAL SPECIFICATION

We employ two specifications.

3.1 Difference-in-Difference Specification

We first estimate the following difference-in-difference specification of the well-known gravity equation for exports in each of seven broad high-technology sectors, spanning chemicals, machinery, and equipment, and corresponding to familiar industrial classifications:

$$LnX_{ijt} = \alpha_1 + \alpha_2 Y_{ijt} + \beta_1 Tier1_j + \beta_3 Tier3_j + \beta_4 Tier4_j + \sum_{i=2}^{5} (\beta_{1i} Tier1_j + \beta_{3i} Tier3_j + \beta_{4i} Tier4_j) + \nu_i + \mu_j + \varepsilon_{ijt} \quad (3.1)$$

where X_{ijt} is exports from exporter country i to importer country j; Y_{ijt} are conventional gravity controls (population, GDP per capita for importer and exporter, distance); $Tier(s)_{jt}$ is a dummy variable that equals one if importing country j is a *Tier(s)* country at time t, where s=1, 3, or 4; ν_{it} is an exporter-by-year fixed effect; μ_j is an importer fixed effect; and ε_{ijt} is the idiosyncratic error term. Tier 2 is the omitted default tier. In the difference-in-difference terminology, tier 2 importers are our control group against which we compare our treatment groups, which consist of tier 1, tier 3, and tier 4 importers. Under the premise that export controls have minor impacts on tier 2 trading partners, we can interpret our coefficients on tiers 1, 2, and 3 as estimates of the effects of controls.

Exporting countries initially include the United States and four traditional peers (United Kingdom, Germany, France, and Japan, i running from 2 to 5). We then extend our analysis to include five emerging exporters (i = 6, …, 10) of high-tech goods. These emerging exporters include Brazil, India, China, Mexico, and Israel: countries listed by the US government as having export capabilities in two or more high-tech sectors.[9] We estimate equation 3.1 for each of seven high-tech sectors separately. Since

9. The US Commerce Department's Bureau of Industry and Security keeps track of and reports foreign availability of dual-use products (products that have civilian as well as military uses) in several broad high-tech sectors. These lists identify countries with export capabilities in high-tech sectors covered by the export control regime. Broad sectors include chemical

we include numerous gravity controls in the estimation, we can interpret the coefficients on tier effects as deviations, or in other words, over- or under-exports from the gravity norm for tier 2 exports.

Here, β_1, β_3, and β_4 provide differential tier 1, tier 3, and tier 4 US exports from tier 2 US exports. Coefficients β_{1i}, β_{3i}, and β_{4i} capture differential exports to tiers 1, 3, and 4 over tier 2 exports by each peer exporter *i*, relative to US exports to the same tier over US tier 2 exports. $\beta_1+\beta_{1i}$, $\beta_3+\beta_{3i}$, and $\beta_4+\beta_{4i}$ provide differential tier 1, tier 3, and tier 4 exports of peer exporter *i* from its own normal tier 2 exports. If the United States under-exports to tier 3 and 4 importers that are medium- or high-threat importers and over-exports to tier 1 importers relative to tier 2, we would find $\beta_1>0$ and β_3 and $\beta_4<0$. If peers under-export to tier 1 importers and over-export to tier 3 and 4 importers over tier 2 importers relative to the United States, we would find $\beta_{1i}<0$, $\beta_{3i}>0$, and $\beta_{4i}>0$.

Hence, β_1, β_3, and β_4 for the United States and β_{1i}, β_{3i}, and β_{4i} for each peer *i* are our difference-in-difference estimators of the impact of high-tech export controls on exports. The importer fixed effects control for unobservable importer-specific shocks to exports, while the time effects (subsumed by the exporter-by-time effects) capture unobservable time-specific shocks and trends in export patterns. The difference-in-difference estimators for the United States identify the effect of export controls on exports by focusing on changes in exports to targeted importers under the export control regime relative to other importers pre- and post-classification into targets at various threat levels. Hence, the identifying assumption is that there are no shocks that affect exports to targeted importers relative to other importers at the same time as tier status changes. Additionally, the difference-in-difference estimators for peers look at these changes relative to the United States (the third difference), thus controlling for some of the unobserved importer specific shocks that might vary with time if they are common across the peer exporters and the United States. The exporter and importer fixed effects also account for time-invariant multilateral resistance[10] terms in the gravity equation.

---

and biological agents and related technology and software, high performance computers, missile technology, encryption and communications, satellites, and hot-section technology, spanning the seven high-tech sectors we cover in our analysis. Countries like Ukraine, Russia, South Africa, and Thailand are also reported as having export capabilities in more than two sectors, however, we exclude them due to lack of data availability in the time period we consider.

10. Multilateral resistance describes the way that exports from country *i* to *j* cannot be explained completely by bilateral friction or resistance. Such exports also depend on resistance to *i* exports from all other export destinations and on resistance to *j* imports from all other suppliers. For instance, this would mean that exports from the United Kingdom to Australia could differ from exports from the United Kingdom to a third country at a distance equal to that between the United Kingdom and Australia, if Australia was more remote than this third country. Australia's distance from all other exporters would matter in addition to distance between the United Kingdom and Australia. We control for multilateral resistance with importer and exporter fixed effects in equation 3.1 following Redding and Venables (2004) and Rose and van Wincoop (2001).

3.2 An Alternative Specification

We also estimate a more demanding specification:

$$LnX_{ijt} = \alpha_1 + \sum_{i=2}^{5}(\beta_{1i}Tier1_j + \beta_{3i}Tier3_j + \beta_{4i}Tier4_j) + \nu_i + \mu_j + \delta_j + \varepsilon_{ijt} \quad (3.2)$$

where we include importer-by-time and exporter-by-importer fixed effects along with exporter-by-time fixed effects. However, with importer-by-time effects, we are unable to estimate coefficients on conventional time-variant gravity-equation determinants such as GDP per capita, nor on tiers 1, 3, and 4 for all exporters (US and peers), since they and our tier 1, 3, and 4 variables vary by importer and time. Hence, we are unable to estimate coefficients for tier 1, 3, and 4 for the United States because we naturally treat the United States as our default exporter. This is a disadvantage of this more demanding specification. However, our motivation for estimating this specification is three-fold. First, this approach still identifies the impact on exports of an importer's designation as a security threat. Second, the importer-by-time and exporter-by-time fixed effects allow multilateral resistance terms to vary over time. Third, the exporter-importer fixed effects control for unobserved country-pair specific factors associated with export patterns. Hence, identification is solely and strictly by observing relative changes in export patterns between each country-pair as the importer switches security tiers over time. Since we are unable to estimate the effect of export controls on US exports, we retain our difference-in-difference specification in equation 3.1 as our preferred specification in this working paper. And we ascertain that our results are qualitatively robust to the inclusion of the three sets of fixed effects.

4. RAW DATA TRENDS

The raw data behind our paper reveal patterns on their own. Sometimes these patterns help to interpret subsequent statistical results. At other times, they mislead, and the statistical results correct misimpressions (e.g., so-called smell test).

Table 2 gives a sector-wise break down of high-tech exports for the United States, for its traditional peers, and for emerging exporters in the year 2004, the latest in our preferred, industry-oriented data.[11] For each exporter, the first row gives export values, while the second row gives the percentage of its own high-tech exports in that sector. The column entries for the second row add up to 100 percent. For the United States and traditional peer exporters, sectors 382 (non-electrical machinery), 383 (electrical machinery), and 384 (transport equipment) account for around 70 percent of high-tech exports. Among emerging exporters, we see more diversity. Though 382 through 384 are still major exporting

11. A parallel trade-oriented data set that extends through 2011 is discussed in notes below. We use it to test the robustness of our industry-oriented results and to update them to 2011. See appendix A. Appendix B documents data sources.

sectors, India, Brazil, and Israel also export proportionally more in sector 351 (industrial chemicals). China displays disproportionately concentrated exports in sectors 382 (machinery) and 383 (electrical machinery).

Table 3 gives aggregate high-tech exports by the United States, peer, and emerging exporters to each of the four tiers, and to India and China, in 2004. Again, the second row displays percentage exports to each tier and the row totals equal 100 percent. The table reveals that tier 4 importers account for a tiny portion of everyone's exports, never greater than 3 percent. For the United States, less than 0.2 percent of high-tech exports go to tier 4 importers. For traditional peers, this percentage is between 0.5 and 1 percent. Among emerging exporters, for Brazil and India this figure is slightly higher—between 1 and 3 percent. The majority of high-tech exports, for the United States and peers, and indeed, among emerging exporters, is to the trusted tier 1 importers comprised of the industrialized economies. Exports to tier 1 by the United States amount to about 70 percent of total exports, while the tier 1 percentage is even higher for France, Germany, and the United Kingdom, at around 80 percent. Tier 2 exports for the United States account for about 17 percent of exports, and tier 3 for the United States and for France, the United Kingdom, and Germany account for about 8 percent of high-tech exports. Japan shows a slightly different export pattern, with exports concentrated more heavily to tier 2 countries and to China.

We now turn to export patterns over time for the United States and peers to the high threat countries in tier 4 and to the large tier 3 importers—India and China. Figures 1a, 1b, and 1c show aggregate high-tech exports from the United States and peer countries to tier 4 importers, China and India respectively between 1994 and 2004. These importing countries were initially assigned to their respective tiers in 1996. Figure 1a shows a break in high-tech exports for the peers and the United States to tier 4 importers post-1996. US exports fall marginally while peer exports rise, consistent with the expected negative impact of ultra-strict US export controls on high-tech exports to the (quantitatively tiny) tier 4.

From figure 1b, for China post-1996, US high-tech exports rise, but peer high-tech exports rise even faster, especially from Japan and Germany. By 2004, German and Japanese exports combined are four times US exports. This presents an anomaly. Even though China is a tier 3 importer and hence subject to significant controls, in the raw data we might imagine we observe a negative impact of export controls on US exports to China in a relative sense. In other words, the volume of American high-tech exports to China continues to rise absolutely, but peer high-tech exports to China rise faster. However, in the empirical results that we discuss in later sections, once we control for other gravity determinants of trade, the United States *over*-exports to China in many high-tech categories, and out-performs its traditional peers. Its success is even more pronounced when we include emerging-economy peers among its export rivals.

For India, another tier 3 importer, if anything, it appears from figure 1c as though post-1996, US exports rise while peer exports fall until the mid-2000s. The gap between US and peer high-tech exports widens after 1996, with US high-tech exports being larger than peer high-tech exports. This is the opposite of what one might expect—that export controls would result in relative US export shortfalls to this large tier 3 (medium-threat) country relative to peers, a second anomaly in the raw data. Yet the statistical estimates below reveal little convincing evidence for either under- or over-exports; they are extremely imprecisely estimated.

In sum, raw data trends vary. They are consistent with intuition across most high-threat importers facing distinctively strict American export controls, causing losses of American exports to peer exporters of high-tech exports, but only to the negligible tier 4 category. For the larger medium-threat exporters, we observe US export losses only in a relative sense. Controlling for other export determinants in our empirical analysis, we find that while the United States significantly under-exports to tier 4 exporters (relative to tier 2, the norm), it over-exports to tier 3 exporters, including China, in most sectors, except a key high-tech sector—electrical machinery. Peers display the opposite pattern relative to the United States, they over-export to tier 4 countries and under-export to tier 3 countries over tier 2, except for Germany, which over-exports to tier 3 in electrical machinery. Additionally, the United States over-exports to trusted tier 1 countries and the traditional peers under-export to tier 1 countries relatively, indicating that the 2001 consolidation of tiers 1 and 2, thereby promoting tier 2 importers to tier 1, might have been conducive to mitigating overall US high-tech export losses due to export controls. Substitution among destinations for all countries' exports plays an important role in our assessment, much more so than it did in the earlier 1993 study.

5. RESULTS

We first turn to results for specification 3.1, the main difference-in-difference specification. We then assess our reliance on tier 2 importers as a suitable default norm (i.e., as a group of importers that are little affected by export controls).

We present three sets of results. In the first set of tables (tables 4a, 4b, and 4c), we present results for the United States and traditional peer exporters. In tables 5a, 5b, and 5c, we present results for the United States, traditional peers, and emerging high-tech exporters. Finally, in tables 6a and 6b, we present results for the United States, traditional peers, and each emerging high-tech exporter individually, but with tier 3 importers disaggregated into smaller tier 3 importers and India and China.

Coefficients in table 4a provide relative effects on peer exports (relative to US exports) of an importer switching tier relative to the default tier 2. Coefficients in 4b provide the total effect of export controls on peer exports, in distinction from the effect relative to US exports (part "a" of the table). For

the United States, this so-called total effect is the same as the relative effect, since the United States is our default exporter in the specification, and effects for peer exporters are measured relative to the United States (we hence exclude the United States from our "b" table). For peer exporters, the coefficients in the "b" part are obtained by adding the coefficients for the United States and the peer exporter for each tier, as described above in section 3.1.

For example, from 4b, the total effect on German exports of an importer switching to tier 3 would be the sum of the coefficient on the tier 3 variable (which is the tier 3 effect for the United States), plus the coefficient on German tier 3 from the "a" tables. The interpretations of the coefficients in the "a" and "b" tables differ in the following manner. A positive coefficient on tier 3 x exporter for Germany in the "a" table would mean that Germany under-exports less, or over-exports more to tier 3 countries over the tier 2 norm relative to the United States. On the other hand, a positive coefficient on tier 3 in a "b" table for Germany would mean that it over-exports to tier 3 countries relative to its own tier 2 norm. Though we are mainly interested in the impact of export controls on the United States and on peer exporters relative to the United States, and hence focus primarily on table 4a, table 4b provides some insight into differential export patterns of peer exporters across targeted and default importers. Finally, in table 4c, we provide examples of US, traditional, and emerging peer responses to importers graduating across tiers.

Similar to tables 4a and 4b, tables 5a and 5b provide relative and total effects for our estimation of equation 3.1 with the United States and traditional peers, but with emerging exporters included. Table 5c looks at estimated US shortfalls or overages to medium-threat and high-threat (tier 3 and 4) export destinations and compensating overages or shortfalls by traditional peer and emerging exporters. It is useful in determining the degree to which US export losses to targeted importers are compensated for by peer exporters, thereby enabling us to get at the overall quantitative effect of the export control regime on trade. Table 6a provides relative effects for the estimation of equation 3.1 with coefficients for each emerging exporter estimated separately, and with India, China, and other tier 3 exporters distinguished. Table 6b provides an example of export responses by the United States, traditional peers, and the five emerging exporters when an importer's status switches across tiers.[12]

We then turn in table 7 to results for the alternative specification 3.2, and in their light, return to the main difference-in-difference specification. Results are based on export data over 1994–2004 across high-tech International Standard Industrial Classification (ISIC) sectors. In appendix A, we present counterparts for tables 4a, 5a, 6a, and 7 with export data at the Standard International Trade Classification (SITC) level from 1994–2011, to ascertain if the patterns we uncover in these tables hold for more recent years. We find that they do, especially for the United States. [13]

12. We avoid providing these total effects for table 6a to avoid clutter.

13. In fact, a Chow test for any systematic differences in coefficient estimates for table 5a using data based on the Standard International Trade Classification from 1994–2004 on the one hand, and from 2005–11 on the other, reveals that for

5.1 Tier 2 Importers, Our Putative Default Norm

We first check if tier 2 makes a useful control group for our purposes. If export controls do not have a significant and systematic effect on export patterns of the United States and peer countries, we can interpret differential exports to tiers 1, 3, and 4 relative to tier 2 as estimates of the quantitative effects of export controls. We do this check by estimating equation 3.1 (and also 3.2, our alternative specification) but with a dummy for tier 2 importers and no dummy for tiers 1, 3, and 4. The coefficients on tier 2 for the United States and each peer importer reveal if, with all other importers as the control group, the United States and peer countries over- or under-export to tier 2 importers. Results are presented in appendix tables A1 and A2. If tier 2 is an acceptable default norm, then we expect relative differences in exports to tier 2 importers over other importers to be minimal. Indeed, coefficients show no strong pattern of differential over- or under-exports to tier 2 importers by peer exporters. From table A1, only 5 out of 35 coefficients are highly precisely estimated, and significant sectoral pairs of coefficients have the opposite sign—the US exports more and Germany less of electrical machinery (383) than the norm, and the United States exports less transport equipment (384) and Japan more than the norm. The pattern of the relatively rare significant coefficients is close to random. We take this to imply reasonable support for treating tier 2 importing countries as our norm.[14]

5.2 Difference-in-Difference Specification

Table 4a presents results for equation 3.1 for each of the seven high-tech sectors. Coefficients on tier 1, tier 3, and tier 4 are for the United States, while coefficients on tier 1, tier 3, and tier 4 interacted with each peer dummy give coefficients for the respective peer exporter relative to the United States. Results

---

none of the US tier 3 coefficients can we reject the null hypothesis that there is no systematic difference between the two sets of coefficients. For peer and emerging exporters, in 30 out of 35 cases we cannot reject the null that there is no systematic difference between tier 3 coefficients for these two time periods. For tier 4 coefficients for traditional peers and emerging exporters, in all cases we cannot reject the null of no systematic difference between the two sets of estimates. We also perform a Chow test for equality of coefficients estimated on our industry level data for 1994–2004, versus on the trade data for 1994–2011. We find that again, for the United States, we are unable to reject the null hypothesis of no systematic difference between coefficients for tier 3 and tier 4 importers. The same is true for tier 1 coefficients for the United States, except in sector 383 (electrical machinery). The null hypothesis of no systematic differences cannot be rejected for tier 4 coefficients for traditional peer and emerging exporters either. In the case of tier 1 and tier 3 importers and traditional peer and emerging exporters, we find systematic differences in only a few cases. These cases indicate that the displacement patterns we observe in our results for 1994–2004, namely, that emerging exporters under-export to tier 3 and over-export to tier 1 importers, are exaggerated when we use data for 1994–2011.

14. In the alternative specification in appendix table A2, seven out of 28 coefficients are highly precisely estimated, and all are positive. Four of these coefficients are for Japan alone. These patterns suggest that tier 2 importers are not so normal for traditional peer exporters (especially Japan), however normal they may be for US exports. Since there is no ability in our alternative specification to estimate US over- and under-exports for tier 2, as explained below, we take confidence in the US-focused robustness provided by appendix table A1.

from table 4a indicate that the United States over-exports to tier 1 countries relative to tier 2, the default tier, in all sectors, with the effect estimated with fair precision for five out of seven sectors. The United States under-exports to tier 4 countries relative to tier 2 in all seven sectors.[15] This is in contrast to our four traditional peer countries, who, relative to the United States, under-export slightly to tier 1 countries relative to tier 2 (mildly for Germany and Japan), and over-export to the high-threat tier 4 countries. A natural interpretation of these results casts doubt upon the security efficacy of multilateral export controls. Our results seem to suggest that peer exporters do not enforce controls as stringently as the United States. But the United States seems to be able to make up a portion of its lost tier 4 exports by out-competing traditional peers among trusted tier 1 customers.

For tier 3 countries, the United States results overall seem at first inconclusive. But when we expand peers to include our five emerging exporters in table 5a, the United States appears mildly to over-export relative to tier 2 in five out of the seven sectors, though positive coefficients are precisely estimated for only one. In this regression (table 5a) US over-exports to tier 3 look much stronger, and US over-exports to tier 1 much weaker. The natural interpretation is still the same—the United States makes up in less-controlled markets what it may lose in tightly controlled markets. But the identity of the over-performing alternative export destinations changes, as we discuss below—US exporters out-perform traditional peers, but not emerging peers, in trusted destinations, but out-perform both in medium-threat destinations.

Among table 4a's traditional peers in tier 3 importers, while no stark patterns emerges overall, the United Kingdom under-exports to tier 3 countries in all sectors with the effects being statistically significant in all but one sector, where it is significant at the 10 percent level. A notable exception is the electrical machinery sector (ISIC 383), where the United States significantly under-exports to countries in tier 3, while Germany over-exports to countries in tier 3 relative to the United States. Overall, results suggest losses of US high-tech exports only to tier 4, or high-threat importers.

Exponents of the coefficients for tier 4 for the United States in row three of table 4a give the proportional change in US exports when a country switches from tier 2, the default, to tier 4. The magnitudes of these effects indicate that US exports would virtually vanish—99 to 97 percent losses—to a trading partner demoted from tier 2 to tier 4.

Table 4b provides the coefficient estimates of exponents of $\beta_1+\beta_{1i}$, $\beta_3+\beta_{3i}$, and $\beta_4+\beta_{4i}$ less one, for each peer exporter, and hence gives the proportional change of each peer's exports when an importer switches to a particular tier from the default tier 2. Results show that when an importer switches to tier 4 from tier 2, while US exports would almost vanish, peer exporters would increase their own exports to

15. Note that the coefficients on tier 4 are extremely large. However, we expect this since high-tech exports to high-threat destinations are virtually choked off.

any such demoted tier 4 countries. For example in the industrial chemicals sector (ISIC 351), US exports would shrink to roughly 2 percent of the norm for a country demoted from tier 2 to 4, but the United Kingdom (for instance) would increase its exports by 84 percent.

To illustrate how to use these results quantitatively, in the first panel of table 4c, we present a calculation for sector 384 (transport equipment), a large export sector, especially for the United States and traditional peers. We calculate export gains and losses for the United States and peer countries for the year 2004 if tier 1 importers were to be promoted from tier 2 (the default) to tier 1.[16] We find that US exports would increase by $58 billion, while German exports would increase slightly less, by $44 billion. French and Japanese exports would actually fall, resulting in a slightly mitigated net gain for these importers from being promoted one tier. Hence, results indicate significant substitution between suppliers by importing countries and across markets (destinations) by exporting countries. We find this echoed in most of our results—results indicate that exporters facing restrictions to certain markets can substitute away to less restricted markets, while exporters with looser controls compensate to a certain extent for export losses in restricted markets. However, as we show in a subsequent discussion, we find that overall, high and medium-threat importers are denied high-tech exports from the 10 exporters included in our analysis.

As the next step, we estimate equation 3.1 for the United States, traditional peers, and five emerging exporters that have growing capabilities in exporting high-tech products. Tables 5a and 5b show results that include the emerging exporters.[17] First, we note from table 5a that the flavor of some of the results from table 4a remains the same for traditional peer exporters. They have relative over-exports in tier 4 and under-exports in tiers 1 and 3 (Germany again, exceptionally, over-exports electrical machinery to tier 3, relative to the United States). Emerging exporter peers, relative to the United States, significantly over-export to tier 1 countries and tier 4 countries and significantly under-export to tier 3 countries (relative to tier 2 countries). This helps explain the interesting effects they have on our earlier US estimates. Our previous estimates of US over-exports to the trusted tier 1 countries now essentially disappear. Instead, the United States, relative to both traditional and emerging peers, now appears to over-export to moderate-threat tier 3 importers—significantly in six out of seven sectors. Tier 3 importers now seem to be the compensatory refuge where US exporters make up from losses elsewhere. We attribute these changes in US estimates to the fact that our gravity-norm for exports has now changed.

16. We calculated these changes in billions of dollars as follows: For the United States, the $58 billion figure is arrived at as [0.8/(1+0.8)]*$131 billion. In other words, as the tier 1 coefficient divided by (1 + tier 1) coefficient, multiplied by US exports to tier 1 countries.

17. In order to answer clearly the question of whether foreign availability of high-tech products has grown beyond the traditional western exporters, we constrain the three tier coefficients to be the same for each of the five emerging peers. We subsequently loosen this restriction, as we describe below.

The peer-exporter bar (norm) has become higher in tier 1 markets (historically more open to emerging-country exports), and lower in tier 3 markets due to the addition of emerging exporters.

In table 5b we present the marginal effects of coefficients in table 5a for emerging exporters only. Marginal effects indicate over- or under-exports to tier 1, tier 3, and tier 4 importers by emerging exporters relative to their exports to the default tier 2 importers. The table indicates over-exports by emerging exporters to tier 1 countries in all but one industry, scientific equipment. Similarly, emerging exporters under-export to tier 3 importers relative to default tier 2 importers in all but one industry: other chemicals. Emerging exports to high-threat tier 4 importers do not seem to differ statistically from imports to default tier 2 importers with the exception of transport equipment over-exports.

Table 5c presents estimated net export shortfalls (or overages) to medium- and high-threat (tier 3 and 4) importers from the 10 exporters we consider in this study, by sector. Net export shortfalls (or overages) indicate US shortfalls (or overages) adjusted for (see the discussion above of interpreting the β coefficients) shortfalls (or overages) in traditional peer and emerging exporters. The first two panels present figures for tier 3 and tier 4 importers respectively, and the third panel presents figures for total shortfalls to both categories of importers. The table shows net export shortfalls in almost all sectors across tier 3 and tier 4 importers (except for the chemicals sectors, ISIC 351 and 352, for tier 4). Focusing on the last panel, denied exports to these medium- to high-threat countries vary from large shortfalls of between 60 and 75 percent in ISIC sectors transport equipment and basic metals, to smaller shortfalls of less than 30 percent in electrical machinery and scientific equipment. To summarize, this table provides evidence that despite high degrees of substitutability between export suppliers and export destinations, export controls did work overall to deprive target importers of high-tech exports.

In the next table, given that tier 3 targets include large emerging importers like India and China, we disaggregate tier 3 effects into effects for India, China, and all other tier 3 importers.[18] Table 3 reveals that in 2004, China accounts for roughly 38 percent of aggregate US and peer exports to tier 3 countries, but India only 7 percent. We also estimate tier coefficients for each of our five emerging exporters individually. Table 6a presents results. While the flavor of results for tiers 1 and 4 remain similar, among tier 3 importers, results in table 6a indicate that US over-exports to tier 3 importers are mainly driven by over-exports to tier 3 countries other than India and China. Germany relative (to the United States) over-exports to China in all types of machinery (ISIC 382-83) and over-exports to small tier 3 countries in electrical machinery.

Both France and the United Kingdom under-export to China relative to the United States, and along with Germany, to India. In the case of Japan, effects for India, where significant, are heterogeneous across sectors. Japan seems to under-export to China relative to the United States in sectors 381 (basic

18. Though most are of small size, tier 3 importers also include countries like Russia and Egypt.

metals) and 384 (transport equipment). For all sectors taken together, there is reasonably strong evidence that traditional peers relatively under-export to the larger tier 3 countries.[19]

Results for emerging exporters are striking—even remembering that they control for (i.e., wash out) trends in comparative advantage that are captured by year effects (year dummy variables) unique to each exporter. Over-exports in tier 1 markets can all be attributed to Brazil, Mexico, and Israel. China and India actually under-export to tier 1 on balance and perform less well than the United States and Japan in tier 1, but better than traditional US rivals, who under-export significantly to tier 1. Brazil, Mexico, and Israel also over-export to China and to India, relative to the United States, and much more so relative to traditional US rivals. China under-exports to India, and India under-exports to China in comparison to the United States, indicating weak bilateral trade between these two large emerging exporters in high-tech products. In high-threat tier 4 importer markets, all emerging exporters over-export relative to the United States, except, unsurprisingly, Israel, which behaves like the United States and practices a virtual embargo.

In Table 6b, we use our regression estimates to illustrate quantitative magnitudes for the case of machinery (except electrical) (ISIC 382). We calculate export losses and gains for the United States and peer exporters for the year 2004 when Latvia is promoted to a tier 2 country from tier 3 (which it was in 2002). We estimate that US exports to Latvia would decrease by about $11 million. Mexican, Brazilian, and Israeli exports would increase as a result of this promotion by $5 million and Chinese and German exports would decrease by about $102 million, resulting in an anomalous net loss of $108 million as a result of this promotion.[20] Once again these results suggest a very high degree of substitution between export destinations and export suppliers.

5.3 Alternate Specification

We present results for the alternate specification 3.2, which includes importer-by-time, exporter-by-time, and exporter-by-importer fixed effects for the United States, traditional peers, and emerging exporters, in table 7 (most closely related to table 5a in our specification in section 5.2). One advantage of this specification is that these fixed effects control for time-varying multilateral resistance in trade flows. Additionally, the exporter-by-importer fixed effects control for unobserved heterogeneity in country-pair trade relationships by differencing out average (over time) exports between each exporter-tier pair, resulting in a tighter identification of the pure effect of export control promotions and demotions across tiers on relative export patterns of peer exporters. Under this specification, for identification, we need only

19. These findings, controlling for other determinants of export penetration, contrast with the trends in figure 1b.

20. The anomalous net Latvian loss of imports from becoming less of a security threat is more exactly a loss only from our 10 focus exporters (the United States and nine peers); we cannot discern whether high-tech producers like Russia or other European suppliers restored some of these losses.

the following, reasonably natural (and weak) condition to hold: any unobserved shocks in export behavior of peer exporters relative to the United States (all relative to the default tier 2 importers) do not follow the exact same pattern over time as importer tier switches.

However, these advantages come at a cost.[21] The inclusion of three sets of fixed effects is demanding on the data (it removes much of its inherent variation) and we see some loss in precision of our estimates. Also, we are unable to estimate the effect of export controls on US exports since the specification allows us to estimate only relative export behavior of peers to the United States. Thus, by including importer-exporter fixed effects, we throw away some of the variation that we are interested in for the purposes of our fundamental question. Specifically, we are unable to look at enduring-for-the-whole-period relative patterns of US over- and under-exports to, for instance, tier 4 versus tier 2 countries.

We present results for traditional peers and emerging exporters in table 7, implicitly relative to the United States.[22] We still find evidence that traditional peer exporters under-export to tier 1 and tier 3 countries and over-export to tier 4 countries, though these results are not precisely estimated for all sectors. We observe that emerging exporters are estimated still to over-export to tier 4 (in two sectors) and under-export to tier 3, but no longer seem to over-export to tier 1. Overall, we find that our results for tier 4 countries remain qualitatively similar, with some differences for tier 1 importers. Specifically, once average exports between exporter-importer pairs over the time period are accounted for, emerging exporters do not seem to over-export to tier 1 countries. Thus, our results still present similar implications—substitutability and compensation between export suppliers and destinations, potential export losses for the United States in marginal tier 4 markets, and a suggestion that peer exporters, both traditional and emerging, do not adhere as rigidly to controls in those markets as the United States.

Since the more demanding alternative specification produces results for rich- and emerging-country export rivals (peers) that have the same flavor and pattern as our preferred difference-in-difference specification, we add to our confidence that the difference-in-difference results for American exports are reliable.

6. CONCLUSION

Using a difference-in-difference estimation technique in the framework of a gravity model of trade, this study shows that American high-tech export controls are indeed associated with expected losses of US exports, but only to targeted high-threat importers. However, since these high-threat importers account

21. See DeRosa and Harrigan (2011) for a discussion of why a specification like our preferred 3.1, which uses the cross-section variation in the data in panel data over a short time period, might be preferable to a specification like 3.2, which only uses time variation. Also, see Bergstrand and Egger (2010) for an excellent survey on the estimation of gravity models.

22. We also estimate this specification for traditional peer exporters alone. We find that the coefficients are very similar to the ones we observe in table 7 and we do not present them in the paper.

for a negligible proportion of US high-tech exports, loosening controls on these importers would result in modest export gains at best, according to our results. Those results indicate that traditional peer exporters like Germany, France, the United Kingdom, and Japan, and indeed, emerging exporters with high-tech capabilities, compensate for some of these US export losses to high-threat importers. This suggests that the Wassenaar and similar anti-proliferation arrangements, underpinning multilateral export controls, have not been completely effective—to a certain extent, peer countries make up for US shortfalls to high-threat countries. Calls for reengineering and streamlining the multilateral export control regime to ensure its success in meeting its security objective may indeed be well taken. Ultimately, however, our evidence suggests that export controls do deprive high-threat and, in fact, even medium-threat importers of considerable amounts of high-tech exports.

Our findings also reveal that relative to traditional peer exporters, the US over-exports to trusted industrialized countries relative to default importers, though not as much as emerging exporters do. Traditional peer exporters under-export to these industrialized importers, underscoring our finding of a high degree of substitutability between export markets and export suppliers. Though emerging peers seem to undercut exceptional US export performance in tier 1 markets, they do not do so in medium-threat tier 3. Tier 3 estimates, in fact, provide some of the most surprising estimates. They would seem to suggest that US firms and/or regulators discover ways to ease, perhaps even to bypass, export controls in the case of these specific medium-threat importing partners,[23] avoiding US export losses overall.

To sum up in a sentence the policy implications of our estimates, we seem to find that high-tech export controls, like money, are fungible. They can deny a given source country's exports to particular target countries, but those same target countries can reclaim some of their desired import demand by arbitraging across alternative suppliers with differing control intensity. They can seem to impose export sacrifices on countries with strict controls, but those foregone exports can be diverted toward less dangerous and uncontrolled markets and enhance the hyper-strict country's export competitiveness there.

Export-control fungibility is thus code for two important kinds of eviscerating substitution. First, substitution among exporters with differing intensities of controls seems to undermine some of the intended denial of high-tech exports to threatening importers—the importers manage to source some denied imports from alternate suppliers. Second, substitution among destination markets for American and peer exporters seems to offset much of the alleged export shortfall from national-security controls—exporters seem to be able to out-compete their rivals in less-controlled destinations when they have been held back by their own controls in threatening destinations.

The former kind of substitution, among exporters, means that there is scope for better coordination among exporters in implementing multilateral controls in the interest of security, though we find

23. Richardson and Sundaram (2013) provide detailed illustrations.

that high- and medium-threat destinations are denied high-tech exports overall. The latter kind of substitution, among export destination markets, is good news for those who worry about losses of high-tech export-market share and associated losses of national competitiveness. Wherever there are uncontrolled markets, there's the chance for compensatory export recovery—where there's a will to export, there's a way. This good-news kind of substitution also helps explain why this study estimates much smaller American export losses from controls than the Richardson (1993) study did for an earlier generation of export controls.

In conclusion, it appears that modern high-tech export controls do have their intended benefit—that of keeping potentially dangerous technology from countries perceived as threats, though substitution means that this is somewhat compromised by the ability of these importers to source from US rivals, both traditional and emerging. In markets perceived as moderate threats, export losses are borne by traditional and emerging exporters, not their American counterparts. These findings strongly support the current momentum to refocus and streamline American export controls and push for better implementation of the multilateral regime.

REFERENCES

Annual Policy Reports. 1995–2005, various years. Bureau of Industry and Security (formerly Bureau of Export Administration). Washington.

Bergstrand, J. H. and P. Egger. 2010. Gravity Equations and Economic Frictions in the World Economy: A Survey. Mimeo, June 2010. South Bend, IN: University of Notre Dame.

Card, D. and A. B. Krueger. 1994. Minimum Wages and Employment: A Case Study of the Fast-Food Industry in New Jersey and Pennsylvania. *American Economic Review* 84, no. 4: 772–793.

DeRosa, D. A. 2004. US Free Trade Agreements with ASEAN. In *Free Trade Agreements: US Strategies and Priorities*, ed., Jeffrey Schott. Washington: Peterson Institute for International Economics.

DeRosa, D. A. 2007. Impact of US Economic Sanctions on Trade. In *Economic Sanctions Reconsidered*, *3rd edition*, eds., Elliott et al. Washington: Peterson Institute for International Economics.

DeRosa, D. A. 2008. Gravity Model Analysis. In *Maghreb Regional and Global Integration: A Dream to be Fulfilled*, eds., G. C. Hufbauer and C. Brunel. Washington: Peterson Institute for International Economics.

DeRosa, D. A. 2009. Morocco's Economic Performance Under the US-Morocco Free Trade Agreement. In *Maghreb Regional and Global Integration: A Dream to Be Fulfilled*, eds., G. C. Hufbauer and C. Brunel. Washington: Peterson Institute for International Economics.

DeRosa, D. A. and J. P. Gilbert. 2006. Potential Benefits of a US-Colombia FTA. In *Trade Relations Between Columbia and the United States*, ed., Jeffrey J. Schott. Washington: Peterson Institute for International Economics.

DeRosa, D. A. and J. Harrigan. 2011. Gravity Applications and Methodological Review. Unpublished seminar background papers. Washington: Peterson Institute for International Economics, April 8.

EC (European Commission). 2011. The Dual-Use Export Control System of the European Union: Ensuring Security and Competitiveness in a Changing World. Brussels: CO 393 final, June 30. Available at http://trade.ec.europa.eu/doclib/docs/2011/june/tradoc_148020.pdf (accessed June 6, 2013).

Elliott, K. A., G. C. Hufbauer, J. J. Schott, and B. Oegg. 2007. *Economic Sanctions Reconsidered, 3rd edition*. Washington: Peterson Institute for International Economics.

Frankel, J. A. 1997. *Regional Trading Blocs in the World Economic System*. Washington: Peterson Institute for International Economics.

Grimmet, R. F. 2006. Military Technology and Conventional Weapons Export Controls: The Wassenaar Arrangement. Congressional Research Service, Library of Congress.

Gruber, J. 1994. The Incidence of Mandated Maternity Benefits. *American Economic Review* 84, no. 3: 622–641.

Hanson, G. H. and C. Xiang. 2004. The Home-Market Effect and Bilateral Trade Patterns. *American Economic Review* 94, no. 4: 1108–1129.

Hsu, Nina. 2010. Reforming US Export Controls. Available at http://www.amchamchina.org/article/6295 (accessed June 7, 2013).

Hufbauer, G. C. 2010. *Three Scenarios for the World Economy 2010 to 2020: Implications for Trade Policy and Social Indicators*. Report prepared for the US National Intelligence Council, Washington.

Hufbauer, G. C. and C. Brunel, eds. 2008. *Maghreb Regional and Global Integration: A Dream to be Fulfilled*. Washington: Peterson Institute for International Economics.

Hufbauer, G. C., K. A. Elliott, T. Cyrus, and E. Winston. 1997. US Economic Sanctions: Their Impact on Trade, Jobs, and Wages. PIIE Working Paper, April. Washington: Peterson Institute for International Economics.

Hufbauer, G. C. and C. Brunel. 2009. *Capitalizing on the Morocco-US Free Trade Agreement: A Road Map for Success*. Washington: Peterson Institute for International Economics.

McLoughlin, Glenn J. and Ian F. Fergusson. 2005. High Performance Computers and Export Control Policy: Issues for Congress. CRS Report for Congress, CRS Web, Order Code RL31175. Available at http://www.fas.org/sgp/crs/natsec/RL31175.pdf (accessed June 7, 2013).

Nicita, A. and Marcelo Olarreaga. 2006. Trade, Production and Protection 1976–2004. Mimeo. Washington: World Bank.

NRC (National Research Council of the National Academies). 2009a. *Beyond 'Fortress America': National Security Controls on Science and Technology in a Globalized World.* Washington: National Academies Press.

NRC (National Research Council of the National Academies). 2009b. A Survey of Attitudes and Actions on Dual-Use Research in the Life Sciences. NRC's Committee on Assessing Fundamental Attitudes of Life Scientists as a Basis for Biosecurity Education, in collaboration with the American Association for the Advancement of Science. Washington: National Academies Press.

Redding, S. and A. J. Venables. 2004. Economic Geography and International Inequality. *Journal of International Economics* 62, no. 1: 53–82.

Richardson, J. D. 1993. *Sizing Up US Export Disincentives*. Washington: Institute for International Economics.

Richardson, J.D. and A. Sundaram. 2013. *Sizing Up US Export Disincentives for a New Generation of National-Security Export Controls*. PIIE Policy Brief 13-13. Washington: Peterson Institute for International Economics

Rose, A. K. and E. van Wincoop. 2001. National Money as a Barrier to International Trade: The Real Case for Currency Union. *American Economic Review* 91, no. 2: 386–390.

Schott, J. J., ed. 2004. *Free Trade Agreements: US Strategies and Priorities*. Washington: Peterson Institute for International Economics.

Schott, J. J., ed. 2006. *Trade Relations Between Columbia and the United States.* Washington: Peterson Institute for International Economics.

Sundaram, A. 2011. Estimating the Impact of Export Deterrents: An Analysis of US Hi-technology Export Controls. Mimeo, presented at the Midwest International Economics Group Meetings, University of Notre Dame, May 2011.

Thorbecke, W. 2010. *How Would an Appreciation of the Yuan Affect the People's Republic of China's Surplus in Processing Trade?* ADBI Working Paper Series No. 219. Manila: Asian Development Bank Institute.

Wallerstein, M. B. 2009. Losing Controls: How U.S. Export Restrictions Jeopardize National Security and Harm Competitiveness. *Foreign Affairs* 88, no. 6 (November/December): 11–18.

Table 1a Country tier classification for 1994–2004

Year	Tier 1	Tier 2	Tier 3	Tier 4
1994 –95	Australia, Belgium, Canada, Denmark, France, Germany, Greece, Italy, Japan, Luxembourg, Netherlands, Norway, Portugal, Spain, Turkey, the United Kingdom, United States	[All countries not in tier 1 or tier 3 were classified as tier 2 for these two years.]	Albania, Armenia, Azerbaijan, Belarus, Bulgaria, Czech Republic, Estonia, Georgia, Hungary, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Moldova, Poland, Romania, Russia, Slovakia, Tajikistan, Turkmenistan, Ukraine, Uzbekistan, Vietnam	[See note 3) for treatment of tier 4 countries during this period.]
1996–99	Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Holy See, Iceland, Ireland, Italy, Japan, Liechtenstein, Luxembourg, Mexico, Monaco, Netherlands, New Zealand, Norway, Portugal, San Marino, Spain, Sweden, Switzerland, Turkey, and the United Kingdom	Antigua and Barbuda, Argentina, Bahamas, Barbados, Bangladesh, Belize, Benin, Bhutan, Bolivia, Botswana, Brazil, Brunei, Burkina Faso, Burma, Burundi, Cameroon, Cape Verde, Central Africa, Chad, Chile, Colombia, Congo, Costa Rica, Cote d'Ivoire, Cyprus, Czech Republic, Dominica, Dominican Republic, Ecuador, El Salvador, Equatorial Guinea, Eritrea, Ethiopia, Fiji, Gabon, The Gambia, Ghana, Grenada, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, Hong Kong, Hungary, Indonesia, Jamaica, Kenya, Kiribati, Republic of Korea , Lesotho, Liberia, Madagascar, Malawi, Malaysia, Maldives, Mali, Malta, Marshall Islands, Mauritius, Federated States of Micronesia , Mozambique, Namibia, Nauru, Nepal, Nicaragua, Niger, Nigeria, Palau, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Rwanda, St. Kitts and Nevis, St. Lucia, St. Vincent and Grenadines, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Singapore, Slovak Republic, Slovenia, Solomon Islands, Somalia, South Africa, Sri Lanka, Surinam, Swaziland, Taiwan, Tanzania, Togo, Tonga, Thailand, Trinidad and Tobago, Tuvalu, Uganda, Uruguay, Western Sahara, Western Samoa, Zaire, Zambia, and Zimbabwe	Afghanistan, Albania, Algeria, Andorra, Angola, Armenia, Azerbaijan, Bahrain, Belarus, Bosnia and Herzegovina, Bulgaria, Cambodia, People's Republic of China , Comoros, Croatia, Djibouti, Egypt, Estonia, Georgia, India, Israel, Jordan, Kazakhstan, Kuwait, Kyrgyzstan, Laos, Latvia, Lebanon, Lithuania, Macedonia (The Former Republic of Yugoslavia), Mauritania, Moldova, Mongolia, Morocco, Oman, Pakistan, Qatar, Romania, Russia, Saudi Arabia, Serbia and Montenegro, Tajikistan, Tunisia, Turkmenistan, Ukraine, United Arab Emirates, Uzbekistan, Vanuatu, Vietnam, and Yemen	Cuba, Iran, Iraq, Libya, North Korea, Sudan, and Syria

(table continues)

Table 1a Country tier classification for 1994–2004 *(continued)*

Year	Tier 1	Tier 2	Tier 3	Tier 4
2000	(+) Argentina, Brazil, Czech Republic, Hungary, Poland	(–) Argentina, Brazil, Czech Republic, Hungary, Poland, Macau (+) Estonia, Romania	(–)Estonia, Romania, (+) Macau	Same as above
2001	Merge tiers 1 and 2 (+) Lithuania		(–) Lithuania	Same as above
2002–04	(+) Latvia		(–) Latvia	

Notes: (1) The classification is for high performance computers. (2) A (–) sign before a country indicates that it was removed from that tier. A (+) sign indicates that it was added to that tier. (3) Tier 4 importers Iran, Iraq, North Korea, Sudan, Syria, and Cuba have been classified tier 4 or high-threat from 1996 through 2004. This means that for 1994 and 1995, these tier 4 importers have been classified as tier 2 importers. Hence, the tier 4 coefficients we identify capture effects of a regime shift from COCOM (Coordinating Committee for Multilateral Export Controls) targets, which included countries that were signatories to the Warsaw Pact, to more recent WASSENAAR (Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies) targets. Any impact of tier 4, high-threat status, on imports from the 10 exporters that is constant over the entire time period, 1994 through 2004, will be accounted for empirically by our importer dummies.

Sources: Annual Policy Reports, Bureau of Industry and Security (formerly Bureau of Export Administration), Washington: 1995–2005; Grimmet (2006); McLoughlin and Fergusson (2005).

Table 1b Multilateral export control agreements

Year	Members
1994 COCOM	Australia, Belgium, Canada, Denmark, France, Germany, Greece, Italy, Japan, Luxembourg, Netherlands, Norway, Portugal, Spain, Turkey, the United Kingdom, United States
1995 COCOM	(+) Austria, Finland, Ireland, New Zealand, Sweden, Switzerland
1996 WASSENAAR	(+) Russia, Czech Republic, Hungary, Poland, Slovakia
1997–20h04 WASSENAAR	(+) Argentina, Republic of Korea, Romania, Bulgaria, Ukraine

COCOM = Coordinating Committee for Multilateral Export Controls
WASSENAAR = Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies

Note: A (+) sign before a country indicates that it became an adherent to the respective agreement during the period listed.

Source: Annual Policy Reports, Bureau of Industry and Security (formerly Bureau of Export Administration), Washington: 1995–2005.

Table 2 Total high-tech exports in 2004 by sector for the United States, traditional and emerging peer exporters (billions of US dollars and percent)

	351	352	381	382	383	384	385	
ISIC	Industrial chemicals	Chemical products	Metal products	Machinery	Electrical machinery	Transport equipment	Scientific equipment	Total
United States	71	43	18	139	125	143	48	586
	12	7	3	24	21	24	8	
Traditional peers								
France	27	40	10	45	41	98	12	274
	10	15	4	17	15	36	5	
Germany	65	55	34	172	107	205	35	673
	10	8	5	26	16	30	5	
Japan	36	11	10	110	117	142	31	457
	8	2	2	24	26	31	7	
United Kingdom	24	34	9	50	37	51	14	219
	11	15	4	23	17	23	7	
Emerging exporters								
Brazil	5	1	1	8	3	15	0	34
	15	4	3	23	10	42	1	
China	20	7	28	123	134	23	17	352
	6	2	8	35	38	6	5	
India	7	3	2	3	2	3	0	21
	33	15	11	16	9	13	2	
Israel	5	2	1	3	6	0	1	18
	26	10	3	17	34	2	8	
Mexico	5	3	6	29	49	34	7	132
	3	3	5	22	37	26	5	
Total								
	265	199	119	682	622	713	166	2,766
	10	7	4	25	22	26	6	

Notes: Second row for each country gives percentage of total exports in each sector. Exports are in 2005 dollars, percentages in even-numbered rows sum to 100.

Source: COMTRADE database, see appendix B.

Table 3 Total high-tech exports in 2004 by tier for the United States, peers and emerging exporters (billions of US dollars and percent)

	Tier 1	Tier 2*	Tier 3 small**	India	China	Tier 4	Total
United States	432.50	100.50	23.70	4.11	23.40	0.89	585.1
	73.92	17.18	4.05	0.70	4.00	0.15	n.a.
Traditional peers							
France	217.63	22.37	22.90	1.26	5.62	3.50	273.28
	79.64	8.19	8.38	0.46	2.06	1.28	n.a.
Germany	555.12	45.88	41.5	3.29	23.00	5.21	674.00
	82.36	6.81	6.16	0.49	3.41	0.77	n.a.
Japan	245.03	122.97	20.00	2.50	59.20	1.53	451.23
	54.30	27.25	4.43	0.55	13.12	0.34	n.a.
United Kingdom	182.62	16.38	13.80	1.30	3.07	1.38	218.55
	83.56	7.50	6.31	0.59	1.40	0.63	n.a.
Emerging exporters							
Brazil	26.17	5.83	0.92	0.25	0.62	0.21	33.99
	76.99	17.15	2.70	0.74	1.81	0.61	n.a.
China	211.01	116.99	16.10	3.92	n.a.	2.95	350.97
	60.12	33.33	4.59	1.12	n.a.	0.84	n.a.
India	9.31	5.79	3.49	n.a.	1.31	0.66	20.56
	45.30	28.15	16.98	n.a.	6.37	3.21	n.a.
Israel	13.41	3.19	0.50	0.35	0.67	0	18.12
	74.01	17.58	2.75	1.91	3.71	0.02	n.a.
Mexico	127.08	3.92	0.17	0.04	0.39	0.12	131.72
	96.47	2.98	0.13	0.03	0.30	0.09	n.a.
Total							
	2,026.44	433.56	143.00	17.00	117.00	16.40	2753.40
	73.60	15.75	5.19	0.62	4.25	0.60	n.a.

n.a. = Not applicable, not meaningful

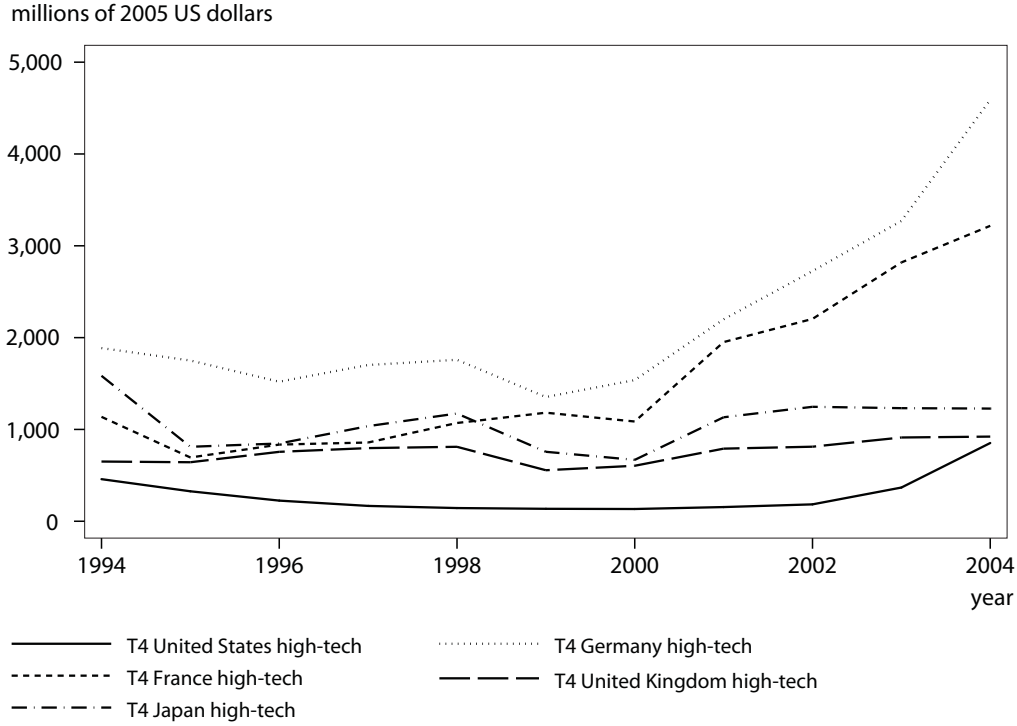
*For 2004, tier 2 was consolidated with tier 1. We split tier 1 exports in 2004 into tier 1 and tier 2 exports in the same proportion as in 2000, the year before the two tiers were merged. See table 1a.

**Tier 3 small markets include all tier 3 countries except China and India. Except for countries like Egypt and Russia most of them are small.

Notes: Second row for each country gives percentage of total exports to each tier. Exports are in 2005 dollars.

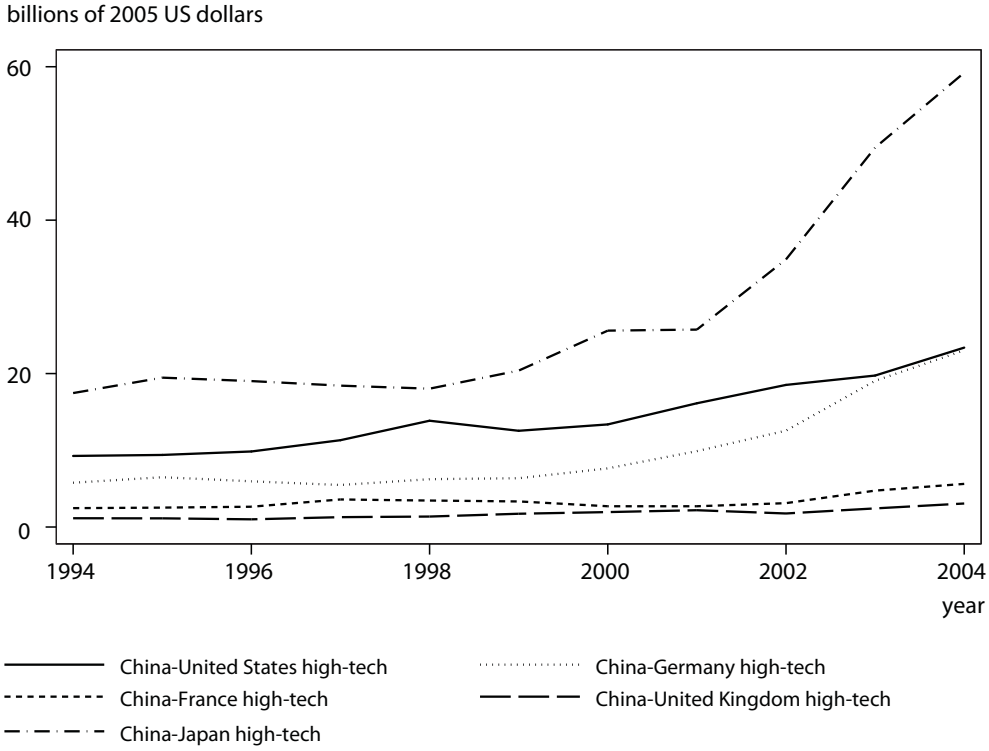
Source: COMTRADE database, see appendix B.

Figure 1a US and peer high-tech exports to tier 4 countries



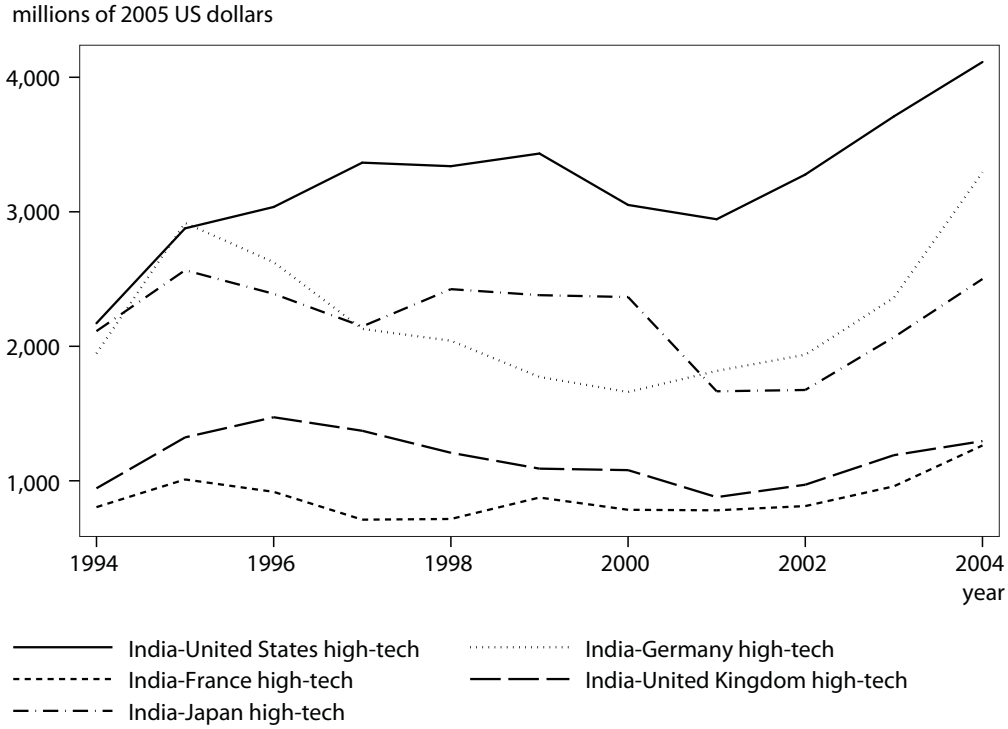
Source: COMTRADE database, see appendix B.

Figure 1b US and peer high-tech exports to China



Source: COMTRADE database, see appendix B.

Figure 1c US and peer high-tech exports to India



Source: COMTRADE database, see appendix B.

Table 4a Difference-in-difference specification, United States and traditional peer countries (France, United Kingdom, Germany, and Japan), 1994–2004

	(351)	(352)	(381)	(382)	(383)	(384)	(385)
Ln(exports) high-tech	**Industrial chemicals**	**Chemical products**	**Metal products**	**Machinery**	**Electrical machinery**	**Transport equipment**	**Scientific equipment**
Tier 1	0.467**	0.555**	0.560**	0.26	0.111	0.641***	0.377**
	(0.229)	(0.215)	(0.243)	(0.178)	(0.147)	(0.209)	(0.148)
Tier 3	0.163	0.034	0.364	0.11	–0.293*	0.813***	0.053
	(0.245)	(0.208)	(0.243)	(0.165)	(0.157)	(0.22)	(0.174)
Tier 4	–3.850***	–3.265**	–4.640***	–4.847***	–3.624**	–3.144**	–3.895***
	(1.208)	(1.339)	(1.577)	(1.569)	(1.569)	(1.6)	(1.411)
Tier 1 x exporter is France	–0.927***	–1.497***	–1.123***	–0.679***	–0.952***	–1.014***	–1.448***
	(0.278)	(0.261)	(0.295)	(0.253)	(0.203)	(0.275)	(0.208)
Tier 3 x exporter is France	0.012	–0.257	–0.544	–0.263	–0.194	–1.028***	–0.382
	(0.322)	(0.288)	(0.352)	(0.266)	(0.257)	(0.294)	(0.272)
Tier 4 x exporter is France	5.104***	3.755**	6.499***	6.659***	5.500***	5.417***	5.219***
	(1.273)	(1.513)	(1.87)	(1.817)	(1.541)	(1.961)	(1.617)
Tier 1 x exporter is Germany	–0.530**	–0.612**	–0.417	–0.219	0.138	–0.349	–0.519***
	(0.267)	(0.248)	(0.269)	(0.203)	(0.182)	(0.251)	(0.179)
Tier 3 x exporter is Germany	0.158	0.442	–0.163	0.029	0.788***	0.14	0.148
	(0.311)	(0.269)	(0.286)	(0.21)	(0.204)	(0.294)	(0.213)
Tier 4 x exporter is Germany	5.248***	4.865***	6.610***	6.712***	6.690***	5.148***	5.981***
	(1.306)	(1.514)	(1.847)	(1.813)	(1.529)	(1.946)	(1.63)
Tier 1 x exporter is United Kingdom	–1.244***	–1.389***	–1.313***	–0.634***	–0.624***	–0.720***	–1.119***
	(0.263)	(0.255)	(0.309)	(0.233)	(0.203)	(0.273)	(0.225)
Tier 3 x exporter is United Kingdom	–0.806***	–0.725***	–0.980***	–0.551**	–0.419*	–1.189***	–0.665***
	(0.293)	(0.25)	(0.297)	(0.226)	(0.23)	(0.283)	(0.24)
Tier 4 x exporter is United Kingdom	4.460***	4.175***	6.256***	6.472***	5.422***	4.631**	5.018***
	(1.329)	(1.545)	(1.835)	(1.851)	(1.571)	(1.95)	(1.664)
Tier 1 x exporter is Japan	0.256	0.259	–0.422	0.252	0.590**	–0.980***	–0.034
	(0.335)	(0.336)	(0.296)	(0.253)	(0.255)	(0.262)	(0.219)
Tier 3 x exporter is Japan	–0.298	–0.198	–1.257***	–0.433	0.021	–1.951***	–0.013
	(0.41)	(0.404)	(0.366)	(0.288)	(0.282)	(0.298)	(0.223)
Tier 4 x exporter is Japan	4.977***	6.109***	6.746***	6.956***	6.347***	4.546**	5.774***
	(1.343)	(1.532)	(1.778)	(1.83)	(1.528)	(1.989)	(1.627)
R^2	0.986	0.988	0.988	0.993	0.992	0.99	0.99

Notes: (1) Regressions include 168 importing countries and five exporting countries for 11 years. N = 9,240. (2) Standard errors are clustered at the country-pair level. (3) All specifications include gravity controls for distance, importer GDP per capita, and importer population in logs. (4) All specifications include exporter-by-year fixed effects and importer fixed effects. (5) Tier 2 is the default tier against which coefficients can be compared. (6) Exports are in 2005 US dollars. (7) *** p<0.01, ** p<0.05, * p<0.1.

Source: COMTRADE database, see appendix B; authors' calculations.

Table 4b Difference-in-difference specification, United States and traditional peer countries (France, United Kingdom, Germany, and Japan), 1994–2004: Marginal effects for each peer country by tier

	(351)	(352)	(381)	(382)	(383)	(384)	(385)
Ln(exports) high-tech	Industrial chemicals	Chemical products	Metal products	Machinery	Electrical machinery	Transport equipment	Scientific equipment
Tier 1 x exporter is France	–0.369**	–0.610***	–0.431***	–0.342**	–0.569***	–0.311**	–0.657***
Tier 3 x exporter is France	0.192	–0.2	–0.165	–0.141	–0.385**	–0.194	–0.28
Tier 4 x exporter is France	2.504*	0.632	5.419*	5.121*	5.532*	8.709***	2.757*
Tier 1 x exporter is Germany	–0.061	–0.055	0.153	0.043	0.283*	0.339*	–0.132
Tier 3 x exporter is Germany	0.378	0.609**	0.223	0.149	0.641***	1.593***	0.223
Tier 4 x exporter is Germany	3.047*	3.954**	6.171**	5.456**	20.459***	6.420**	7.051***
Tier 1 x exporter is United Kingdom	–0.541***	–0.565***	–0.529***	–0.312**	–0.401***	–0.076	–0.524***
Tier 3 x exporter is United Kingdom	–0.474***	–0.499***	–0.460***	–0.356***	–0.509***	–0.314*	–0.458***
Tier 4 x exporter is United Kingdom	0.84	1.485	4.034*	4.076*	5.037*	3.423*	2.074
Tier 1 x exporter is Japan	1.060***	1.257***	0.147	0.669***	1.016***	–0.287*	0.409**
Tier 3 x exporter is Japan	–0.126	–0.152	–0.591***	–0.276	–0.238	–0.680***	0.041
Tier 4 x exporter is Japan	2.086	16.181***	7.216**	7.235**	14.229***	3.062	5.542***

Notes: (1) *** p<0.01, ** p<0.05, * p<0.1. (2) Coefficients reported are obtained by taking exponents of marginal effects, subtracted by one.

Source: COMTRADE database, see appendix B; authors' calculations.

Table 4c Estimated impact of export controls on export behavior, example 1: ISIC=384 (transport equipment)

Exporter	United States	France	Germany	United Kingdom	Japan
Importer: Tier 1 countries					
2004 exports (billions of 2005 US dollars)	131.00	86.90	189.00	48.30	118.00
Tier 1 coefficient (from table 4a and b)	0.80	–0.3	0.4	–0.08*	–0.3
Promoted to tier 1 from tier 2 (change in billions of 2005 US dollars)	58.22	–37.24	43.62		–50.57
Importer: Tier 4 countries					
2004 exports (billions of 2005 US dollars)	0.23	1.90	1.19	0.11	0.68
Tier 4 coefficient (from table 4a and b)	–0.95	8.7	6.4	3.4	3.1*
Promoted to tier 2 from tier 4 (change in billions of 2005 US dollars)	4.33	–1.70	–1.03	–0.08	–0.52

*Coefficient imprecisely estimated.

Source: COMTRADE database, see appendix B; authors' calculations.

Table 5a Difference-in-difference specification, United States, traditional peer countries (France, United Kingdom, Germany, and Japan), and five emerging countries, 1994–2004

	(351)	(352)	(381)	(382)	(383)	(384)	(385)
Ln(exports) high-tech	Industrial chemicals	Chemical products	Metal products	Machinery	Electrical machinery	Transport equipment	Scientific equipment
Tier 1	–0.146	0.184	0.137	–0.121	–0.463***	0.217	–0.081
	(0.241)	(0.236)	(0.243)	(0.201)	(0.177)	(0.242)	(0.179)
Tier 3	0.655**	0.464*	0.867***	0.724***	0.373	1.259***	0.452*
	(0.308)	(0.272)	(0.285)	(0.254)	(0.249)	(0.303)	(0.242)
Tier 4	–2.948**	–2.646*	–4.247**	–4.011**	–3.151**	–3.068*	–3.774**
	(1.327)	(1.552)	(1.928)	(1.768)	(1.586)	(1.764)	(1.613)
Tier 1 x exporter is France	–1.029***	–1.784***	–1.276***	–0.871***	–1.107***	–1.304***	–1.634***
	(0.332)	(0.338)	(0.329)	(0.31)	(0.293)	(0.33)	(0.278)
Tier 3 x exporter is France	–0.116	–0.590*	–0.716*	–0.485	–0.365	–1.375***	–0.598*
	(0.401)	(0.358)	(0.395)	(0.339)	(0.36)	(0.362)	(0.343)
Tier 4 x exporter is France	5.018***	3.528**	6.381***	6.507***	5.383***	5.182***	5.072***
	(1.353)	(1.644)	(2.1)	(1.872)	(1.587)	(1.949)	(1.708)
Tier 1 x exporter is Germany	–0.635**	–0.892***	–0.569*	–0.415	–0.024	–0.651**	–0.708***
	(0.303)	(0.301)	(0.297)	(0.261)	(0.252)	(0.314)	(0.242)
Tier 3 x exporter is Germany	0.001	0.041	–0.37	–0.24	0.580*	–0.282	–0.113
	(0.384)	(0.327)	(0.353)	(0.298)	(0.31)	(0.378)	(0.293)
Tier 4 x exporter is Germany	5.152***	4.617***	6.480***	6.544***	6.558***	4.886**	5.818***
	(1.356)	(1.649)	(2.099)	(1.868)	(1.599)	(1.969)	(1.722)
Tier 1 x exporter is United Kingdom	–1.342***	–1.664***	–1.458***	–0.823***	–0.783***	–1.021***	–1.305***
	(0.339)	(0.34)	(0.355)	(0.302)	(0.294)	(0.36)	(0.31)
Tier 3 x exporter is United Kingdom	–0.929**	–1.046***	–1.146***	–0.766**	–0.587*	–1.529***	–0.874***
	(0.388)	(0.317)	(0.373)	(0.323)	(0.332)	(0.383)	(0.332)
Tier 4 x exporter is United Kingdom	4.380***	3.964**	6.146***	6.330***	5.309***	4.406**	4.879***
	(1.436)	(1.693)	(2.112)	(1.903)	(1.654)	(1.979)	(1.777)
Tier 1 x exporter is Japan	0.265	0.281	–0.435	0.262	0.585**	–0.974***	–0.029
	(0.333)	(0.333)	(0.288)	(0.249)	(0.241)	(0.298)	(0.21)
Tier 3 x exporter is Japan	–0.366	–0.37	–1.351***	–0.548*	–0.07	–2.136***	–0.127
	(0.439)	(0.453)	(0.395)	(0.314)	(0.317)	(0.362)	(0.266)
Tier 4 x exporter is Japan	4.981***	6.120***	6.745***	6.962***	6.348***	4.552**	5.778***
	(1.384)	(1.682)	(2.09)	(1.878)	(1.569)	(2.04)	(1.717)
Tier 1 x exporter is emerging	0.616**	0.564**	0.542**	0.661***	1.099***	0.448	0.336
	(0.283)	(0.285)	(0.276)	(0.243)	(0.225)	(0.301)	(0.238(
Tier 3 x exporter is emerging	–1.240***	–0.772**	–1.985***	–1.481***	–1.142***	–2.320***	–0.961***
	(0.37)	(0.35)	(0.348)	(0.326)	(0.323)	(0.375)	(0.307)
Tier 4 x exporter is emerging	2.682	2.947	4.441**	4.747**	3.811**	4.415**	3.658*
	(1.645)	(1.81)	(2.239)	(2.125)	(1.848)	(2.037)	(1.912)
R^2	0.958	0.956	0.96	0.968	0.961	0.956	0.959

Notes: (1) Regressions include 168 importing countries and 10 exporting countries (United States and peers, Brazil, India, China, Mexico, and Israel for 11 years). N = 18,480. (2) Standard errors are clustered at the country-pair level. (3) All specifications include gravity controls for distance, importer GDP per capita, and importer population in logs. (4) All specifications include importer and exporter-by-year fixed effects. (5) Tier 2 is the default tier against which coefficients can be compared. (6) Exports are in 2005 US dollars. (7) *** p<0.01, ** p<0.05, * p<0.1.

Source: COMTRADE data, see appendix B; authors' calculations.

Table 5b Difference-in-difference specification, United States, traditional peer countries (France, United Kingdom, Germany, and Japan), and five emerging countries, 1994–2004: Marginal effects for emerging importers by tier

	(351)	(352)	(381)	(382)	(383)	(384)	(385)
Ln(exports) high-tech	**Industrial chemicals**	**Chemical products**	**Metal products**	**Machinery**	**Electrical machinery**	**Transport equipment**	**Scientific equipment**
Tier 1 x exporter is emerging	0.600***	1.113***	0.973***	0.717***	0.888***	0.944***	0.29
Tier 3 x exporter is emerging	–0.443***	–0.265	–0.673***	–0.531***	–0.536***	–0.654***	–0.399*
Tier 4 x exporter is emerging	–0.233	0.351	0.214	1.087	0.935	2.846**	–0.11

Notes: (1) *** p<0.01, ** p<0.05, * p<0.1. (2) Coefficients reported are obtained by taking exponents of marginal effects, subtracted by one.

Source: COMTRADE database, see appendix B; authors' calculations.

Table 5c Difference-in-difference specification, United States, traditional peer countries (France, United Kingdom, Germany, and Japan) and five emerging countries, 1994–2004: Export shortfalls and overages (millions of 2005 US dollars)

	(351)	(352)	(381)	(382)	(383)	(384)	(385)	Row Total
Tier 3 export shortfalls								
Tier 3 exports	30,445	15,311	10,281	83,359	63,671	57,322	17,139	277,527
Tier 3 shortfall/overage (norm = tier 2)	–13,324	–8,403	–25,818	–38,399	–14,047	–181,494	–3,042	–284,528
Tier 3 shortfall/overage as percent of normal exports	–30	–35	–72	–32	–18	–76	–15	–51
Tier 3 shortfall/overage (norm = tier 1+2)	–18,014	–1,097	–27,157	–45,845	–21,885	–105,664	–449	–220,113
Tier 3 shortfall/overage as percent of normal exports	–37	–7	–73	–35	–26	–65	–3	–44
Tier 4 export shortfalls								
Tier 4 exports	1,294	897	700	5,151	2,581	5,022	802	16,447
Tier 4 shortfall/overage (norm = tier 2)	417	317	–822	–8,001	–4,401	81	–1,756	–14,165
Tier 4 shortfall/overage as percent of normal exports	48	55	–54	–61	–63	2	–69	–46
Tier 4 shortfall/overage (norm = tier 1+2)	431	281	–956	–7,263	–2,988	–546	–1,805	–12,846
Tier 4 shortfall/overage as percent of normal exports	50	46	–58	–59	–54	–10	–69	–44
Total export shortfalls to tier 3 and tier 4								
Tier 3 + tier 4 exports	31,738	16,209	10,980	88,510	66,252	62,344	17,941	293,974
Tier 3 + tier 4 export shortfall/overage (norm = tier 2)	–12,907	–8,085	–26,640	–46,401	–18,448	–181,413	–4,799	–298,693
Tier 3 + tier 4 shortfall/overage as percent of normal exports	–29	–33	–71	–34	–22	–74	–21	–50
Tier 3 + tier 4 export shortfall/overage (norm = tier 1+2)	–17,582	–816	–28,113	–53,109	–24,873	–106,211	–2,254	–232,958
Tier 3 + tier 4 shortfall/overage as percent of normal exports	–36	–5	–72	–38	–27	–63	–11	–44

Source: COMTRADE database, see appendix B; authors' calculations.

Table 6a Difference-in-difference specification, United States, traditional peer countries (France, United Kingdom, Germany, and Japan), and five emerging countries, 1994–2004, disaggregated effects among emerging exporters and tier 3 destinations

	(351)	(352)	(381)	(382)	(383)	(384)	(385)
Ln(exports) high-tech	Industrial chemicals	Chemical products	Metal products	Machinery	Electrical machinery	Transport equipment	Scientific equipment
Tier 1	–0.149	0.172	0.133	–0.124	–0.465***	0.214	–0.083
	(0.237)	(0.229)	(0.239)	(0.196)	(0.172)	(0.238)	(0.175)
Tier 3 small	0.680**	0.462*	0.895***	0.787***	0.407	1.246***	0.485**
	(0.308)	(0.269)	(0.288)	(0.253)	(0.25)	(0.305)	(0.244)
China	0.328	0.257	0.637	–0.51	–0.416	1.375	0.133
	(0.66)	(0.668)	(0.658)	(0.478)	(0.562)	(0.857)	(0.578)
India	–0.425	–0.733	–0.12	–0.722	–0.057	1.971**	–0.487
	(0.696)	(0.727)	(0.741)	(0.477)	(0.416)	(0.812)	(0.578)
Tier 4	–2.953**	–2.663*	–4.247**	–4.013**	–3.148**	–3.059*	–3.772**
	(1.328)	(1.543)	(1.931)	(1.77)	(1.591)	(1.768)	(1.614)
Tier 1 x exporter is France	–1.031***	–1.754***	–1.288***	–0.882***	–1.127***	–1.327***	–1.651***
	(0.325)	(0.33)	(0.324)	(0.304)	(0.286)	(0.328)	(0.273)
Tier 3 small x exporter is France	–0.035	–0.477	–0.717*	–0.484	–0.359	–1.396***	–0.591*
	(0.397)	(0.351)	(0.395)	(0.332)	(0.355)	(0.363)	(0.34)
China x exporter is France	–2.054***	–2.459***	–0.880***	–0.648**	–1.048***	–0.993***	–1.370***
	(0.301)	(0.289)	(0.308)	(0.266)	(0.278)	(0.291)	(0.279)
India x exporter is France	–1.929***	–2.156***	–1.236***	–0.956***	–1.116***	–2.131***	–1.074***
	(0.305)	(0.295)	(0.315)	(0.27)	(0.285)	(0.297)	(0.282)
Tier 4 x exporter is France	5.016***	3.551**	6.371***	6.498***	5.366***	5.163***	5.058***
	(1.353)	(1.641)	(2.105)	(1.873)	(1.589)	(1.953)	(1.71)
Tier 1 x exporter is Germany	–0.635**	–0.858***	–0.582**	–0.423*	–0.044	–0.680**	–0.724***
	(0.295)	(0.293)	(0.292)	(0.253)	(0.243)	(0.311)	(0.236)
Tier 3 small x exporter is Germany	0.071	0.142	–0.372	–0.265	0.570*	–0.271	–0.118
	(0.377)	(0.32)	(0.349)	(0.287)	(0.299)	(0.376)	(0.286)
China x exporter is Germany	–1.598***	–0.720***	–0.681***	0.343*	0.379*	–0.915***	–0.500**
	(0.261)	(0.238)	(0.258)	(0.205)	(0.208)	(0.276)	(0.204)
India x exporter is Germany	–1.417***	–1.418***	–0.810***	–0.259	–0.085	–1.999***	–0.600***
	(0.269)	(0.248)	(0.269)	(0.214)	(0.222)	(0.285)	(0.212)
Tier 4 x exporter is Germany	5.152***	4.646***	6.469***	6.537***	6.541***	4.860**	5.803***
	(1.356)	(1.645)	(2.104)	(1.87)	(1.6)	(1.973)	(1.724)
Tier 1 x exporter is United Kingdom	–1.342***	–1.631***	–1.472***	–0.833***	–0.803***	–1.046***	–1.322***
	(0.332)	(0.331)	(0.351)	(0.295)	(0.287)	(0.359)	(0.305)
Tier 3 small x exporter is United Kingdom	–0.854**	–0.962***	–1.139***	–0.772**	–0.587*	–1.543***	–0.876***
	(0.383)	(0.311)	(0.371)	(0.317)	(0.326)	(0.384)	(0.328)
China x exporter is United Kingdom	–2.987***	–2.230***	–2.083***	–1.232***	–1.312***	–2.299***	–1.754***
	(0.298)	(0.26)	(0.305)	(0.253)	(0.27)	(0.33)	(0.276)
India x exporter is United Kingdom	–2.311***	–1.840***	–1.249***	–0.585**	–0.907***	–1.434***	–0.817***
	(0.302)	(0.265)	(0.311)	(0.257)	(0.276)	(0.334)	(0.279)

(table continues)

Table 6a Difference-in-difference specification, United States, traditional peer countries (France, United Kingdom, Germany, and Japan), and five emerging countries, 1994–2004, disaggregated effects among emerging exporters and tier 3 destinations *(continued)*

	(351)	(352)	(381)	(382)	(383)	(384)	(385)
Ln(exports) high-tech	**Industrial chemicals**	**Chemical products**	**Metal products**	**Machinery**	**Electrical machinery**	**Transport equipment**	**Scientific equipment**
Tier 4 x exporter is United Kingdom	4.378***	3.989**	6.136***	6.322***	5.293***	4.388**	4.867***
	(1.436)	(1.69)	(2.117)	(1.905)	(1.655)	(1.984)	(1.779)
Tier 1 x exporter is Japan	0.263	0.277	–0.431	0.265	0.587**	–0.981***	–0.027
	(0.332)	(0.331)	(0.287)	(0.248)	(0.241)	(0.297)	(0.21)
Tier 3 small x exporter is Japan	–0.361	–0.378	–1.370***	–0.562*	–0.076	–2.063***	–0.129
	(0.445)	(0.46)	(0.4)	(0.315)	(0.319)	(0.361)	(0.267)
China x exporter is Japan	–0.511	0	–1.736***	–0.549*	–0.165	–5.045***	–0.336
	(0.392)	(0.384)	(0.362)	(0.295)	(0.345)	(0.38)	(0.279)
India x exporter is Japan	–0.21	0.860***	–0.353	–0.132	–0.258	–3.735***	–0.246
	(0.348)	(0.333)	(0.301)	(0.246)	(0.27)	(0.317)	(0.225)
Tier 4 x exporter is Japan	4.981***	6.121***	6.747***	6.963***	6.348***	4.545**	5.778***
	(1.385)	(1.678)	(2.095)	(1.881)	(1.573)	(2.046)	(1.72)
Tier 1 x exporter is India	–0.592*	–1.935***	–0.765**	–0.952***	–0.492*	–1.733***	–1.167***
	(0.312)	(0.321)	(0.333)	(0.304)	(0.268)	(0.345)	(0.336)
Tier 3 small x exporter is India	–1.057**	–1.585***	–2.475***	–1.840***	–1.435***	–3.029***	–1.234***
	(0.427)	(0.41)	(0.476)	(0.412)	(0.417)	(0.483)	(0.413)
China x exporter is India	–2.461***	–3.711***	–5.120***	–3.259***	–2.836***	–5.940***	–3.714***
	(0.336)	(0.346)	(0.354)	(0.335)	(0.341)	(0.37)	(0.346)
Tier 4 x exporter is India	4.743***	3.156*	6.274***	6.440***	6.206***	4.498**	5.796***
	(1.39)	(1.656)	(2.145)	(1.937)	(1.719)	(1.93)	(1.757)
Tier 1 x exporter is China	–0.656**	–0.515*	–0.735**	–0.045	0.331	–1.238***	–0.465*
	(0.3)	(0.312)	(0.292)	(0.263)	(0.254)	(0.325)	(0.259)
Tier 3 small x exporter is China	–0.432	–0.308	–1.426***	–0.277	0.148	–1.764***	–0.513
	(0.452)	(0.397)	(0.36)	(0.325)	(0.358)	(0.434)	(0.362)
India x exporter is China	–1.457***	–0.475	–3.026***	–1.535***	–1.041***	–4.275***	–1.603***
	(0.357)	(0.357)	(0.33)	(0.277)	(0.337)	(0.369)	(0.293)
Tier 4 x exporter is China	5.758***	5.424***	7.033***	7.699***	7.182***	5.696***	6.712***
	(1.338)	(1.675)	(2.076)	(1.842)	(1.587)	(1.985)	(1.706)
Tier 1 x exporter is Brazil	1.172***	0.519	–0.233	0.119	1.578***	1.092**	0.205
	(0.445)	(0.485)	(0.381)	(0.364)	(0.403)	(0.457)	(0.393)
Tier 3 small x exporter is Brazil	–1.735**	–2.387***	–2.607***	–2.239***	–1.416**	–3.235***	–1.227**
	(0.758)	(0.696)	(0.622)	(0.559)	(0.68)	(0.785)	(0.589)
China x exporter is Brazil	1.614***	2.765***	–0.369	0.624*	3.058***	2.698***	1.617***
	(0.431)	(0.468)	(0.385)	(0.326)	(0.44)	(0.476)	(0.4)
India x exporter is Brazil	2.152***	2.260***	0.04	0.657**	2.770***	1.959***	2.120***
	(0.429)	(0.466)	(0.38)	(0.322)	(0.438)	(0.472)	(0.398)
Tier 4 x exporter is Brazil	5.347***	5.012**	6.827***	7.634***	8.451***	6.941***	6.416***
	(1.506)	(2.119)	(2.161)	(1.87)	(1.612)	(2.278)	(1.942)

(table continues)

Table 6a Difference-in-difference specification, United States, traditional peer countries (France, United Kingdom, Germany, and Japan), and five emerging countries, 1994–2004, disaggregated effects among emerging exporters and tier 3 destinations *(continued)*

	(351)	(352)	(381)	(382)	(383)	(384)	(385)
Ln(exports) high-tech	**Industrial chemicals**	**Chemical products**	**Metal products**	**Machinery**	**Electrical machinery**	**Transport equipment**	**Scientific equipment**
Tier 1 x exporter is Mexico	1.119**	1.284**	2.000***	2.163***	2.191***	1.628**	1.120**
	(0.557)	(0.511)	(0.435)	(0.479)	(0.498)	(0.651)	(0.548)
Tier 3 small x exporter is Mexico	–2.538***	–1.125	–2.576***	–2.445***	–2.153***	–1.993***	–1.914***
	(0.696)	(0.728)	(0.634)	(0.726)	(0.618)	(0.75)	(0.607)
China x exporter is Mexico	2.564***	3.119***	1.986***	4.982***	2.616***	3.880***	2.258***
	(0.513)	(0.548)	(0.49)	(0.512)	(0.472)	(0.574)	(0.479)
India x exporter is Mexico	2.384***	4.349***	4.191***	3.232***	1.481***	2.358***	2.707***
	(0.514)	(0.547)	(0.49)	(0.512)	(0.472)	(0.573)	(0.479)
Tier 4 x exporter is Mexico	4.595**	5.249***	5.289**	7.952***	3.476*	6.777***	4.231**
	(2.194)	(2.008)	(2.53)	(2.48)	(2.043)	(2.374)	(2.113)
Tier 1 x exporter is Israel	2.089***	3.495***	2.522***	2.103***	1.969***	2.574***	2.055***
	(0.428)	(0.4)	(0.423)	(0.38)	(0.377)	(0.465)	(0.383)
Tier 3 small x exporter is Israel	–0.79	1.216	–1.233	–1.045	–1.276	–2.038***	–0.294
	(0.775)	(0.859)	(0.841)	(0.804)	(0.864)	(0.787)	(0.739)
China x exporter is Israel	1.693***	4.078***	2.166***	1.764***	1.716***	–1.096**	3.331***
	(0.469)	(0.471)	(0.48)	(0.408)	(0.415)	(0.477)	(0.453)
India x exporter is Israel	2.574***	4.151***	2.549***	1.743***	1.769***	2.789***	2.676***
	(0.479)	(0.485)	(0.493)	(0.417)	(0.435)	(0.489)	(0.461)
Tier 4 x exporter is Israel	–6.983***	–4.010**	–3.188	–5.956***	–6.238***	–1.821	–4.847**
	(1.838)	(1.916)	(2.377)	(2.201)	(1.951)	(2.214)	(1.924)
R^2	0.96	0.959	0.962	0.971	0.964	0.958	0.962

Notes: (1) Regressions include 168 importing countries and 10 exporting countries (United States and peers, Brazil, India, China, Mexico, and Israel for 11 years). N = 18,480. (2) Standard errors are clustered at the country-pair level. (3) All specifications include gravity controls for distance, importer GDP per capita, and importer population in logs. (4) All specifications include importer and exporter-by-year fixed effects. (5) Tier 2 is the default tier against which coefficients can be compared. (6) Exports are in 2005 US dollars. (7) *** p<0.01, ** p<0.05, * p<0.1.

Source: COMTRADE database, see appendix B; authors' calculations.

Table 6b Estimated impact of export controls on export behavior—example of Latvia graduating to tier 2 from tier 3 (ISIC=382 (machinery), importer: Latvia)

Exporter	**Brazil**	**China**	**Germany**	**France**	**United Kingdom**	**India**	**Israel**	**Japan**	**Mexico**	**United States**
2004 exports (millions of 2005 US dollars)	0.12	32.9	219	15.7	30.2	1.82	2.32	10.3	0.04	20.2
Tier 3 marginal effects	–0.77	0.66	0.68	0.35*	0.01*	0.25*	–0.65	–0.23*	–0.81	1.2
Promoted to tier 2 (change in millions of US dollars)	0.39	–13.13	–88.98	–4.09	–0.44	–0.37	4.33	3.04	0.18	–11

*Coefficient estimated imprecisely

Source: COMTRADE database, see appendix B; authors' calculations.

Table 7 Alternate specification, United States, traditional peer countries (France, United Kingdom, Germany, and Japan), and five emerging countries, 1994–2004

	(351)	(352)	(381)	(382)	(383)	(384)	(385)
Ln(exports) high-tech	Industrial chemicals	Chemical products	Metal products	Machinery	Electrical machinery	Transport equipment	Scientific equipment
Tier 1 x exporter is France	–0.284	–0.035	–0.350*	–0.064	0.043	–0.500***	–0.757***
	(0.204)	(0.16)	(0.181)	(0.145)	(0.152)	(0.19)	(0.174)
Tier 3 x exporter is France	–0.884***	–0.177	–0.344	–0.381**	–0.322	–0.419	–0.381*
	(0.306)	(0.223)	(0.216)	(0.191)	(0.216)	(0.306)	(0.195)
Tier 4 x exporter is France	3.700**	–0.082	–0.461	4.102***	1.322	4.265***	3.889***
	(1.626)	(0.88)	(1.076)	(1.373)	(1.293)	(1.261)	(1.408)
Tier 1 x exporter is Germany	–0.056	0.017	–0.207	–0.022	0.113	–0.091	–0.029
	(0.175)	(0.161)	(0.153)	(0.124)	(0.143)	(0.163)	(0.139)
Tier 3 x exporter is Germany	–0.749**	0.058	0.181	–0.093	0.037	–0.32	0.117
	(0.294)	(0.207)	(0.233)	(0.172)	(0.215)	(0.231)	(0.177)
Tier 4 x exporter is Germany	1.318	–0.978	0.049	1.830*	–0.47	2.598***	2.071**
	(1.009)	(0.865)	(0.997)	(0.967)	(1.115)	(0.891)	(0.841)
Tier 1 x exporter is United Kingdom	–0.143	–0.306*	–0.238	–0.081	–0.068	–0.026	–0.14
	(0.171)	(0.159)	(0.165)	(0.126)	(0.143)	(0.178)	(0.145)
Tier 3 x exporter is United Kingdom	–0.799***	–0.212	–0.227	–0.303*	–0.285	–0.163	–0.107
	(0.305)	(0.205)	(0.202)	(0.164)	(0.21)	(0.224)	(0.188)
Tier 4 x exporter is United Kingdom	0.806	–1.408	–0.581	1.464	–0.546	2.106**	1.365
	(1.012)	(0.914)	(1.047)	(1.044)	(1.1)	(0.868)	(0.89)
Tier 1 x exporter is Japan	–0.311	–0.373*	–0.589***	–0.306**	–0.291*	–0.172	–0.740***
	(0.239)	(0.216)	(0.194)	(0.147)	(0.161)	(0.169)	(0.168)
Tier 3 x exporter is Japan	–1.364***	–0.396	–0.353	–0.416**	–0.483**	0.078	0.008
	(0.348)	(0.265)	(0.304)	(0.184)	(0.207)	(0.283)	(0.228)
Tier 4 x exporter is Japan	0.691	–0.374	1.303	2.295**	1.339	1.853**	3.010***
	(1.163)	(0.923)	(1.239)	(0.934)	(1.235)	(0.886)	(1.154)
Tier 1 x exporter is emerging	–0.261	0.124	–0.021	–0.164	–0.191	–0.148	–0.401***
	(0.174)	(0.162)	(0.157)	(0.133)	(0.144)	(0.172)	(0.145)
Tier 3 x exporter is emerging	–0.837***	–0.249	–0.668***	–0.540***	–0.423*	–1.135***	–0.241
	(0.319)	(0.242)	(0.231)	(0.208)	(0.228)	(0.264)	(0.215)
Tier 4 x exporter is emerging	1.802*	–0.381	–0.021	2.840***	0.071	2.536***	1.435
	(1.052)	(0.946)	(1.059)	(1.008)	(1.104)	(0.902)	(0.925)
R^2	0.908	0.928	0.916	0.909	0.915	0.912	0.915

Notes: (1) Regressions include 168 importing countries and 10 exporting countries (United States and peers, Brazil, India, China, Mexico, and Israel for 11 years). N = 18,480. (2) Standard errors are robust. (3) All specifications include importer-by-year, exporter-by-year and exporter-by-importer fixed effects. (4) Tier 2 is the default tier against which coefficients can be compared. (5) Exports are in 2005 US dollars. (6) *** p<0.01, ** p<0.05, * p<0.1.

Source: COMTRADE database, see appendix B; authors' calculations.

APPENDIX A: ROBUSTNESS

Table A1 Difference-in-difference specification, United States and traditional peer countries, 1994–2004, tier 2 (default tier) exports

	(351)	(352)	(381)	(382)	(383)	(384)	(385)
Ln(exports) high-tech	Industrial chemicals	Chemical products	Metal products	Machinery	Electrical machinery	Transport equipment	Scientific equipment
Tier 2	0.018	0.031	–0.107	0.146	0.353**	–0.470**	0.157
	(0.258)	(0.218)	(0.283)	(0.217)	(0.177)	(0.225)	(0.192)
Tier 2 x exporter is France	–0.059	0.380	0.239	–0.079	0.050	0.578*	0.364
	(0.316)	(0.288)	(0.384)	(0.308)	(0.265)	(0.303)	(0.275)
Tier 2 x exporter is Germany	–0.298	–0.415	–0.246	–0.422	–0.989***	–0.339	–0.321
	(0.311)	(0.272)	(0.352)	(0.266)	(0.232)	(0.294)	(0.235)
Tier 2 x exporter is United Kingdom	0.579*	0.599**	0.581	0.091	0.079	0.624**	0.435*
	(0.300)	(0.263)	(0.363)	(0.281)	(0.249)	(0.297)	(0.262)
Tier 2 x exporter is Japan	–0.227	–0.357	0.465	–0.268	–0.616**	1.210***	–0.344
	(0.374)	(0.376)	(0.371)	(0.314)	(0.296)	(0.298)	(0.253)
R^2	0.986	0.988	0.986	0.992	0.991	0.990	0.989

Notes: (1) Regressions include 168 importing countries and five exporting countries for 11 years. N = 9,240. (2) Standard errors are clustered at the country-pair level. (3) All specifications include gravity controls for distance, importer GDP per capita, and importer population in logs. (4) All specifications include exporter-by-year fixed effects and importer fixed effects. (5) Exports are in 2005 US dollars. (6) *** p<0.01, ** p<0.05, * p<0.1.

Source: COMTRADE database, see appendix B; authors' calculations.

Table A2 Alternate specification, United States and traditional peer countries, 1994–2004, tier 2 (default tier) exports

	(351)	(352)	(381)	(382)	(383)	(384)	(385)
Ln(exports) high-tech	Industrial chemicals	Chemical products	Metal products	Machinery	Electrical machinery	Transport equipment	Scientific equipment
Tier 2 x exporter is France	0.296	0.076	0.354**	–0.013	0.012	0.289*	0.463***
	(0.187)	(0.133)	(0.147)	(0.123)	(0.120)	(0.161)	(0.151)
Tier 2 x exporter is Germany	0.198	0.009	0.087	–0.032	–0.068	0.045	–0.097
	(0.158)	(0.132)	(0.129)	(0.093)	(0.113)	(0.134)	(0.120)
Tier 2 x exporter is United Kingdom	0.294*	0.323**	0.248*	0.083	0.149	–0.023	0.073
	(0.156)	(0.132)	(0.136)	(0.098)	(0.114)	(0.144)	(0.127)
Tier 2 x exporter is Japan	0.573***	0.378**	0.446***	0.233*	0.279**	0.019	0.375**
	(0.207)	(0.179)	(0.168)	(0.120)	(0.128)	(0.139)	(0.146)
R^2	0.902	0.928	0.910	0.938	0.928	0.914	0.911

Notes: (1) Regressions include 168 importing countries and five exporting countries for 11 years. N = 9,240. (2) Standard errors are robust. (3) All specifications include exporter-by-year, importer-by-year and exporter-by-importer fixed effects. (4) Exports are in 2005 US dollars. (5) *** p<0.01, ** p<0.05, * p<0.1.

Source: COMTRADE database, see appendix B; authors' calculations.

Table A3 Country tier movements: 2004–11

	Tier 1	Tier 3	Tier 4
2004–05 WASSENAAR		(+) Iraq	(–) Iraq
2006—10 WASSENAAR	(+) Bulgaria	(–) Bulgaria	
2011 WASSENAAR	(+) Albania, Croatia	(–) Albania, Croatia	

WASSENAAR = Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies

Source: COMTRADE data, see appendix B; authors' calculations.

Table A4 Difference-in-difference specification, United States and traditional peer countries (France, United Kingdom, Germany, and Japan) across comparable SITC traded-product categories, 1994–2011

Ln(Exports) high-tech	Organic/ inorganic chemicals	Other chemicals	Basic metals	Industrial, office machinery	Electrical machinery, telecom	Transport equipment	Scientific equipment
Tier 1	0.055	–0.049	0.120	0.055	–0.052	0.140	0.201
	(0.225)	(0.179)	(0.202)	(0.145)	(0.147)	(0.188)	(0.144)
Tier 3	0.250	–0.162	0.107	0.183	–0.230	0.988***	0.067
	(0.265)	(0.200)	(0.219)	(0.178)	(0.175)	(0.232)	(0.178)
Tier 4	–3.461***	–3.011***	–4.652***	–5.797***	–4.479***	–4.334***	–3.612***
	(1.019)	(0.501)	(0.942)	(0.880)	(0.586)	(0.816)	(0.636)
Tier 1 x exporter is France	–0.746***	–0.633***	–0.594**	–0.515***	–0.710***	–0.794***	–0.971***
	(0.276)	(0.213)	(0.242)	(0.170)	(0.191)	(0.230)	(0.183)
Tier 3 x exporter is France	–0.145	0.133	–0.371	–0.312	–0.172	–1.219***	–0.357
	(0.335)	(0.254)	(0.298)	(0.208)	(0.240)	(0.271)	(0.237)
Tier 4 x exporter is France	4.004***	2.997***	4.683***	6.438***	4.456***	5.359***	3.784***
	(0.792)	(0.651)	(1.298)	(1.064)	(0.881)	(1.044)	(0.920)
Tier 1 x exporter is Germany	–0.725***	–0.015	–0.080	–0.033	0.174	0.072	–0.254
	(0.256)	(0.191)	(0.224)	(0.154)	(0.167)	(0.206)	(0.159)
Tier 3 x exporter is Germany	–0.251	0.741***	0.053	0.236	0.761***	0.040	0.217
	(0.310)	(0.220)	(0.260)	(0.171)	(0.194)	(0.247)	(0.200)
Tier 4 x exporter is Germany	4.106***	3.902***	5.062***	6.851***	5.549***	5.371***	4.646***
	(0.785)	(0.670)	(1.313)	(1.078)	(0.816)	(0.957)	(0.924)
Tier 1 x exporter is United Kingdom	–1.134***	–0.560***	–0.913***	–0.551***	–0.377**	–0.359	–0.845***
	(0.257)	(0.211)	(0.243)	(0.164)	(0.182)	(0.218)	(0.188)
Tier 3 x exporter is United Kingdom	–0.947***	–0.216	–0.851***	–0.499***	–0.180	–1.308***	–0.606***
	(0.315)	(0.220)	(0.263)	(0.174)	(0.204)	(0.242)	(0.212)
Tier 4 x exporter is United Kingdom	3.665***	3.206***	4.293***	6.353***	4.263***	4.534***	3.529***
	(0.784)	(0.694)	(1.253)	(1.072)	(0.899)	(0.947)	(0.961)
Tier 1 x exporter is Japan	0.564	0.479*	–0.131	0.175	0.318	–0.792***	0.011
	(0.407)	(0.259)	(0.272)	(0.208)	(0.230)	(0.232)	(0.207)
Tier 3 x exporter is Japan	–0.046	0.217	–0.781**	–0.271	0.198	–2.099***	–0.036
	(0.492)	(0.280)	(0.334)	(0.223)	(0.249)	(0.266)	(0.220)
Tier 4 x exporter is Japan	4.606***	3.886***	5.062***	6.811***	5.334***	4.397***	4.623***
	(0.901)	(0.640)	(1.251)	(1.078)	(0.864)	(0.984)	(0.941)
R^2	0.982	0.994	0.992	0.996	0.994	0.993	0.994

SITC = Standard International Trade Classification

Notes: (1) Regressions include 167 importing countries and five exporting countries (United States and peers) for 18 years. N = 15,030. (2) Standard errors are clustered at the country-pair level. (3) All specifications include gravity controls for distance, importer GDP per capita, and importer population in logs. (4) All specifications include importer and exporter-by-year fixed effects. (5) Tier 2 is the default tier against which coefficients can be compared. (6) Exports are in 2005 US dollars. (7) *** p<0.01, ** p<0.05, * p<0.1.

Source: COMTRADE database, see appendix B; authors' calculations.

Table A5 Difference-in-difference specification, United States, traditional peer countries (France, United Kingdom, Germany, and Japan), and emerging countries across comparable SITC traded-product categories, 1994–2011

Ln(exports) high-tech	Organic/ inorganic chemicals	Other chemicals	Basic metals	Industrial, office machinery	Electrical machinery, telecom	Transport equipment	Scientific equipment
Tier 1	–0.353	–0.141	–0.126	–0.230	–0.159	–0.144	–0.041
	(0.230)	(0.191)	(0.204)	(0.152)	(0.154)	(0.208)	(0.158)
Tier 3	0.343	0.194	0.464*	0.572**	0.199	1.621***	0.356
	(0.328)	(0.251)	(0.281)	(0.226)	(0.234)	(0.307)	(0.234)
Tier 4	–3.202***	–2.711***	–4.287***	–5.643***	–4.319***	–4.508***	–3.777***
	(0.915)	(0.853)	(1.406)	(1.157)	(0.949)	(1.148)	(1.017)
Tier 1 x exporter is France	–0.624**	–0.756***	–0.586**	–0.512**	–0.761***	–0.855***	–1.013***
	(0.304)	(0.253)	(0.263)	(0.201)	(0.225)	(0.264)	(0.217)
Tier 3 x exporter is France	0.027	–0.038	–0.347	–0.302	–0.233	–1.307***	–0.413
	(0.415)	(0.316)	(0.355)	(0.265)	(0.296)	(0.349)	(0.304)
Tier 4 x exporter is France	4.119***	2.882***	4.697***	6.444***	4.414***	5.301***	3.746***
	(0.874)	(0.864)	(1.532)	(1.224)	(1.082)	(1.207)	(1.112)
Tier 1 x exporter is Germany	–0.593**	–0.138	–0.067	–0.028	0.120	0.009	–0.299
	(0.277)	(0.223)	(0.238)	(0.181)	(0.193)	(0.244)	(0.187)
Tier 3 x exporter is Germany	–0.046	0.540*	0.084	0.249	0.688***	–0.063	0.151
	(0.393)	(0.288)	(0.320)	(0.243)	(0.255)	(0.360)	(0.261)
Tier 4 x exporter is Germany	4.234***	3.779***	5.080***	6.859***	5.502***	5.308***	4.604***
	(0.848)	(0.850)	(1.539)	(1.245)	(1.060)	(1.237)	(1.113)
Tier 1 x exporter is United Kingdom	–1.004***	–0.675***	–0.897***	–0.542***	–0.427*	–0.428	–0.887***
	(0.287)	(0.260)	(0.273)	(0.205)	(0.221)	(0.271)	(0.232)
Tier 3 x exporter is United Kingdom	–0.777*	–0.379	–0.825**	–0.487*	–0.240	–1.396***	–0.660**
	(0.415)	(0.305)	(0.337)	(0.264)	(0.285)	(0.357)	(0.298)
Tier 4 x exporter is United Kingdom	3.777***	3.101***	4.309***	6.361***	4.222***	4.476***	3.494***
	(0.939)	(0.965)	(1.570)	(1.230)	(1.114)	(1.271)	(1.173)
Tier 1 x exporter is Japan	0.537	0.477*	–0.164	0.155	0.299	–0.820***	–0.003
	(0.408)	(0.258)	(0.264)	(0.193)	(0.218)	(0.251)	(0.196)
Tier 3 x exporter is Japan	0.036	0.125	–0.778**	–0.272	0.159	–2.158***	–0.071
	(0.567)	(0.313)	(0.388)	(0.265)	(0.282)	(0.348)	(0.258)
Tier 4 x exporter is Japan	4.588***	3.892***	5.047***	6.802***	5.329***	4.389***	4.620***
	(1.111)	(0.884)	(1.563)	(1.264)	(1.067)	(1.385)	(1.118)

(table continues)

Table A5 Difference-in-difference specification, United States, traditional peer countries (France, United Kingdom, Germany, and Japan), and emerging countries across comparable SITC traded-product categories, 1994–2011 *(continued)*

Ln(exports) high-tech	Organic/ inorganic chemicals	Other chemicals	Basic metals	Industrial, office machinery	Electrical machinery, telecom	Transport equipment	Scientific equipment
Tier 1 x exporter is emerging	0.473*	0.395*	0.290	0.326*	0.506**	–0.023	–0.013
	(0.266)	(0.234)	(0.239)	(0.194)	(0.199)	(0.263)	(0.208)
Tier 3 x exporter is emerging	–0.524	–0.548*	–1.236***	–0.973***	–0.705**	–2.311***	–0.926***
	(0.396)	(0.309)	(0.334)	(0.272)	(0.285)	(0.371)	(0.291)
Tier 4 x exporter is emerging	3.478***	1.741	3.036*	5.199***	3.559***	3.771***	2.987**
	(1.171)	(1.169)	(1.754)	(1.462)	(1.333)	(1.380)	(1.319)
R^2	0.956	0.975	0.971	0.982	0.978	0.965	0.975

SITC = Standard International Trade Classification

Notes: (1) Regressions include 167 importing countries and 10 exporting countries (United States and peers, Brazil, China, India, Israel, and Mexico) for 18 years. N = 30,060. (2) Standard errors are clustered at the country-pair level. (3) All specifications include gravity controls for distance, importer GDP per capita, and importer population in logs. (4) All specifications include importer and exporter-by-year fixed effects. (5) Tier 2 is the default tier against which coefficients can be compared. (6) Exports are in 2005 US dollars. (7) *** p<0.01, ** p<0.05, * p<0.1.

Source: COMTRADE database, see appendix B; authors' calculations.

Table A6 Difference-in-difference specification, United States, traditional peer countries (France, United Kingdom, Germany, and Japan), and emerging countries across comparable SITC traded-product categories, 1994–2011

Ln(exports) high-tech	Organic/ inorganic chemicals	Other chemicals	Basic metals	Industrial, office machinery	Electrical machinery, telecom	Transport equipment	Scientific equipment
Tier 1	–0.358	–0.134	–0.122	–0.227	–0.151	–0.137	–0.039
	(0.228)	(0.190)	(0.203)	(0.151)	(0.154)	(0.208)	(0.156)
Tier 3 small	0.361	0.216	0.505*	0.632***	0.232	1.669***	0.397*
	(0.330)	(0.255)	(0.281)	(0.227)	(0.237)	(0.311)	(0.237)
China	0.146	0.672	0.515	–0.054	0.424	0.758	0.625
	(0.486)	(0.543)	(0.508)	(0.434)	(0.453)	(0.905)	(0.487)
India	–0.538	–0.196	0.005	–0.573*	0.387	2.224***	–0.471
	(0.491)	(0.670)	(0.584)	(0.300)	(0.461)	(0.825)	(0.418)
Tier 4	–3.207***	–2.699***	–4.276***	–5.634***	–4.303***	–4.494***	–3.767***
	(0.927)	(0.849)	(1.384)	(1.139)	(0.918)	(1.143)	(1.013)
Tier 1 x exporter is France	–0.628**	–0.797***	–0.629**	–0.544***	–0.814***	–0.901***	–1.054***
	(0.301)	(0.253)	(0.262)	(0.196)	(0.226)	(0.264)	(0.216)
Tier 3 small x exporter is France	0.071	0.008	–0.383	–0.330	–0.271	–1.391***	–0.441
	(0.414)	(0.313)	(0.354)	(0.258)	(0.297)	(0.351)	(0.303)
China x exporter is France	–0.943***	–2.196***	–1.098***	–0.622***	–1.219***	–0.664**	–1.406***
	(0.337)	(0.263)	(0.305)	(0.214)	(0.242)	(0.274)	(0.259)
India x exporter is France	–1.159***	–2.512***	–0.841***	–0.857***	–1.048***	–1.359***	–0.855***
	(0.340)	(0.268)	(0.310)	(0.217)	(0.246)	(0.280)	(0.262)
Tier 4 x exporter is France	4.116***	2.844***	4.656***	6.414***	4.364***	5.256***	3.708***
	(0.874)	(0.873)	(1.549)	(1.234)	(1.094)	(1.220)	(1.121)
Tier 1 x exporter is Germany	–0.596**	–0.176	–0.109	–0.058	0.067	–0.046	–0.340*
	(0.273)	(0.222)	(0.235)	(0.175)	(0.192)	(0.243)	(0.185)
Tier 3 small x exporter is Germany	–0.004	0.548*	0.019	0.189	0.621**	–0.123	0.101
	(0.391)	(0.287)	(0.317)	(0.233)	(0.254)	(0.361)	(0.258)
China x exporter is Germany	–1.088***	–0.638***	0.118	0.644***	0.334*	–0.126	–0.199
	(0.285)	(0.216)	(0.256)	(0.172)	(0.195)	(0.248)	(0.204)
India x exporter is Germany	–0.974***	–1.309***	–0.259	0.215	0.034	–1.486***	–0.331
	(0.292)	(0.224)	(0.265)	(0.178)	(0.203)	(0.258)	(0.210)
Tier 4 x exporter is Germany	4.232***	3.742***	5.037***	6.828***	5.449***	5.252***	4.563***
	(0.848)	(0.860)	(1.556)	(1.254)	(1.071)	(1.247)	(1.122)
Tier 1 x exporter is United Kingdom	–1.008***	–0.712***	–0.941***	–0.573***	–0.479**	–0.481*	–0.927***
	(0.284)	(0.260)	(0.272)	(0.201)	(0.222)	(0.271)	(0.232)
Tier 3 small x exporter is United Kingdom	–0.729*	–0.358	–0.860**	–0.523**	–0.285	–1.443***	–0.693**
	(0.414)	(0.304)	(0.337)	(0.259)	(0.286)	(0.359)	(0.297)

(table continues)

Table A6 Difference-in-difference specification, United States, traditional peer countries (France, United Kingdom, Germany, and Japan), and emerging countries across comparable SITC traded-product categories, 1994–2011 *(continued)*

Ln(exports) high-tech	Organic/ inorganic chemicals	Other chemicals	Basic metals	Industrial, office machinery	Electrical machinery, telecom	Transport equipment	Scientific equipment
China x exporter is United Kingdom	–2.300***	–1.926***	–1.842***	–0.969***	–1.200***	–2.121***	–1.587***
	(0.328)	(0.254)	(0.294)	(0.214)	(0.247)	(0.287)	(0.262)
India x exporter is United Kingdom	–1.602***	–2.123***	–1.020***	–0.411*	–0.594**	–1.945***	–0.842***
	(0.331)	(0.258)	(0.298)	(0.217)	(0.250)	(0.291)	(0.264)
Tier 4 x exporter is United Kingdom	3.773***	3.067***	4.270***	6.333***	4.175***	4.428***	3.458***
	(0.939)	(0.973)	(1.585)	(1.239)	(1.123)	(1.281)	(1.181)
Tier 1 x exporter is Japan	0.544	0.482*	–0.153	0.162	0.307	–0.823***	0.005
	(0.408)	(0.259)	(0.264)	(0.193)	(0.219)	(0.252)	(0.197)
Tier 3 small x exporter is Japan	–0.007	0.105	–0.835**	–0.304	0.125	–2.127***	–0.105
	(0.575)	(0.316)	(0.392)	(0.265)	(0.285)	(0.351)	(0.259)
China x exporter is Japan	1.504***	0.217	–0.491	–0.109	0.189	–4.381***	0.119
	(0.469)	(0.319)	(0.354)	(0.255)	(0.278)	(0.347)	(0.263)
India x exporter is Japan	0.997**	–0.012	0.363	0.088	0.030	–3.509***	0.114
	(0.436)	(0.277)	(0.305)	(0.219)	(0.237)	(0.292)	(0.227)
Tier 4 x exporter is Japan	4.594***	3.896***	5.056***	6.807***	5.335***	4.386***	4.626***
	(1.111)	(0.893)	(1.579)	(1.273)	(1.078)	(1.398)	(1.127)
Tier 1 x exporter is India	–0.749**	–0.811***	–0.507	–0.671**	–0.527*	–0.936***	–0.769***
	(0.320)	(0.270)	(0.311)	(0.288)	(0.299)	(0.331)	(0.286)
Tier 3 small x exporter is India	–0.713	–0.986***	–1.868***	–1.388***	–1.345***	–2.992***	–0.983**
	(0.480)	(0.353)	(0.443)	(0.391)	(0.406)	(0.441)	(0.383)
China x exporter is India	–2.266***	–3.648***	–4.496***	–2.731***	–3.052***	–5.396***	–3.361***
	(0.402)	(0.322)	(0.361)	(0.323)	(0.330)	(0.352)	(0.346)
Tier 4 x exporter is India	3.990***	2.483***	4.791***	6.699***	5.113***	4.751***	4.352***
	(0.894)	(0.897)	(1.606)	(1.282)	(1.231)	(1.237)	(1.192)
Tier 1 x exporter is China	–0.129	–0.186	–0.803***	–0.052	0.043	–1.107***	–0.266
	(0.305)	(0.257)	(0.251)	(0.234)	(0.210)	(0.293)	(0.243)
Tier 3 small x exporter is China	0.738	–0.165	–1.223***	–0.117	–0.065	–2.015***	–0.381
	(0.453)	(0.355)	(0.362)	(0.297)	(0.289)	(0.383)	(0.312)
India x exporter is China	–0.516	–1.074***	–2.766***	–0.975***	–1.161***	–3.932***	–1.234***
	(0.373)	(0.312)	(0.320)	(0.270)	(0.269)	(0.331)	(0.270)
Tier 4 x exporter is China	5.673***	4.316***	5.181***	7.519***	5.621***	5.669***	5.206***
	(0.782)	(0.873)	(1.547)	(1.216)	(1.096)	(1.204)	(1.130)
Tier 1 x exporter is Brazil	0.975**	0.270	–0.465	–0.189	0.105	0.515	–0.634*
	(0.418)	(0.393)	(0.332)	(0.326)	(0.377)	(0.462)	(0.378)

(table continues)

Table A6 Difference-in-difference specification, United States, traditional peer countries (France, United Kingdom, Germany, and Japan), and emerging countries across comparable SITC traded-product categories, 1994–2011 *(continued)*

Ln(exports) high-tech	Organic/ inorganic chemicals	Other chemicals	Basic metals	Industrial, office machinery	Electrical machinery, telecom	Transport equipment	Scientific equipment
Tier 3 small x exporter is Brazil	–0.887	–1.028*	–1.644***	–1.148**	–1.359**	–3.016***	–0.839*
	(0.745)	(0.595)	(0.524)	(0.446)	(0.563)	(0.738)	(0.509)
China x exporter is Brazil	1.826***	0.336	–0.524	0.171	0.679*	1.664***	0.623
	(0.511)	(0.419)	(0.358)	(0.327)	(0.383)	(0.496)	(0.397)
India x exporter is Brazil	2.729***	0.413	–0.555	0.378	0.511	1.365***	0.847**
	(0.510)	(0.418)	(0.355)	(0.324)	(0.381)	(0.493)	(0.396)
Tier 4 x exporter is Brazil	5.517***	4.105***	4.602***	7.085***	5.495***	6.628***	4.257***
	(1.108)	(1.010)	(1.584)	(1.288)	(1.197)	(1.530)	(1.333)
Tier 1 x exporter is Mexico	0.260	0.624	0.912**	0.835**	1.270***	0.133	0.501
	(0.476)	(0.459)	(0.424)	(0.389)	(0.408)	(0.559)	(0.469)
Tier 3 small x exporter is Mexico	–1.670**	–0.745	–1.522**	–1.647**	–0.202	–1.655**	–1.623**
	(0.765)	(0.696)	(0.714)	(0.643)	(0.684)	(0.801)	(0.695)
China x exporter is Mexico	1.833***	0.845	1.262**	2.790***	0.947**	1.802***	1.572***
	(0.558)	(0.540)	(0.509)	(0.412)	(0.477)	(0.617)	(0.516)
India x exporter is Mexico	1.199**	2.045***	1.837***	1.526***	0.231	0.484	2.445***
	(0.558)	(0.540)	(0.509)	(0.412)	(0.477)	(0.617)	(0.516)
Tier 4 x exporter is Mexico	5.486***	3.145**	5.263***	6.312***	5.858***	3.745**	4.588***
	(1.841)	(1.481)	(2.025)	(1.743)	(1.411)	(1.725)	(1.527)
Tier 1 x exporter is Israel	2.061***	2.128***	2.383***	1.781***	1.701***	1.368***	1.182***
	(0.415)	(0.419)	(0.410)	(0.356)	(0.377)	(0.476)	(0.339)
Tier 3 small x exporter is Israel	–0.389	–0.063	–0.239	–0.908	–0.818	–2.332***	–1.161*
	(0.808)	(0.692)	(0.743)	(0.675)	(0.657)	(0.883)	(0.641)
China x exporter is Israel	2.916***	2.555***	2.748***	1.350***	0.991**	–0.797	1.601***
	(0.533)	(0.474)	(0.518)	(0.375)	(0.388)	(0.558)	(0.389)
India x exporter is Israel	3.507***	3.233***	3.106***	1.650***	1.411***	1.741***	1.843***
	(0.540)	(0.485)	(0.529)	(0.381)	(0.396)	(0.569)	(0.395)
Tier 4 x exporter is Israel	–3.227	–5.354***	–4.674**	–1.617	–4.333**	–1.959	–3.471*
	(2.582)	(1.696)	(1.994)	(2.689)	(1.932)	(2.503)	(2.039)
R^2	0.958	0.977	0.973	0.984	0.979	0.967	0.976

SITC = Standard International Trade Classification

Notes: (1) Regressions include 167 importing countries and 10 exporting countries (United States and peers, Brazil, China, India, Israel, and Mexico) for 18 years. N = 30,060. (2) Standard errors are clustered at the country-pair level. (3) All specifications include gravity controls for distance, importer GDP per capita, and importer population in logs. (4) All specifications include importer and exporter-by-year fixed effects. (5) Tier 2 is the default tier against which coefficients can be compared. (6) Exports are in 2005 US dollars. (7) *** p<0.01, ** p<0.05, * p<0.1.

Source: COMTRADE database, see appendix B; authors' calculations.

Table A7 Alternate specification, United States, traditional peer countries (France, United Kingdom, Germany, and Japan), and emerging countries across comparable SITC traded-product categories, 1994–2011

Ln(Exports) High-tech	Organic/ inorganic chemicals	Other chemicals	Basic metals	Industrial, office machinery	Electrical machinery, telecom	Transport equipment	Scientific equipment
Tier 1 x exporter is France	–0.425***	0.438***	0.167	0.022	0.179*	–0.435***	–0.266**
	(0.155)	(0.103)	(0.123)	(0.096)	(0.109)	(0.142)	(0.109)
Tier 3 x exporter is France	–1.544***	–0.388*	–0.494**	–0.421**	–0.541**	–0.083	–0.449**
	(0.310)	(0.217)	(0.225)	(0.198)	(0.212)	(0.312)	(0.217)
Tier 4 x exporter is France	0.696	–0.137	–0.276	2.707**	0.967	2.024	1.558
	(1.644)	(1.006)	(1.042)	(1.276)	(1.181)	(1.298)	(1.200)
Tier 1 x exporter is Germany	–0.276*	0.316***	–0.034	0.042	0.149	0.111	–0.010
	(0.143)	(0.100)	(0.113)	(0.091)	(0.102)	(0.126)	(0.097)
Tier 3 x exporter is Germany	–0.746**	–0.410**	–0.101	–0.243	–0.319*	–0.083	–0.190
	(0.311)	(0.207)	(0.212)	(0.159)	(0.178)	(0.236)	(0.188)
Tier 4 x exporter is Germany	–0.681	–0.375	–0.193	1.842	0.586	1.235	1.368
	(1.646)	(1.009)	(1.034)	(1.132)	(1.064)	(1.096)	(0.901)
Tier 1 x exporter is United Kingdom	–0.612***	0.190*	–0.055	–0.117	–0.074	0.046	–0.121
	(0.143)	(0.100)	(0.121)	(0.091)	(0.102)	(0.125)	(0.101)
Tier 3 x exporter is United Kingdom	–1.273***	–0.623***	–0.416**	–0.421***	–0.490***	–0.073	–0.466**
	(0.296)	(0.214)	(0.206)	(0.154)	(0.169)	(0.228)	(0.195)
Tier 4 x exporter is United Kingdom	–0.303	–0.538	–0.842	1.663	–0.111	0.711	0.294
	(1.642)	(1.020)	(1.054)	(1.136)	(1.063)	(1.074)	(0.884)
Tier 1 x exporter is Japan	–0.138	0.452***	–0.325**	–0.099	–0.519***	–0.182	–0.391***
	(0.189)	(0.124)	(0.135)	(0.106)	(0.113)	(0.124)	(0.110)
Tier 3 x exporter is Japan	–0.937***	–0.738***	–1.198***	–0.541***	–0.905***	–0.140	–0.345
	(0.349)	(0.286)	(0.264)	(0.186)	(0.187)	(0.276)	(0.235)
Tier 4 x exporter is Japan	0.983	–0.055	–1.040	1.653	0.587	0.907	1.249
	(1.726)	(1.030)	(1.074)	(1.134)	(1.103)	(1.074)	(0.975)
Tier 1 x exporter is emerging	–0.149	0.560***	0.066	–0.167*	0.201*	–0.325**	–0.295***
	(0.131)	(0.104)	(0.114)	(0.098)	(0.103)	(0.126)	(0.101)
Tier 3 x exporter is emerging	–0.940***	–0.552**	–0.697***	–0.455**	–0.658***	–0.328	–0.537**
	(0.288)	(0.231)	(0.221)	(0.183)	(0.203)	(0.259)	(0.213)
Tier 4 x exporter is emerging	0.847	–0.737	–0.605	1.751	0.263	0.367	0.207
	(1.622)	(1.001)	(1.072)	(1.167)	(1.084)	(1.074)	(0.906)
R^2	0.921	0.920	0.908	0.916	0.903	0.913	0.922

SITC = Standard International Trade Classification

Notes: (1) Regressions include 167 importing countries and 10 exporting countries (United States and peers, Brazil, China, India, Israel, and Mexico) for 18 years. N = 30,060. (2) Standard errors are robust. (3) All specifications include importer-by-year, exporter-by-year, and exporter-by-importer fixed effects. (4) Tier 2 is the default tier against which coefficients can be compared. (5) Exports are in 2005 US dollars. (6) *** p<0.01, ** p<0.05, * p<0.1.

Source: COMTRADE database, see appendix B; authors' calculations.

APPENDIX B: DATA

Export data (value of exports):

ISIC level analysis (1994–2004):

Recorded in Nicita and Olarreaga (2006); original source: Trade, Production, and Protection Database, Washington: World Bank. Calculated from the COMTRADE database, United Nations Statistic Division (UNSD), available at www.worldbank.org\trade.

SITC level analysis (1994–2011):

Obtained from the United Nations' COMTRADE database.

Data obtained in current US dollars converted to constant US 2005 dollars using Wholesale Price Index for the United States from World Development Indicators, Washington: World Bank.

The SITC corresponding to the ISIC sectors are as follows:

ISIC Rev 2	Description	SITC Rev 3	Description
351	Industrial chemicals	51, 52	Organic/inorganic chemicals
352	Chemical products	53–56, 59	Other chemicals
381	Metal products	69	Basic metals
382	Machinery	71–75, 81	Industrial, office machinery
383	Electrical machinery	76, 77	Electrical machinery, telecom
384	Transport equipment	78, 79	Transport equipment
385	Scientific equipment	87, 88	Scientific equipment

Missing values:

We first calculate the share of each importer in total exports of each exporter for a given year. We then linearly interpolate the shares over time and calculate exports for missing years for each exporter x importer pair by multiplying the share by total exports. For missing values that remain after this replacement, we set exports to equal zero.

Zero exports are then set to a small value (equal to one), as often done in estimating gravity equations. For a discussion of the risks of this treatment of zero trade flows, see DeRosa and Harrigan (2011).

Distance data (geodesic distance between capitals):

Trade, Production, and Protection Database, see above.

GDP per capita (international dollars) and population data: ISIC level analysis (1994–2004):

Population from World Development Indicators, Washington: World Bank. GDP per capita data from Penn World Tables, version 6.3.

SITC level analysis (1994–2011):

Population (in 1000s) and GDP per capita data from Penn World Tables, version 7.1. Since the Penn World Tables did not have updated data for 2011 on GDP per capita, these figures have been filled in using linear interpolation. In other words, GDP is assumed to grow at the same rate between 2010 and 2011 as between 2009 and 2010.

GDP per capita in international current dollars converted to 2005 dollars using Wholesale Price Index for the United States from World Development Indicators, Washington: World Bank.