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Trade Spillovers of Domestic Subsidies

Lorenzo Rotunno and Michele Ruta

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Prepared by Lorenzo Rotunno and Michele Ruta*

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ABSTRACT: As governments resort to industrial policies to achieve economic and non-economic objectives, the number of subsidies implemented each year has more than tripled in the last decade. Using detailed data across a large number of advanced and emerging economies, we empirically investigate the effects of domestic subsidies on international trade flows. Estimates from a difference-in-difference specification show that on average subsidies promote both exports and imports. These effects are partly driven by selection into subsidies, as governments target export-oriented and import-competing products. The results however mask significant differences across countries. Specifically, exports of subsidized products from G20 emerging markets increase 8 percent more than exports of other products, with no evidence of selection. The gravity estimates confirm that subsidies promote international relative to domestic trade. These spillover effects are concentrated in some industries, such as electrical machinery, and are stronger when subsidies are given through tax breaks than other policy instruments. The subsidy-led rise in trade calls for international cooperation to manage risks of retaliatory actions and possible drifts towards a subsidy war.

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* We are grateful to Alberto Behar, Marijn Bolhuis, Oliver Exton, Andrea Presbitero, Martin Sommer, Adrian Wood, Yoto Yotov and Robert Zymek for useful comments.

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Trade Spillovers of Domestic Subsidies *

Lorenzo Rotunno† Michele Ruta‡

February 21, 2024

Abstract

As governments resort to industrial policies to achieve economic and non-economic objectives, the number of subsidies implemented each year has more than tripled in the last decade. Using detailed data across a large number of advanced and emerging economies, we empirically investigate the effects of domestic subsidies on international trade flows. Estimates from a difference-in-difference specification show that on average subsidies promote both exports and imports. These effects are partly driven by selection into subsidies, as governments target export-oriented and import-competing products. The results however mask significant differences across countries. Specifically, exports of subsidized products from G20 emerging markets increase 8 percent more than exports of other products, with no evidence of selection. The gravity estimates confirm that subsidies promote international relative to domestic trade. These spillover effects are concentrated in some industries, such as electrical machinery, and are stronger when subsidies are given through tax breaks than other policy instruments. The subsidy-led rise in trade calls for international cooperation to manage risks of retaliatory actions and possible drifts towards a subsidy war.

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I. INTRODUCTION

Industrial policies and subsidies have made a comeback into the global policy stage. Notable examples include the Inflation Reduction Act (IRA) and the CHIPS and Science Act in the US, the European Green Deal, and the Digital Europe program in the EU, as well as China's Made in China 2025 program. These comprehensive policy packages, implemented by the world's three largest economies, encompass a wide range of industrial policies and subsidies. Other developed and emerging economies are also increasingly active in this area (Cherif, Engher, and Hasanov, 2024; Evenett and others, 2024; Juhász and others, 2022). Whether driven by economic motives, such as industrial development, supply-chain resilience, and technology adoption, or non-economic concerns like national security, health, and the environment, these interventions are anticipated to have discernible impacts on economic outcomes. By directing resources towards certain sectors, firms and activities, industrial policies and subsidies can alter relative efficiency and hence affect international trade flows. In this paper, we concentrate on subsidies as the primary instrument of industrial policy and empirically investigate the cross-border spillover effects these measures exert through international trade.

Even though not explicitly tied to a trade objective, domestic subsidies can impact international trade flows in different and sometimes contradicting ways.[1] When directed towards import-competing industries, subsidies are expected to expand domestic production and curtail imports, aligning with import-substitution strategies.[2] Conversely, when subsidies are aimed at sectors with a comparative advantage and large and export-oriented firms, they are expected to increase production and can boost exports. Subsidies can also act as a catalyst for trade by helping firms address market failures and overcome fixed costs of exporting and importing (e.g., if the firms are financially constrained). More broadly, subsidies can reshape firm-level productivity and industry-level comparative advantage (e.g., through R&D subsi-

[1] For brevity, in the rest of the paper we refer indistinctly to subsidies and domestic subsidies as any subsidy that is independent to where the product is sold. Subsidies that discriminate between foreign and domestic markets are referred explicitly as *export* subsidies.

[2] As domestic production expands following the subsidy, firms may increase their imports of intermediate inputs. Although this positive effect on imports may not significantly impact our empirical analysis at the product level, given our focus on narrowly defined products (HS 6-digit code), it becomes relevant in the industry-level analysis if there are significant imports of intermediates classified within the same industry.

dies), thereby influencing trade patterns.[3] Consequently, the direction of these effects remains ambiguous and is likely to vary across products, industries, and countries.

This paper employs detailed data from the Global Trade Alert (GTA) to empirically examine the direction and magnitude of the trade effects induced by subsidies. In our data, subsidies are defined as government measures that involve an unrequited financial transfer creating an advantage for the beneficiaries (IMF, OECD, World Bank and WTO, 2022; UNCTAD, 2019).[4] We focus on subsidies given to firms (thus excluding consumption subsidies) irrespective of the destinations of their sales (thus excluding export subsidies and trade finance). The raw data cover 193 economies between 2009 and 2021 and provide information on the targeted products at the HS6 level, the specific policy instrument (e.g. whether the subsidy takes the form of a loan, a grant or a tax exemption), and whether the measure is trade distortive (i.e., it almost certainly discriminates against foreign commercial interests, as assessed by the GTA evaluators (Evenett and Fritz, 2020)). For each subsidy and other policies, the GTA database records also its date of announcement, implementation and removal (if it occurs). Notably, the data provide information on the timing and type of policy changes – information on the monetary value of subsidies and on the existence of subsidies (and other GTA policies) introduced before 2009 is missing.

Our empirical strategy involves two distinct yet complementary exercises. In the first, we employ a difference-in-difference strategy to estimate the effects of subsidies on exports and imports at the product level. This entails comparing changes in exports and imports of a product targeted by subsidies with those of non-targeted products within the same industry. While capable of identifying effects on the export and import sides, this approach cannot fully control for the dynamics specific to the targeted products that may confound the effect of subsidies. In an alternative empirical strategy, we explicitly account for these industry- and country-specific shocks that accompany the implementation of subsidies. Using a gravity model at the industry level, we estimate the effect of subsidies on international relative to domestic trade. This method allows us to isolate the impact of subsidies while netting out the influence of exporter- and importer-specific shocks, as well as bilateral determinants of trade.

[3] Subsidy policies can alter trade patterns also through general equilibrium effects. These have "domestic" (e.g., through wages and the labour market) and "international" components (e.g., through effects on the terms of trade) that are not identified in our empirical analysis separately from the direct, 'partial-equilibrium' effects.

[4] As pointed out in IMF, OECD, World Bank and WTO (2022), this definition encompasses a large range of policy interventions, which we list in the Data section. It excludes however other government policies such as import or export restrictions that can indirectly (e.g., through the induced changes in market prices) support firms. These policies are also measured in the GTA database and we control for their influence in the empirical analysis.

While this approach forgoes the separation of export and import effects, it provides a means to assess the effects on a measure of trade spillovers – how subsidies allocate sales across domestic and international markets.

A descriptive analysis of subsidy data extracted from the GTA database highlights four facts regarding the evolution of subsidies over time, across sectors, countries and type of policy instrument.[5] First, the global use of subsidies has experienced a substantial increase since 2009. Notably, approximately 60 percent of all distortive interventions recorded in the GTA database by the last year of our sample took the form of subsidies. This upward trend conceals a notable shift in the sectoral composition, with more subsidies introduced in manufacturing and fewer in primary industries. While prior research has underscored the predominant role of G20 economies in adopting subsidies, our analysis sheds light on the increasingly significant contributions of emerging economies (EMs) within the G20 group (G20 EMs). The domestic subsidy share of all GTA policies has risen to 67 percent for the average G20 EM in 2021, consistently surpassing the equivalent share for the average G20 advanced economy (G20 AE). Lastly, we observe that direct transfers, such as grants and state aid, constitute the primary type of instrument employed for subsidies – their importance has increased during the COVID years, 2020 and 2021.

These descriptive patterns set the stage for our econometric analysis, relating the variation in subsidies across products, industries and countries to trade flows. Our baseline estimates from the difference-in-difference specification for the full sample suggest that the exports of subsidized products are 2 percent higher after the subsidy than before, relative to other products. On the import side, the average effect is also positive and of approximately 4 percent. The interpretation of these findings is however affected by the evidence of strong pre-trends: governments direct subsidies to products that were already going through an increase in both exports and imports. Moreover, the results on the dynamic effects for the full sample indicate that imports and exports of subsidized products, while higher after the subsidy, stop growing relative to other products. The evidence on exports suggests that the policy, while presumably increasing total output, is unable to support further the growth in export sales observed before the subsidy is introduced. The results on the import side underscore the absence of any import-substitution effects – if anything, imports of products that are already facing an import surge are higher after the introduction of subsidies.[6] Taken together, the effects on the

[5] See also Hoekman and Nelson (2021); IMF, OECD, World Bank and WTO (2022); World Bank (2023).

[6] The estimates on the other GTA policies suggest that more 'trade-related' measures such as temporary import restrictions have their intended effect of reducing imports significantly in the targeted products. On the export side, export restrictions have a negative impact on export flows.

export and import sides suggest that on average, subsidies are not able to shift comparative advantage patterns.

This evidence for positive trade effects and significant pre-trends obtained on the full sample conceals important heterogeneity across countries. We find that trade spillovers from domestic subsidies are strongest for G20 EMs. The difference-in-difference estimates indicate that subsidies durably boost exports both on the intensive and extensive margins (without significant pre-trends) while imports react weakly, suggesting that for these countries' subsidies might have contributed to changes in comparative advantage. The estimates imply that subsidies increase the value of exports of targeted products from G20 EMs by 7.6 percent and the probability of exporting a product by 2.2 percentage points, relative to other products. The effect on the intensive margin of exporting is particularly sizeable – it is equivalent to more than twice the average yearly change in exports from G20 EMs at the product level (3.1 percent growth). Interestingly, when we decompose the trade effects of subsidies imposed by G20 EMs by destination of exports and source of imports, we find that the spillover effects are strongest for trade with non-G20 economies. Namely, exports from G20 EMs of products targeted by subsidies increase in non-G20 markets and imports from these economies of targeted products fall in G20 EMs. For G20 AEs, the results are in line with those from the full sample – exports and imports of subsidized products are higher than those of other products, and they are increasing before the subsidy is announced, suggesting strong selection effects.

The results from the gravity estimations indicate that the introduction of subsidies amplifies trade flows relative to domestic sales. According to our gravity estimates, when an exporter implements a subsidy, the disparity between international trade and domestic sales in the industry diminishes by 16 percent. These findings qualify the evidence from the difference-in-difference estimations, suggesting that the increase in international trade observed after the introduction of subsidies is more important than any changes in output sold to the domestic market. This provides a strong indication of trade spillovers and bolsters the presumption that subsidies in recent years have primarily been part of outward-oriented industrial policy strategies adopted in many countries (Juhász, Lane, and Rodrik, 2023).

As in the difference-in-difference analysis, the estimates of the gravity specifications vary importantly across country groups. In particular, we find that subsidies increase international trade especially between countries of different groups – between G20 AEs, G20 EMs and non-G20 countries, compared to domestic trade. This piece of evidence further highlights how domestic subsidies, by affecting trade between countries of different income groups, may trigger contentious policy reactions by other countries.

These effects of subsidies display also important heterogeneity across industries and type of policy instruments. The pro-trade effects of subsidies are particularly robust in the electrical machinery industry, as well as in the apparel and textile industries. When categorizing our domestic subsidies indicator based on the type of policy instrument, we observe that policies that entail a loss of government revenue, such as tax breaks, exert the most robust and positive influence on trade. Their impact surpasses that of other instruments, including state aid, grants, and loans, which have gained popularity in recent years and can be better targeted to achieve specific goals without impacting trade patterns. The greater trade impact of tax breaks relative to other instruments can however also conceal differences in size between policy instruments, which cannot be measured with the GTA data.

Through the estimation of the relationship between trade and subsidies, this paper uncovers the significant spillover effects that domestic subsidies can exert through trade flows. Because of their impact on trade, domestic subsidies can alter the international level playing field and exacerbate the urge by governments to engage in tit-for-tat strategies, whose ultimate welfare effect – something that is beyond the scope of this study – is difficult to predict.[7] Enhanced multilateral cooperation might be called for to prevent governments to engage in detrimental retaliatory actions – which can lead to subsidy wars – triggered by the trade effects of domestic subsidies (Bown, 2023b; Hoekman and Nelson, 2021).

Our paper contributes to a recent body of empirical work on the consequences of industrial policies, with a specific focus on subsidies, which primarily relies on country-specific case studies delving into the impact of government interventions on competition, productivity, prices, and labor markets (refer to reviews by Juhász, Lane, and Rodrik (2023), Cherif and Hasanov (2019), and Pack and Saggi (2006)).[8] Some of these studies speak to the trade spillovers of subsidies. Kalouptsidi (2018), adopting a model-based approach, demonstrates that the large subsidies introduced by China in the shipbuilding industry led to significant production reallocation across exporters in the industry, and boosted trade by lowering freight rates. Lane (2022) finds that industries targeted by Korea's industrial policies in the 1970s (the heavy and chemical industries) significantly increased exports and improved efficiency rela-

[7]While purely suggestive, the subsidies data from 2023 show that there is a 73.8 percent that a country introduces a subsidy within one year of another country having imposed already a subsidy in the same product (Evenett and others, 2024).

[8]Examples of recent papers in this area are Aghion and others (2015); Barwick, Kalouptsidi, and Zahur (2019); Choi and Levchenko (2021); Criscuolo and others (2019); Manelici and Pantea (2021).

tive to other industries.[9] Closer to the objective of our analysis, Navarra (2023) exploits data on the universe of federal subsidies in US and finds that politically motivated interventions boost exports both directly and through supply chain linkages. Positive effects of subsidies on the exporting activities of beneficiary firms are also found in Ireland (Görg, Henry, and Strobl, 2008) and China (Girma and others, 2009; Girma, Görg, and Stepanok, 2020).[10] We contribute to this area of work by adopting a broader perspective in our empirical analysis, which encompass multiple countries and industries, and estimate both exports and imports effects. We also investigate the effects of subsidies on international relative to domestic sales, a measure pertinent to the existence of trade spillovers. The importance of assessing and investigating these spillovers has been recently emphasized by Hoekman and Nelson (2021), IMF, OECD, World Bank and WTO (2022), and Bown (2023a,b).[11]

Our empirical analysis serves as a valuable complement to theoretical investigations exploring the characteristics of optimal subsidies in open economies from both unilateral and multilateral perspectives, when governments have access to other policy instruments such as import tariffs and domestic regulations (Bacchetta and Ruta, 2011; Bagwell and Staiger, 2001, 2006; Lee, 2016). In recent years, quantitative trade models, accounting for various market structures and incorporating external economies of scale, have emerged to examine the global welfare implications of domestic subsidies (Bartelme and others, 2019; Kucheryavyy, Lyn, and Rodríguez-Clare, 2023; Lashkaripour and Lugovskyy, 2023).[12] These models are con-

[9] A number of important contributions have stressed the protectionist and distortive effects of industrial policies (Baldwin and Krugman, 1988; Irwin and Pavcnik, 2004; Krueger and Tuncer, 1982). Other papers have exploited historical data to identify the effects of infant-industry protectionist policies (Harris, Keay, and Lewis, 2015; Juhász, 2018).

[10] Like in our setting, these few papers estimate the effects of corporate subsidies excluding export promotion activities, such as export subsidies. A vast literature has assessed the effectiveness of export promotion in different countries and for different export margins (e.g., Munch and Schaur (2018); and Volpe Martincus and Carballo (2008).

[11] Our gravity specification closely aligns with that employed in a recent report by World Bank (2023). Similar to our approach, they estimate the impact of subsidies on international relative to domestic trade, utilizing industry-level variation. Using data on subsidies from around 40 countries for 2018, they also find evidence that subsidies enhance international relative to domestic flows. Our more extensive dataset enables us to systematically account for the influence of time-invariant unobserved determinants of bilateral trade and country-industry shocks in our gravity estimations.

[12] These models consider the case of production or employment subsidies/taxes. In our data, only a minority of subsidies are classified as "production subsidies", whereas tax breaks may include reduction of taxes on production. In practice, many of the government interventions that are classified in the data as "subsidies", including state aid and grants, can be thought as supporting production, especially if linked (explicitly or implicitly) to the maintaining of production and employment in the country.

sistent with a gravity-like equation for bilateral trade flows at the industry level. Our finding of important trade effects resulting from domestic subsidies corroborates a common underlying result of these models – i.e., that domestic subsidies can affect trade flows by altering production incentives and world prices.[13]

The rest of the paper is organized as follows. Section II describes the data used in the analysis, with a focus on the subsidy data as these have been used less than the data on trade. Section III presents some stylized facts about the variation in the use of subsidies over time, and across sectors, countries and types of policy instrument. In section IV, we describe the empirical strategy and discuss the associated results. Section V concludes by outlining some important avenues for future research on the topic of trade and subsidies.

II. DATA

In the empirical analysis, we use data on subsidies and trade flows across products, industries and countries. While the sources and processing of trade data are relatively standard in the literature, obtaining comparable data on subsidies across countries and over time poses a considerable challenge.

We obtain information on the adoption of subsidies from the Global Trade Alert (GTA) database. Launched at the onset of the Global Financial Crisis at the end of 2008, the database collects information on credible policy changes that are likely to alter the relative treatment of foreign commercial interests. For each policy change, the database includes details such as the implementing country, the policy instrument (one among 60 different types, including subsidies), the targeted products (defined at the 6-digit HS level), announcement dates, implementation dates, withdrawal dates (if applicable), and its expected impact on foreign commercial interests (distortive, neutral or liberalizing). The data are collected by a team of trade policy experts and are based on official documents (e.g., a government decree and an official budget speech) whenever possible. Given its comprehensiveness and comparability across countries, the database has been used to measure the incidence of non-tariff measures and the level of protectionism (Datt, Hoekman, and Malouche, 2011; Disdier, Fontagné, and

[13]Using a general equilibrium model of trade, Attinasi, Boeckelmann, and Meunier (2023) estimate the impact of two industrial policies (tax credit for the purchase of electric vehicles and the bonus for investment in renewable energy equipment) that are included in the U.S. IRA program on trade flows. They find sizeable effects on the concerned sector – electrical and optical equipment.

Tresa, 2021; Kinzius, Sandkamp, and Yalcin, 2019). Juhász and others (2022) and Evenett and others (2024) also employ the GTA data as a source of information on industrial policies.

The policies cataloged in the GTA database are unilateral – i.e., they are not part of international agreements like those within the WTO and Preferential Trade Agreements (PTAs). For the majority of these policies, the database furnishes a list of affected HS-6 digit products. Because we link subsidies to trade flows through product information, policies lacking details on targeted products (most of them being in the services sector) are excluded from the sample. Additionally, we omit policy changes classified as horizontal by the GTA (constituting 6 percent of the total number of policy interventions) to concentrate on policies with some degree of product and industry targeting. To enhance cross-country comparability, we further restrict the sample to governmental national and supranational policies (EU-level policies being a prominent example), thus excluding policies implemented by financial institutions, which account for about 20 percent of the policy sample. Lastly, our focus is on policies evaluated by the GTA as "distortive" (rather than neutral or liberalizing), indicating an increase in discrimination against foreign firms.[14]

To construct an annual panel dataset, we use the announcement and removal dates of the policies. The year a policy is introduced is determined as the earlier of the announcement and inception years. If the resulting date is after July 1st, the introduction of the policy is set to the following year.[15] Likewise, the last year a policy remains in effect (in cases where it is removed during the sample period) corresponds to the year of removal if the removal occurs after June 31st; otherwise, it is designated as the year prior.

Our definition of subsidies relies on the list of policy instruments provided in the GTA, which draws from the UNCTAD MAST classification of non-tariff measures ((UNCTAD, 2019)) and has been widely accepted (IMF, OECD, World Bank and WTO, 2022). Specifically, all policies classified under chapters L (domestic policies) and P7 (export promotion) of the MAST classification are encompassed in our subsidy measures. According to the UNCTAD

[14] Because they are usually directed to national and domestically headquartered firms, 82 percent of the domestic subsidies in the GTA data are classified as distortive. In the empirical analysis, we verify our baseline findings when including also policies categorized by the GTA as non-distortive. Across all GTA policies, about 30 percent are categorized as liberalizing, 7 percent as neutral, and the remaining 63 percent as distortive.

[15] We consider the announcement date to incorporate anticipation effects as much as possible. Because entries in the GTA database are done retrospectively, there a few cases where the date of entry info force is prior to the date of announcement. In about 80 percent of the sample the announcement and the inception date coincide. Conditional on the inception date being later, the median difference between inception and announcement is 13 days.

MAST classification, domestic subsidies are government measures that involve a financial transfer creating an advantage for the beneficiaries.[16] Since we exclude consumption subsidies, our empirical definition of domestic subsidies includes corporate subsidies except export subsidies. In our analysis, we lump together export promotion policies including export subsidies, trade finance, and other export incentives. Further categorization within the domestic subsidy aggregate involves different subsidy policy instruments: production subsidies, subsidies transferring resources from governments to firms (excluding production subsidies), subsidies resulting in losses in government revenues, and policies in which governments assume risks related to actions by beneficiary firms.[17] In our empirical analysis, we account for the influence of other policy changes documented in the GTA database, which are aggregated into import restrictions (tariffs and quantitative restrictions), technical barriers to trade, temporary import restrictions (anti-dumping and countervailing duties, and safeguards), macro policies (FDI restrictions, capital and credit controls, devaluations, balance of payments measures), local content requirements, government procurement restrictions, export restrictions, and other policies (migration and intellectual property).

While harnessing the comprehensive nature of the GTA data in our analysis, three key points merit attention. First, the database records policy changes but lacks information on the stock of subsidies and other policies introduced before 2009, which marks the inception of our sample. Consequently, in our empirical analysis, we exploit variation in the presence of subsidies and other GTA policies announced from 2009 onward. The existence of legacy subsidies introduced before 2009 should attenuate any effect of these policies – e.g., in the case of products and industries that receive subsidies in the data at some point after 2009, but that in reality had been subsidized throughout our sample period.[18] Another possible caveat of the database is the reporting biases that can emerge as the inclusion and treatment of a pol-

[16]The "financial" nature of the transfers is interpreted in a broad sense. It includes also "in-kind" grants, such as preferential or free access to land, infrastructure and natural resources.

[17]These groups adhere to definitions outlined in the MAST classification and are specified in the Corporate Subsidy Inventory database, a subset of the GTA database. Production subsidies are identified by a GTA policy category. Subsidies transferring resources to firms fall under GTA categories such as "State aid, unspecified," "Financial assistance in foreign market," "Capital injection and equity stakes (including bailouts)," "Financial grant," "In-kind grant," and "State aid, nes." Subsidies causing a loss in government revenues include "Import incentive," "Tax or social insurance relief," and "Price stabilization." Policies resulting in a transfer of risk include "Interest payment subsidy," "State loan," and "Loan guarantee."

[18]If we could observe legacy subsidies, these products and industries would be subsidized throughout the period, and hence they would not contribute to identifying any effects on trade (in the empirical specification, they would be collinear with the unit fixed effects). Assuming that any trade effect is larger when going from zero to some subsidy than having an incremental increase in subsidies, in our data we are attributing a possibly weak

icy change rely on the coding and interpretation by the GTA experts of documents available online. The rich set of fixed effects in our cross-country empirical specifications absorb the influences of biases that are specific to countries, sectors and products (e.g., policy transparency varying across countries). Finally, the database does not provide information on the monetary value of subsidies, making it challenging to identify effects along the intensive margin of government intervention. In the empirics, we measure the presence of subsidies in a product or sector with a dummy variable. This approach is favored over a count variable measuring the number of subsidy policies, as this would worsen the measurement error along the intensive margin (e.g., in the case of one subsidy being larger than the sum of multiple other subsidies).

Our empirical analysis investigates the relationship between GTA variables on subsidies and trade variables. In the difference-in-difference specifications at the product level, we utilize annual export and import values from the CEPII BACI dataset until 2021 ((Gaulier and Zignago, 2010)).[19] For gravity estimations, bilateral trade values are sourced from the ITPD-E database ((Borchert and others, 2021)), which also includes data on internal trade – a critical component for implementing our empirical strategy. The annual data extend until 2019 and cover 170 industries. To align the ITPD-E industry classification with the HS 6-digit products available in the GTA database, both sources are aggregated at the ISIC Revision 3 2-digit sector level.[20] Due to the absence of information in the GTA database, our sample excludes services. Other variables employed in the analysis include bilateral determinants of trade costs (distance, colonial relationship, contiguity, and common official language), GDP, and population, all obtained from the CEPII Gravity database ((Conte and others, 2022)). To mitigate potential measurement errors in the trade and GTA policy variables, we exclude small countries from our sample, defined as those with an average population of less than 1 million over our sample period (2009 - 2021).

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change in trade (due to the real incremental change in subsidy) to a large (from nothing to some) change in subsidy, thus attenuating the estimated effect.

[19]The data are based on the HS 2007 classification system and are converted to the 2012 version using a correspondence table from the UN (https://unstats.un.org/unsd/classifications/Econ). Approximately 10 percent of the HS 2007 6-digit products span multiple HS 2012 6-digit products. In such cases, values are equally distributed across HS 2012 product lines before summing export and import values by HS 2012 product.

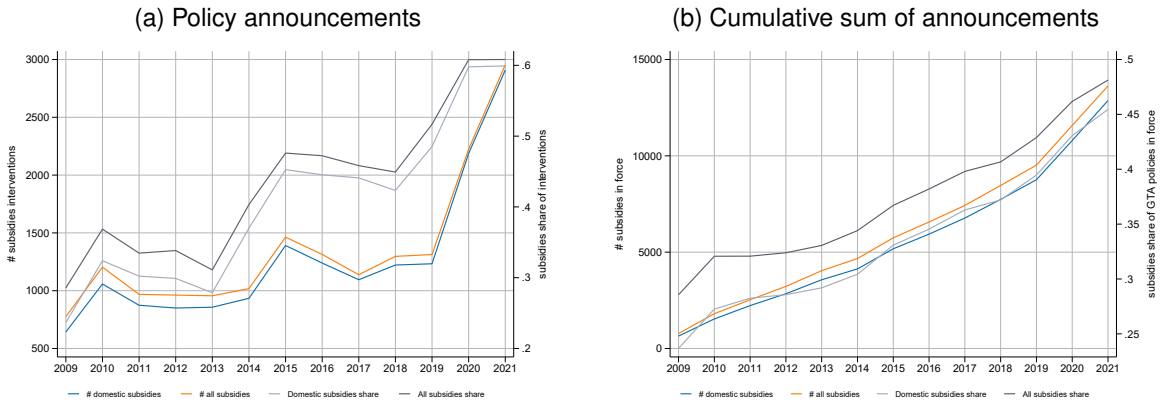
[20]Crosswalks from ITPD-E industries to ISIC Revision 3 industries are provided by the ITPD-E website. Correspondence tables from the UN are employed to aggregate HS 6-digit products to ISIC Revision 3 2-digit sectors.

III. STYLIZED FACTS ON THE USE OF SUBSIDIES

In this section, we delve into the subsidies data and establish four facts about the variation in the use of subsidies over time and across countries, sectors and type of instrument. Our measures for assessing the prevalence of subsidies encompasses both the number of subsidies announced (and the subsidy share of all GTA policy announcements) by year, and the cumulative sum of announcements, accounting for policies that may no longer be in force.

Fact 1: Domestic subsidies have been constantly on the rise since 2009. Figure 1 illustrates the trajectory of government announcements of subsidies and the subsidy share of all GTA policy announcements in panel (a), along with the number and share of subsidies introduced since 2009 and still in force in panel (b). Both charts underscore an upward trend in the global use of subsidies. The number of subsidy announcements went from 760 in 2009 to about 3000 in 2021. This escalation is specific to subsidies rather than encompassing all GTA policies – the subsidy share of all GTA policy announcements increased from 29 to 60 percent over the same period. The pronounced increases observed in 2020 and 2021, likely attributed to the policy response to the global COVID crisis, accelerated an already robust upward trend – the subsidy share of GTA announcements was already at 50 percent by 2019. The charts also reveal a marginal disparity between all subsidies and domestic subsidies, indicating a minor role played by export promotion policies (such as trade finance, export subsidies, and other export incentives). Panel (b) corroborates the ascending trend in the number of subsidy interventions, with the portion of GTA policies attributed to domestic subsidies nearly doubling from 2009 to 2021 (rising from 25 to 45 percent). By the end of the sample, the tally reaches around 14,000 subsidy interventions globally.

Figure 1. Number of subsidies and subsidy share of all GTA policies over time



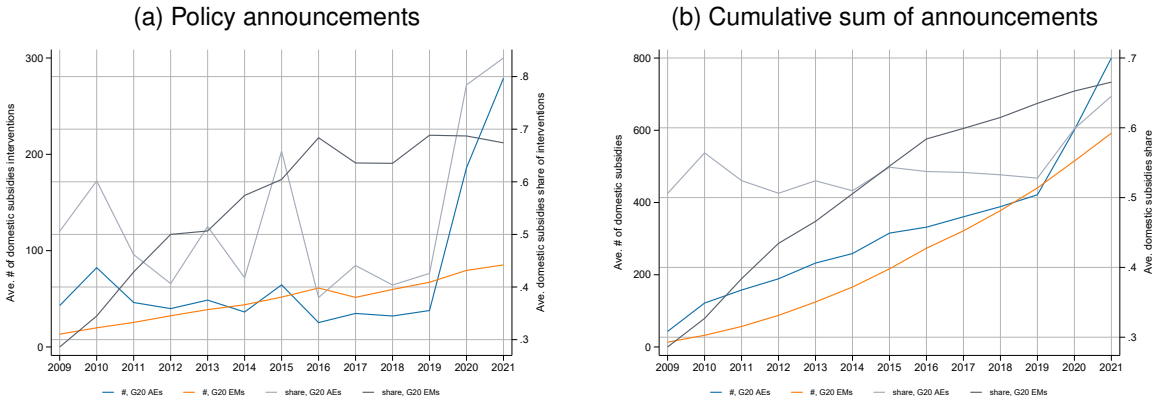
Note: In panel (a), we count the number of new policies by year of announcements. If the announcement happens on or after July 1st, the following year is the year of announcement. The subsidy share is relative to the total number of policy announcements from the GTA database (see the Data section for a description of the sample). In panel (b) we count the number of policies introduced since 2009 and in force at a given year. A policy is a country-policy combination (e.g., policies adopted at the supranational level (EU for instance) are counted as many times as the number of countries affected).

Fact 2: Subsidies are largely used by both advanced and emerging G20 economies. We investigate how the adoption of subsidies vary across countries grouped by income level. One striking feature of the data is that most of the subsidies (and other GTA policies) are adopted by G20 economies. In any given year between 2009 and 2021, the number of subsidy policies in force in non-G20 economies is at most 2 percent of the number observed in G20 economies. This aligns with the initial objective of the GTA data initiative, which was to track the use of protectionist policies by major (G20) economies in response to the Global Financial Crisis. To discern differences in subsidy usage, we differentiate between G20 emerging economies (G20 EMs: Argentina, Brazil, China, India, Indonesia, Mexico, Russia, Saudi Arabia, Türkiye, and South Africa) and G20 advanced economies (G20 AEs: Australia, Canada, Republic of Korea, the EU, Japan, and the United States). Figure 2 illustrates, for the average G20 EM and G20 AE, the number of domestic subsidy announcements per year and their cumulative sum over time, along with the domestic subsidy share of all GTA policies.

Both country groups have been rapidly increasing the number of subsidy interventions between 2009 and 2021. While the number of subsidy announcements surged in 2020 and 2021 in G20 AEs, likely due to government interventions mitigating the economic and social consequences of the COVID crisis, emerging economies did not follow the same pattern. Analyzing the policy mix, G20 EMs rely on subsidies relatively more than G20 AEs. The domestic subsidy share of all GTA policies escalated to 67 percent for the average G20 EM in 2021, consistently surpassing the corresponding share for the average G20 AE. This finding is novel

and nuances the result that the adoption of industrial policies (which include some subsidies and other type of policies) correlates with income (Evenett and others, 2024; Juhász and others, 2022). While this is also true across all countries for subsidies in our sample, when we zoom in on the G20 economies (by far the main players in the GTA database) we find that emerging economies rely on subsidies more than G20 AEs in the period up to 2021.

Figure 2. Number of domestic subsidies and subsidy share of all GTA policies by country group and over time



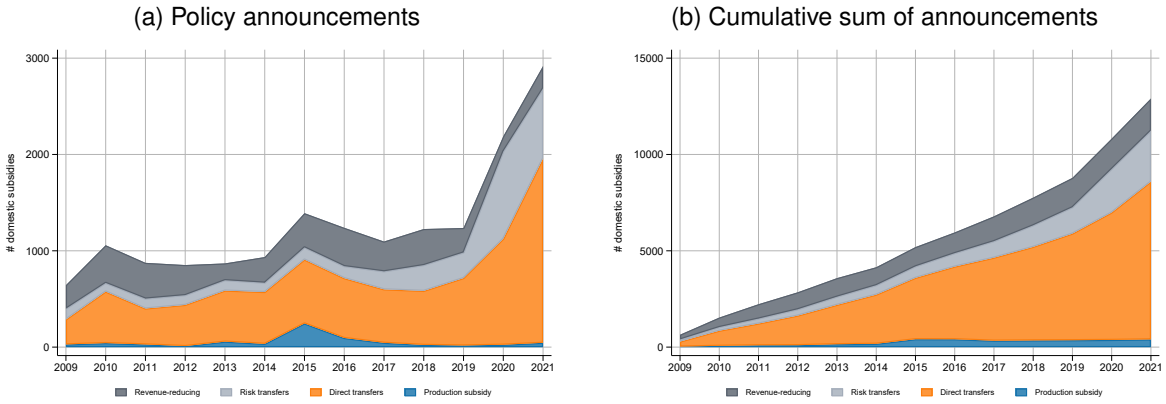
Note: In panel (a), we count the number of new policies by year of announcements. If the announcement happens on or after July 1st, the following year is the year of announcement. In panel (b) we count the number of policies introduced since 2009 and in force at a given year. The subsidy share is relative to the total number of policy announcements from the GTA database (see the Data section for a description of the sample). A policy is a country-policy combination, counted once regardless of the number of products affected. Averages are across countries within a group. The EU is treated as a single country and supranational (EU) policies for its 27 members plus the UK are counted once. "G20 AEs" include: Australia, Canada, Republic of Korea, the EU, Japan and the United States. "G20 EMs" includes: Argentina, Brazil, China, India, Indonesia, Mexico, Russia, Saudi Arabia, Türkiye and South Africa.

Fact 3: State aid and grants have become more common during the recent years. In Figure 3, we categorize the domestic subsidy aggregate into four groups based on the type of policy instrument: production subsidies, direct transfers (including state aid and grants), policies resulting in a loss of government revenues (tax breaks), and policies wherein the government assumes risk related to the beneficiaries' actions (loans). Both the number of policy announcements in panel (a) and their cumulative sum over time in panel (b) highlight the prominence of direct transfers, particularly in the last two years of the sample. This surge is likely due to government interventions aimed at supporting economies during the COVID crisis. In these two years, loans and other risk transfer policies also experienced increased popularity. Production subsidies, which theoretically represent the first-best policy if govern-

ment support is justified by positive externalities in production, assume a marginal role in comparison.

Figure A.1 in Appendix shows the trends for export promotion policies, the other (small) component of subsidies. It shows the two main types of export promotion policies: trade finance and export subsidies. Most of export promotion policies are trade finance interventions, but the number of announcements in these policy area is overall declining over time.

Figure 3. Number of subsidies by type of policy instrument over time



Note: In panel (a), we count the number of new policies by year of announcements. If the announcement happens on or after July 1st, the following year is the year of announcement. In panel (b) we count the number of policies introduced since 2009 and in force at a given year. A policy is a country-policy combination (e.g., policies adopted at the supranational level (EU for instance) are counted as many times as the number of countries affected), counted once regardless of the number of products affected. Direct transfers are subsidies that transfer resources to firms. They are classified in the GTA categories "State aid, unspecified", "Financial assistance in foreign market", "Capital injection and equity stakes (including bailouts)", "Financial grant", "In-kind grant" and "State aid, nes". "Revenue-reducing" policies involve a loss in government revenues ("Import incentive", "Tax or social insurance relief" and "Price stabilisation"). "Risk transfer" policies bring about a transfer of risk from the beneficiary to the government ("Interest payment subsidy", "State loan" and "Loan guarantee").

Fact 4: Subsidies increasingly target manufacturing industries. To explore the sectoral composition of subsidy measures, we leverage product information associated with each policy intervention and categorize products into manufacturing and primary sectors.[21] Figure 4 portrays the progression of the number of subsidies (total and domestic) affecting manufacturing as well as the manufacturing share of all subsidy interventions. In panel (a) we report the policy announcements, and in panel (b) their sum over time. The manufacturing share of domestic subsidy policies in force has surged from 25 to 45 percent throughout the

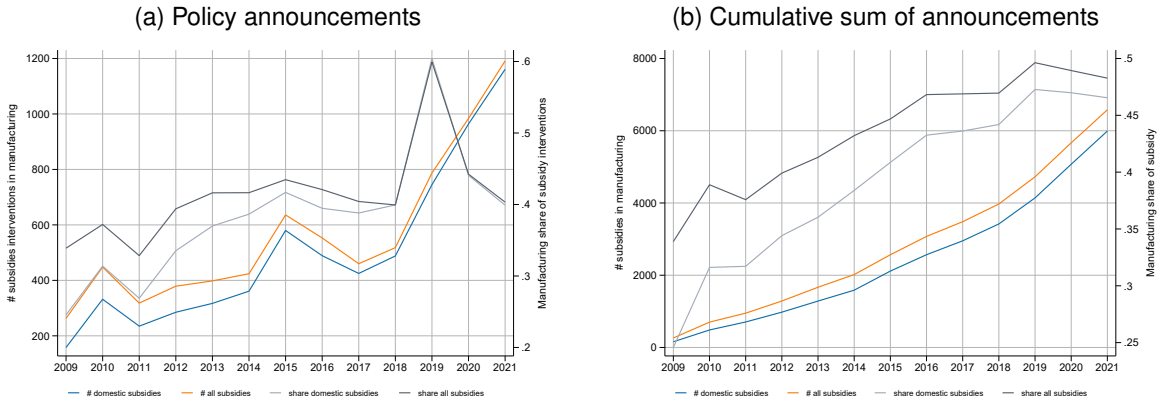
[21]Missing product information relate to services industries (which are not included in the HS classification) or interventions in the manufacturing or agriculture sectors for which the list of targeted products could not be collected.

sample period. By 2021, approximately 600 subsidy policies affect manufacturing products, constituting roughly half of all subsidies (refer to panel (b) in Figure 1).

The rise of manufacturing in subsidies has occurred while governments have comparatively reduced introduction of subsidies in agriculture. As depicted in Figure A.2, governments introduced 278 subsidy policies in the primary sector in 2009, surpassing the 158 measures announced in manufacturing. However, by 2021, a cumulative total of 2391 subsidy policies had been implemented since 2009 in the primary sector – constituting 40 percent of the subsidy policies in force in the manufacturing sector. These trends unequivocally indicate a shift in government interventions from agriculture to manufacturing when it comes to subsidies.

Table A.1 in the appendix reports the number of subsidy announcements since 2009 and in force by ISIC 2-digit industry.[22] The industries with the highest number of domestic subsidy policies by the end of our sample are agriculture, food, chemical, machinery and motor vehicles. Looking at changes between 2009 and 2021, relative to the level in 2009 – which attenuates the influence of size differences across industries – and ignoring the case of tobacco products – which remains with low numbers, we observe the largest increases in domestic subsidies in the apparel and medical and optical equipment.

Figure 4. Number of subsidies in manufacturing and manufacturing share of subsidies over time



Note: In panel (a), we count the number of new policies by year of announcements. If the announcement happens on or after July 1st, the following year is the year of announcement. In panel (b) we count the number of policies introduced since 2009 and in force at a given year. A policy is a country-policy combination (e.g., policies adopted at the supranational level (EU for instance) are counted as many times as the number of countries affected), counted once regardless of the number of products affected. The manufacturing sector is identified by the ISIC 2-digit code to which the targeted products belong.

[22] A government policy is counted as a distinct entry in each industry that it targets.

IV. Empirical analysis and results

In the empirical analysis, we exploit the rich variation in subsidies across countries, products and over time to scrutinize their effects on trade flows. We adopt two distinct and complementary approaches that shed light on different trade responses. These methods are tailored to identify possible spillovers of domestic subsidies on trade.

A. Effects of subsidies on exports and imports at the product level

Our first approach utilizes the product information available from the GTA data to estimate the effect of introducing subsidies on exports and imports. The empirical specification follows a standard difference-in-difference model, where the treatment corresponds to being targeted by a subsidy in a year:

$$\ln\left(X_{ik,t}\right) = \beta_1 S_{ik,t} + \beta_2 IP_{ik,t} + \alpha_{ik} + \alpha_{ik} \times t + \delta_{ic,t} + \mu_{k,t} + \varepsilon_{ik,t} \tag{1}$$

The variable X in eq (1) is the value of exports from or imports by country i in HS 6-digit product k at time t. The S variable is a dummy for the presence of at least one subsidy policy in country i, product k at year t. The associated coefficient β_1 measures the effect of subsidies on exports or imports. To identify such an effect, the rest of the specification controls for different confounding factors. The matrix IP collects the indicator variables for the presence of other GTA policies, aggregated into categories as explained in the Data section. Being targeted by government policies is a rather rare event in our sample. Around 30 percent of the country-product combinations receive at least one of the GTA policies during our sample period – 9 percent receive domestic subsidies.[23] Conditional on receiving a subsidy in a year, the median country-product receives only one subsidy and the average one receives three subsidy interventions. Given the small variation in the number of policies within a product, we focus on a dummy variable to measure the incidence of subsidies and other GTA policies.[24]

The remaining terms in eq (1) encompass an extensive array of fixed effects designed to account for various unobserved factors influencing trade flows and subsidy adoption. The α

[23] Because we are aggregating across possibly multiple interventions of the same type that affect the same product, the starting year of the treatment is the earliest possible, and the last year of treatment (if applicable) is the latest.

[24] Table A.2 in the appendix reports summary statistics for the main variables used in the difference-in-difference specification.

term denotes country-product fixed effects, absorbing time-invariant determinants of product-level exports and imports. By incorporating these fixed effects, the empirical specification resembles a difference-in-difference setting, comparing the variation in trade flows after and before the introduction of a subsidy with differences across the same periods for country-products unaffected by subsidies. To control also for other time-varying determinants of exports and imports, we add country-product specific linear time trends (the $\alpha \times t$ term). These absorb the influence of the trend component of country-product factors (e.g., productivity shocks, business cycles specific to firms in a given product and the resulting political economy relations with governments) that can shape trade flows and the likelihood to be targeted by subsidies.

The δ term collects country-sector-year fixed effects, where a sector is defined as an ISIC 2-digit industry.[25] These fixed effects control for all shocks specific to a sector (e.g., the sectoral component of variation in unilateral trade policy not captured by the *IP* variables) thus forcing the difference-in-difference comparison to be done across HS 6-digit products within the same ISIC 2-digit industry. Importantly, this set of fixed effects controls for reporting biases that can affect the measurement of subsidies, as long as those biases are specific to a country-sector and vary arbitrarily over time.

The μ term represents product-year fixed effects, controlling for global shocks specific to an HS 6-digit product. Finally, ε is the error term. To address autocorrelation in the error term within countries and within products, we implement clustering of standard errors by country and product.

In spite of using a restrictive set of fixed effects and time trends, the estimates from the difference-in-difference specification may still suffer from endogeneity bias. Country and product specific shocks that correlate with subsidies and trade performance can bias our estimates. Productivity shocks and lobbying by firms for subsidies are factors that can sway our estimates – e.g., if governments subsidize firms (and products) with high productivity growth, our estimates of the export effects are upward biased, whereas the estimates on the import side are downward biased.[26] This would be the case if these factors display meaning-

[25] We use ISIC 2-digit sectors to maximize the comparison with the gravity estimation results, which are obtained using data aggregated at that industry level.

[26] Since total imports and exports by country and product can be modeled from a bilateral gravity equation (and if subsidies are modelled as creating wedges between consumer and producer prices), multilateral resistance terms (outward for exports and inward for imports) are other omitted variables from our specification ((1)) (Lampe and others, 2023). Controlling for country-sector-year fixed effects in our specification can attenuate this source of bias (and eliminate it if the multilateral resistance terms do not vary significantly within sectors).

ful variation around a linear trend and within countries and sectors (defined at the ISIC 2-digit level).

The results of the difference-in-difference specification are summarized in Table 1. We report the estimates of specifications with less stringent combinations of fixed effects and of our baseline. The results suggest that introducing any type of subsidies (domestic ones and export promotion policies) is associated with greater exports and imports. The estimates from the specifications featuring the complete set of fixed effects (column (3)) and those incorporating country-product linear time trends (columns (4)) indicate that changes in exports between after and before introducing domestic subsidies are 2 percent higher in targeted than other products. On the import side, the effect amounts to 4 percent. The effects are sizeable as they roughly equal the average yearly percent changes in exports and imports.

Domestic subsidies drive the effect of all subsidies, while export promotion policies exhibit no discernible impact. Additionally, subsidies emerge as the only policies that increase both imports and exports at the product level, as shown in Table A.3 in the appendix, which reports also the coefficients associated with the indicators for other GTA policies. Most of these coefficients have the expected signs – export restrictions inhibit significantly exports, whereas technical barriers to trade, government procurement policies, temporary import restrictions and macro policies have significant and negative effects on imports.

The observed positive correlation between exports, imports and subsidies serves as an initial indication of the potential spillover effects of these policies into international markets. It is also consistent with the arguments of Juhász, Lane, and Rodrik (2023), suggesting that contemporary industrial policies, of which subsidies constitute a crucial element, are characterized by a more outward-oriented focus compared to the import-substitution policies prevalent in past decades.

Table 1. Effects of subsidies on product-level trade

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dep. variable	ln(exports)				ln(imports)			
Subsidies (all)	0.073**	0.029***	0.018***		0.019	0.055***	0.038***	
	(0.030)	(0.009)	(0.006)		(0.021)	(0.008)	(0.007)	
Domestic subsidies				0.018***				0.041***
				(0.006)				(0.007)
Export promotion				0.009				-0.004
				(0.025)				(0.016)
Country-product FE	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	N	N	N	Y	N	N	N
Product-year FE	N	Y	Y	Y	N	Y	Y	Y
Country-sector-year FE	N	Y	Y	Y	N	Y	Y	Y
Country-product time trend	N	N	Y	Y	N	N	Y	Y
Obs	6263882	6255687	6255687	6255687	8683026	8681638	8681638	8681638
R^2	0.86	0.88	0.91	0.91	0.88	0.90	0.92	0.92

Note: Subsidies and other GTA policies are dummies equal to one if there is at least one active intervention targeting a product in a country and year. Other GTA policies are : government procurement, other (than export promotion policies) export restrictions, import restrictions, temporary import barriers, TBTs, macroeconomic policies (FDI and capital restrictions, currency and balance-of-payments measures), local content requirements, and other policies (intellectual property and migration). Sectors are defined as ISIC 2-digit level. Standard errors are clustered by country and product. $*$ significant at 10%; $**$ significant at 5%; $***$ significant at 1%.

To investigate further the average effects from Table 1, we estimate an event-study specification. This approach involves interacting the subsidy dummies with dummies representing periods before and after the subsidy announcement:

$$\ln\left(X_{ik,t}\right) = \sum_{p=-12}^{-2} \beta_1^p S_{ik,t}^p + \sum_{p=0}^{12} \beta_1^p S_{ik,t}^p + \beta_2 IP_{ik,t} + \alpha_{ik} + \alpha_{ik} \times t + \delta_{ic,t} + \mu_{k,t} + \varepsilon_{ik,t} \qquad (2)$$

In eq (2), the superscript p denotes the period before and after the announcement of the subsidy, ranging from -12 (12 years before treatment – i.e., the year 2009 for products that are treated in 2021) to 12 (12 year after treatment – i.e., 2021 for products that entered into treatment in 2009). The count of the period resets for products that cease to receive subsidies and subsequently resume treatment later in the sample. Following standard practice, we exclude the period preceding the treatment from the set of dummies for pre-treatment periods.

The coefficients and associated confidence intervals of the period-specific dummies are presented in Figure 5. Two important patterns stand out. First, the positive effects on exports and imports are rather stable up until 8 years after the introduction of the subsidy.[27] The second

[27]The average effects from these dynamic specifications computed as weighted averages of the 'post' coefficients – with weights equal to the per-period shares of treated observations – are equal to 2.3 percent for exports (standard error=0.7 percent) and 3 percent for imports (standard error=0.7 percent).

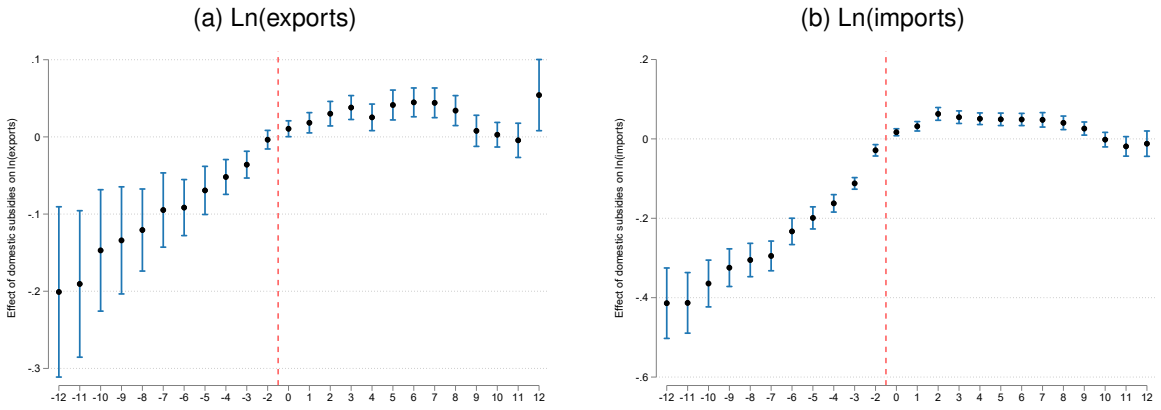
significant finding is the compelling evidence for pre-trends. Exports and imports in products slated to receive subsidies exhibit increases relative to other products years before the subsidy announcement. This challenges the assumption of parallel trends, which requires targeted and non-targeted products to follow similar trends in the absence of subsidies.

The presence of pre-trends complicates the causal interpretation of the estimates and underscores the critical role of product selection into treatment. Political economy mechanisms could explain this result. On the export side, firms in expanding products experiencing a surge in exports may be better able to influence policymakers responsible for allocating subsidies (a scenario of "winners picking government policy").[28] Concurrently, the pronounced pre-trends in imports suggest that import competing firms are also adept at influencing governments to secure subsidies (resembling a scenario of "losers picking government policy" (Baldwin and Robert-Nicoud, 2007)). Given our set of fixed effects, these political economy dynamics operate across products within the same sector, and their temporal variation deviates from linear trends (manifesting as time-specific shocks).[29] Taken together, the 'pre' and 'post' subsidy coefficients on the full sample suggest that the policy is unable to sustain export growth and fails to curb imports in targeted products.

[28]This influence can be exerted through lobbying or indirectly through the role of large firms in local economy (e.g., as a source of employment). While not strictly related to subsidies, existing papers find that larger firms and industries with higher productivity dispersion participate more in lobbying for trade policies (Blanga-Gubbay, Conconi, and Parenti, 2020; Bombardini, 2008). Navarra (2023) finds that politically-motivated subsidies in the US (because given to industries with high employment in U.S. states that are electorally important) increase exports.

[29]Selection based on productivity is unlikely to explain the patterns we find on the export and import sides. If governments target high-productivity firms, we should observe declining imports in the run-up to the subsidy (and declining exports if they target low-productivity firms).

Figure 5. Effects of domestic subsidies on trade flows – event-study specification



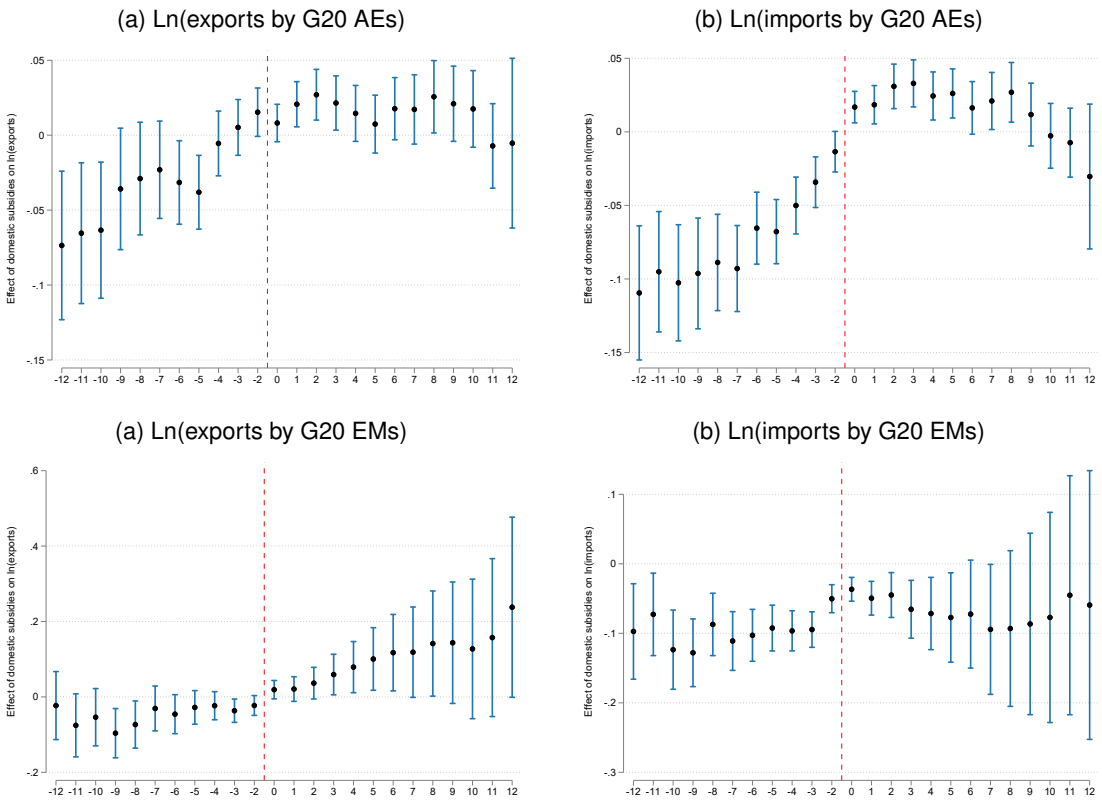
Note: The horizontal axis denotes time before and after a country-product is targeted by a domestic subsidy. The time variable is reset if a product exits and then re-enters treatment. Estimates and 90 percent confidence intervals on the subsidy dummy interacted with periods before and after the treatment. The specification includes dummies for other GTA policies, country-product fixed effects, country-product linear time trends, product-year and country-ISIC 2-digit-year fixed effects.

The difference-in-difference coefficients obtained in the full sample might obscure significant heterogeneity across countries. Given their prominence in subsidy utilization, as illustrated in Figure 2, our focus shifts to G20 members, distinguishing between G20 EMs and G20 AEs.[30] Figure 6 charts the coefficients of our event-study specification (eq (2)) estimated separately by country group. The estimates for G20 AEs closely resemble those of the full sample ones, and they are similarly affected by significant pre-trends. In G20 EMs, subsidies have instead a positive and substantial effect on exports, which increases over time, with little evidence of significant pre-trends. The estimates suggest that exports in targeted products from G20 EMs are on average 7.6 percent higher than exports in other products after receiving the subsidy. The magnitude of this effect is large – it is more than twice the average yearly change in exports from G20 EMs at the product level (3.1 percent growth). Alternatively, the estimates suggest that, if we assign the average product-level G20 EM export 2021-2009 growth of 37.2 percent to the non-subsidized products, receiving subsidies boosted exports by a significant 3 percentage points. The lack of evidence for pre-trends further indicates that for G20 EMs, selection of products into subsidies does not depend on past export performance. The effect on imports is on average negative but poorly estimated and contaminated by significant pre-trends – imports in subsidized products relative to those in other products peak the year before the subsidy and then go down to their previous level.

[30]Unlike in the descriptive analysis, in the regressions we consider separately only the EU members (until 2020) that are also G20: France, Germany, Italy and the United Kingdom.

Figure A.3 in the appendix presents the estimates of the event-study specification by country group, with a further breakdown of trade flows by destination countries: G20 AEs, G20 EMs, and other, non-G20 countries. The effects on exports and imports of G20 EMs are again the strongest. For these countries, the positive effect on exports is propelled by exports to non-G20 countries. Similarly, subsidies by G20 EMs curb imports from non-G20 economies. The effects on trade with other G20 economies, both on the export and the import side is muted, which suggests that spillovers from subsidies through trade are actually concentrated on non-G20 economies. The estimates for G20 AEs suggest that subsidies introduced by these countries increase exports relative to non-targeted products only to other G20 AEs. Conversely, the positive but declining effect on imports is concentrated on imports originating from G20 EMs – with again evidence for significant pre-trends.

Figure 6. Effects of domestic subsidies on trade flows by country group



Note: The horizontal axis denotes time before and after a country-product is targeted by a domestic subsidy. The time variable is reset if a product exits and then re-enters treatment. Estimates and 90 percent confidence intervals on the subsidy dummy interacted with periods before and after the treatment, by country group. The specification includes dummies for other GTA policies, country-product fixed effects, country-product linear time trends, product-year and country-ISIC 2-digit-year fixed effects. “G20 AEs” include: Australia, Canada, Republic of Korea, France, Germany, Italy, the United Kingdom, Japan and the United States. “G20 EMs” includes: Argentina, Brazil, China, India, Indonesia, Mexico, Russia, Saudi Arabia, Türkiye and South Africa.

Our estimates based on standard difference-in-difference models can be biased in the presence of heterogeneous effects across units and over time (De Chaisemartin and d'Haultfoeuille, 2023; Roth and others, 2023). To correct for this possible bias, we implement the imputation approach proposed by Borusyak, Jaravel, and Spiess (2024), which can be applied to our complex empirical setting featuring a staggered and non-absorbing treatment that can repeat itself multiple times – subsidies are introduced at different points in time, can be stopped before the end of the sample period, and products that are no longer targeted can receive subsidies again.[31] The method consists in regressing the outcome variables on the fixed effects and control variables in the sample of non-treated observations (no subsidy), and then take the difference between the observed and the predicted values of the outcome variable in the treated sample – these are observation-specific treatment effects.[32] Table A.4 in the appendix reports the average of these treatment effects for the exports and imports specifications in the full sample and in the subsamples of G20AEs and G20EMs. The results broadly confirms the main findings. In the full sample and in the G20 AE subsample, the effect of subsidies on exports becomes small and not significant, while the one on imports is similar to the baseline, but its interpretation remains affected by the evidence for pre-trends (we reject the null hypothesis that the pre-subsidy coefficients are equal to zero). For G20 EMs, we find that the export effect is higher than in the full and G20AE samples and not contaminated by pre-trends, although smaller than in the baseline.

Additional heterogeneity and robustness checks

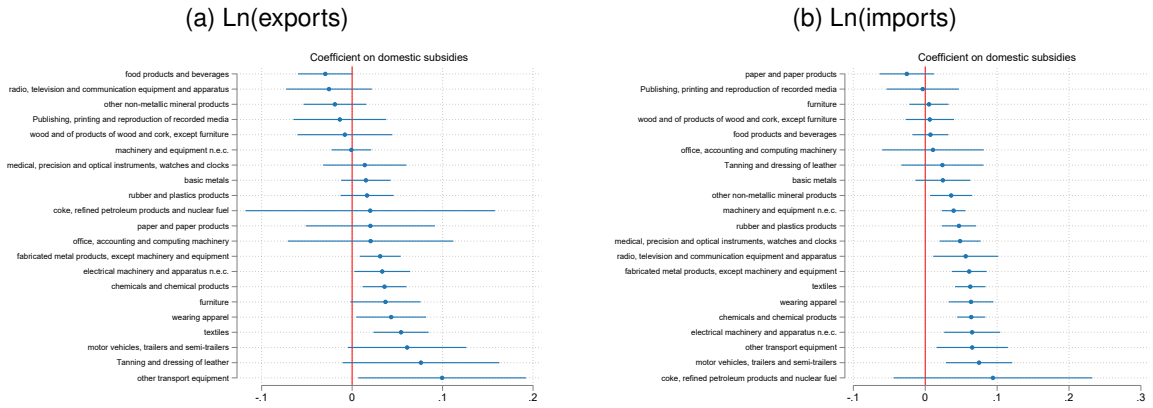
The estimates obtained in the full sample may also hide significant variation across sectors and industries. Given the strong differences in the trends of subsidies between the primary and the manufacturing sectors, Table A.5 reports the estimates of the difference-in-difference specification estimated separately on each sector. The baseline estimates are essentially identical to those obtained in the manufacturing sector, which has received most of the subsidies in the recent years (see Figures 4 and A.2), while the effects on exports and imports in the primary sector are not significant. Figure 7 focuses on manufacturing and displays the coefficients on the subsidy dummy by industry. In our dataset, each industry corresponds to an

[31] See Lee and Wooldridge (2023); Wooldridge (2021) and Liu, Wang, and Xu (2024) for extensions of the approach. Most of the other estimators proposed to avoid the bias of the standard "two-way fixed effects" difference-in-difference estimator apply to staggered entry, and absorbing or non-absorbing treatments (De Chaisemartin and d'Haultfoeuille, 2023).

[32] Before performing the estimation, we exclude from the untreated and treated samples observations in country-product, country-sector-year and product-year combinations that are always treated (their influence is captured by the fixed-effects) – see Borusyak, Jaravel, and Spiess (2024) for a related discussion.

ISIC 2-digit code. None of the coefficients on exports are negative and significant, corroborating the positive association between product-level exports and subsidies. The most robust positive relationships are observed in the textile, furniture, chemicals, and apparel industries. Similar patterns emerge on the import side, with positive and significant effects also found in equipment and machinery industries.

Figure 7. Effects of domestic subsidies on trade flows by industry



Note: Coefficient and associated 90 percent confidence interval on the domestic subsidy dummy in the difference-in-difference regression (1), by industry, defined as a ISIC 2-digit level. We report only manufacturing industries, excluding the tobacco one (effects are highly imprecise). Log of product-level exports and imports are the dependent variable. The regressions control for other GTA policies : export promotion, government procurement, other (than export promotion policies) export restrictions, import restrictions, temporary import barriers, TBTs, macroeconomic policies (FDI and capital restrictions, currency and balance-of-payments measure), local content requirements, and other policies (e.g., intellectual property, migration). All regressions include country-product, product-year, country-year (since the regressions are by sector) fixed effects and country-product linear trends. Standard errors are clustered by country and product.

We investigate further possible heterogeneity in the effects of subsidies along the product and sector dimensions by considering comparative advantage patterns. The pre-trends observed in Figure 5 indicate that subsidies – by expanding exports and imports in products where these were already on the rise – reinforce comparative advantage patterns. To shed light on this possibility, we construct a revealed comparative advantage (RCA) index based on the theory-based gravity estimation proposed by Leromain and Orefice (2014), and consider a comparative advantage dummy for country-products with values of the index greater than one.[33] Columns (1), (2), (6) and (7) of Table A.6 in the appendix reports the domestic subsi-

[33]The estimation method relies on a gravity equation derived from the industry-level Eaton-Kortum model of Costinot, Donaldson, and Komunjer (2012). The productivity of each country-product combination is estimated by the origin-product fixed effect from a gravity model on bilateral trade flows between 2002 and 2009, adjusted by the trade elasticity (set to 6.53 from Costinot, Donaldson, and Komunjer (2012)). In the estimation, we

dies coefficient from the difference-in-difference specification estimated on the comparative advantage subsample (RCA>1) and on the comparative dis-advantage subsample (RCA<1). The results show that the positive baseline export effect is driven by products in which countries have a comparative advantage, whereas the effect is insignificant for the other products (see columns (1) and (2)). On the import side, the positive effect of subsidies is confirmed in the two subsample. These results bolster the suggestion from the pre-trends that in the full sample subsidies do not alter comparative advantage patterns.[34]

The preceding estimates have lumped together various types of domestic subsidy interventions. In columns (5) and (10) of Table A.6, we provide difference-in-difference results after categorizing the domestic subsidy category into four distinct groups of policy instruments, aligning with the breakdown presented in Figure 3: production subsidies, direct transfers to firms (excluding production subsidies), policies transferring risk to the government, and policies leading to losses in government revenues. The findings indicate a substantial positive impact on both exports and imports for tax breaks and other subsidy policies entailing a loss in government revenues. This effect outweighs the negative coefficient on direct transfers.[35] This evidence has to be interpreted with caution though, as it may reflect differences in the intensity of the interventions across instruments rather than specific characteristics of the policy instruments – e.g., the monetary value of tax breaks being normally more important than that of direct transfers.[36]

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aggregate products to the HS 4-digit level. The index equals these estimated productivities adjusted by their sector-specific and country-specific averages (see eq 4 in Leromain and Orefice (2014)).

[34]Table A.6 in the appendix reports also the results of the main difference-in-difference specifications after dropping the U.S. and China from the sample. The two countries play a substantial role as heavy users of subsidies in the sample – as of 2021, the U.S. has 2928 subsidy announcements in force since 2009, representing 23 percent of subsidies announced globally, while China alone accounts for 39 percent of all subsidies in force in 2021. Our results are confirmed even when omitting these influential countries from the sample, as indicated by the virtually unchanged point estimates in columns (3), (4), (8), and (9).

[35]In the estimation sample at the product level, revenue-reducing policies are the commonest domestic subsidy policy. Since direct transfers are more important in terms of interventions (see Figure 3), this pattern reveals that tax breaks and similar policies are less targeted (i.e., they cover more products) than state aid, grants (direct transfers) and loans (risk transfers).

[36]The results suggesting that tax breaks have pro-trade effects and grants and state aid have, if anything, negative effects on imports and exports are consistent with the literature on R&D subsidies finding that tax breaks are more effective for mature and large firms – which are more likely to participate in global markets than other firms, while grants work better when targeted to small firms – which tend to serve the domestic market (IMF, 2024).

Table A.7 confirms our baseline findings in two other robustness checks. In the first one, we expand the set of policies to include also those that the GTA experts codify as "neutral" or "liberalizing". The point estimates in columns (1) to (4) are virtually unchanged from the baseline, implying that our results remain robust irrespective of the classification of policy changes in the GTA database.[37] The second robustness check in Table A.7 extends the set of implementing jurisdictions by adding national financial institutions (NFIs) such state-owned banks, alongside national governments and supranational entities. The coefficients on the all subsidies and domestic subsidies variables are again very similar to baseline, given also the small number of policies affected by policies from NFIs.[38]

Responses along the extensive margins of exporting and importing

Our estimates capture export and import responses along the intensive margin, meaning they are conditional on observing strictly positive export and import values. The literature has shown that adjustments along the extensive margin (i.e., the likelihood to trade in new products and markets) is also important especially for developing countries (Arkolakis, Ganapati, and Muendler, 2021; Besedeš and Prusa, 2011). Domestic subsidies can trigger these adjustments, as they help overcome the fixed costs associated with entering new markets.[39] Our analysis is however limited in this regard to the entering into new exported or imported products, since we do not segment exports and imports by destination.[40]

Estimates from the full sample, as presented in Table A.8 in the appendix, reveal insignificant or very small coefficients on the subsidies variables when we substitute the values (in logs) of imports and exports with dummies for strictly positive values as dependent variables. These negligible effects on the extensive margin are confirmed in the sample of G20 AEs, as

[37] The similar point estimates obtained when including also "liberalizing" subsidies are also explained by the very few cases of such policies – only 3.5 percent of all country-policy-product combinations.

[38] Only 2.5 percent of the product-level sample is affected from distortive policies by NFIs, against the 15 percent of the intervention-level sample – the difference suggesting that policies by NFIS are more targeted (i.e., they affect a narrower set of products) than other policies.

[39]The literature on export promotion programs shows that these programs have positive effects on the probability of entering into new products and new markets (e.g., Volpe Martincus and Carballo (2008) and Volpe Martincus and Carballo (2010)). Our zero effect of "export promotion" policies on exports (both on the intensive margin and on the probability of exporting a product) has no bearing on that literature, because we use the term "export promotion" to group export subsidies and trade finance policies that are different from what the literature refers to as export promotion programs.

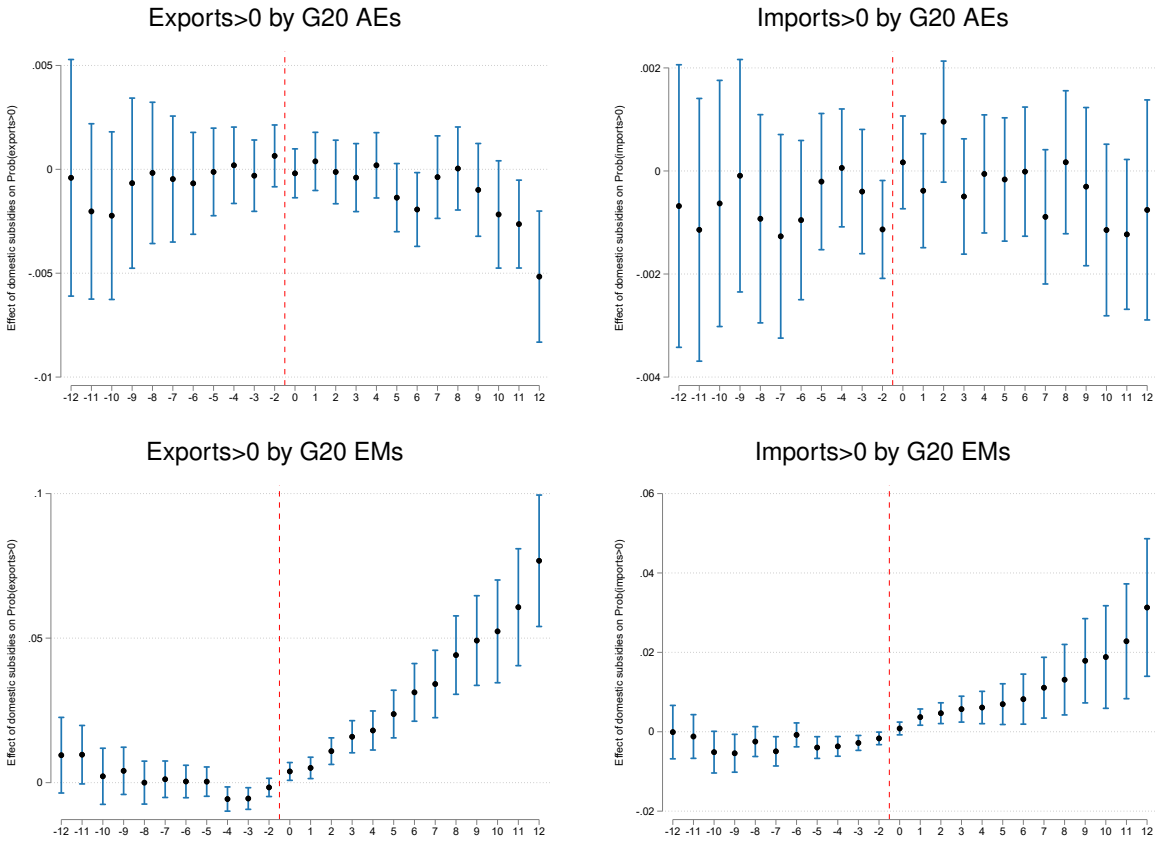
[40]This type of analysis cannot be applied to the gravity model that we employ in the second part of our empirical analysis, since the bilateral and domestic trade data are available at the industry level rather than the more detailed product level that is normally used to investigate responses along the extensive margin.

shown in Figure 8. In contrast, for G20 EMs, we find strong effects on the extensive margin. According to the estimates, products are, on average, 2.2 percentage points more likely to be exported from G20 EMs after receiving subsidies than before, relative to other products. Similarly, the average effect on the probability of importing is 1.5 percentage points. Although the point estimates are precisely measured and display an increasing trend over time (with minimal evidence of pre-trends), they only represent 2.3 percent of the average probability of exporting and 1 percent of the probability of importing.

Figure A.4 in the appendix provides additional insights into the estimate of the event-study specification for G20 EMs by destination group.[41] The effects on the export probability are important for exports to other G20 EMs – amounting to an average increase of 2.8 percentage points or 4 percent of the average probability of a G20 EM exporting to other G20 EMs – and to non-G20s – 2.2 percentage points of 7 percent of the average probability of a G20 EM exporting to non-G20 countries. Meanwhile, the effect on imports is most pronounced (albeit small) for countries outside the G20. When considered alongside the evidence on the intensive margin in Figure A.3, these findings suggest that subsidies exert a strongly positive influence on exports from G20 EMs, especially to non-G20 destinations, along both the intensive and extensive margins of exporting.

[41] Estimates for G20 AEs, although not presented, confirm the null effect on total exports and imports in Figure 8.

Figure 8. Effects of domestic subsidies on export and import probabilities by country group



Note: Dummies for strictly positive exports and imports flows are the dependent variables. Linear probability estimations. The horizontal axis denotes time before and after a country-product is targeted by a domestic subsidy. The time variable is reset if a product exits and then re-enters treatment. Estimates and 90 percent confidence intervals on the domestic subsidy dummy interacted with periods before and after the treatment, by country group. The specification includes dummies for other GTA policies, country-product fixed effects, country-product linear time trends, product-year and country-ISIC 2-digit-year fixed effects. "G20 AEs" include: Australia, Canada, Republic of Korea, France, Germany, Italy, the United Kingdom, Japan and the United States. "G20 EMs" include: Argentina, Brazil, China, India, Indonesia, Mexico, Russia, Saudi Arabia, Türkiye and South Africa.

B. Effects of subsidies on international relative to domestic trade

The estimates from the product-level difference-in-difference specifications indicate that exports and imports increase after receiving domestic subsidies relative to trade in products that are not targeted. The results in the full sample however also reveal the existence of robust pre-trends: products whose exports and imports are on an upward trajectory are more likely to receive subsidies – a pattern that is not observed for G20 EMs. These pre-trends emerge even while controlling for country-product specific time trends, suggesting the presence of time-varying dynamics influencing both trade and the targeting of subsidies.

To alleviate this source of bias and gain insights into the trade spillovers of subsidies, we employ an alternative empirical strategy that relies on a gravity model. This approach offers the advantage of explicitly controlling for time-varying shocks specific to a country-industry, thus absorbing the influence of factors like productivity shocks and political economy forces that can vary between targeted and non-targeted industries. Furthermore, the use of a gravity equation to estimate trade effects of subsidies is consistent with recent quantitative trade models with external economies of scale and subsidy policies (Bartelme and others, 2019; Kucheryavyy, Lyn, and Rodríguez-Clare, 2023; Lashkaripour and Lugovskyy, 2023).

Given that subsidies exhibit variation across countries and industries without discriminating across trading partners, we employ a modified version of the standard gravity model. This approach has been utilized to estimate the trade effects of non-discriminatory policies, such as changes in Most-Favored-Nation (MFN) tariffs, institutional quality, and time to export (Beverelli and others, 2023; Heid, Larch, and Yotov, 2021). The gravity model is specified as follows:

$$X_{ijk,t} = \exp\left[\beta S_{ik,t} \times INT_{ij} + \gamma GRAV_{ijk,t} + \delta_{ik,t} + \mu_{jk,t} + \varepsilon_{ijk,t}\right] \tag{3}$$

The X variable measures the value of sales from origin i to destination j in industry k, and in year t. Importantly, the data includes international (sales from i to j) and domestic (sales from i to i) trade flows. The S variable, like in the difference-in-difference specification (1), is a dummy equal to one if the origin country has at least one subsidy policy announced since 2009 that is in force in industry k at year t. Because we are aggregating the product-level data on subsidies, in robustness checks we replace the dummy variable with a count of the number of subsidy policies in place in the industry. Since the subsidy variable is specific to a country-industry, its effect on bilateral trade cannot be estimated in the presence of origin-industry-year fixed effects (the term δ in the equation). We can nonetheless identify the impact of introducing subsidies on international relative to domestic trade flows. The INT indicator is thus equal to one for international flows. The coefficient of interest β measures the differential effect of subsidies on international vs domestic trade flows. This object provides an indication of how much subsidies displace sales across the border, and hence of the trade spillovers.

The matrix $GRAV$ collects bilateral determinants of trade flows. In preliminary specifications, these include time-invariant trade cost shifters (log of distance and dummies for contiguity, common language and previous colonial relationship) and time-variant WTO and PTA membership dummies. In our baseline specification, the time-invariant variables are replaced by asymmetric country-pair-industry fixed effects. With panel data, the use of these bilateral

fixed effects controls for pre-determined factors that can influence trade flows as well as the introduction of subsidies (Head and Mayer, 2014; Piermartini and Yotov, 2016). To further control for omitted variable bias, the *GRAV* term also includes interactions between the international trade flows dummy and indicators for other GTA policies, GDP, GDP per capita and country-specific dummies for membership in the EU and WTO.[42]

The δ and μ terms are origin-industry and destination-industry year fixed effects, capturing the influence of multilateral resistance terms, output and expenditure in gravity models as well as the average effect of other country-specific variables (including of the subsidy variable). The origin-industry-year fixed effects importantly control for any shock specific to an industry that might affect trade and the propensity to receive a subsidy.

The ε variable is an error term. We follow standard practice in the literature and estimate the gravity equation with the PPML estimator of Silva and Tenreyro (2006) to include zeros and account for heteroskedasticity in the trade data. Standard errors are clustered by origin, destination and symmetric country pairs.

In contrast to the difference-in-difference empirical strategy, the gravity model does not allow for the estimation of export and import effects due to the inclusion of directional (country-industry) fixed effects. However, we can discern the effects of subsidies on international trade (exports plus imports) relative to domestic trade – an indicator of trade spillovers. While we attribute the subsidy policy variable to the exporter consistently with modelling subsidies as given to producers, the choice is inconsequential for the estimates.

The main results of the gravity estimations are reported in Table 2. In column (1), we estimate the coefficient associated with the international trade flows dummy. This term provides an indication of the international border effect (Anderson and Yotov, 2010; McCallum, 1995) – i.e., the difference between international and domestic trade flows. As expected, the results point to a strong border effect, indicating that international trade is 51 percent lower than domestic trade. In the other columns of Table 2, we investigate how this border effect varies with the introduction of subsidies, while controlling for country-pair-industry fixed effects. The positive and significant coefficient on the interaction between the international trade dummy and the indicator for the industry being targeted by at least one subsidy policy introduced since 2009 suggests that international trade increases with subsidies relative to domestic sales. Resources are thus being reallocated from domestic to international markets when the industry receives a subsidy. The effect is sizeable – the gap between international

[42]Table A.9 reports summary statistics for the main variables used in the gravity specifications.

and domestic trade shrinks to a 38 percent difference (from the 51 percent average difference found in column (1)). Columns (3) to (5) suggest that this impact is entirely driven by domestic subsidies, with no effect of export promotion policies. Controlling for the confounding influence of other GTA policies halves the positive effect of subsidies, which remains nonetheless significant.

These results confirm the conclusions drawn from the difference-in-difference estimates, indicating a pro-trade effect of subsidies. The gravity results further suggest that subsidies have a disproportionate effect on international (relative to domestic) trade. This evidence highlights the existence of significant trade spillovers of subsidies.[43]

Table 2. Effects of subsidies on international relative to domestic trade flows

Dep. variable: Bilateral exports	(1)	(2)	(3)	(4)	(5)
Intl. trade flows ×	-0.722***				
	(0.065)				
Subsidies (all)		0.244***			
		(0.028)			
Domestic subsidies			0.229***	0.119***	0.093***
			(0.028)	(0.027)	(0.035)
Export promotion			0.006	0.009	-0.021
			(0.043)	(0.036)	(0.039)
Country-pair-industry FE	N	Y	Y	Y	Y
Intl. trade × Other GTA policies	N	N	N	Y	Y
Intl. trade × country variables	N	N	N	N	Y
Obs	5020184	5020067	5020067	5020067	4873429

Note: Gravity estimates of bilateral trade flows at the industry level (ISIC 2-digit). All columns include importer-industry-year and exporter-industry-year fixed effects, and dummies for FTA and WTO memberships. Col. (1) includes bilateral distance (in logs) and dummies for contiguity, common official language, colonial relationship post 1945 (coefficients not reported). Cols. (2) to (5) have asymmetric country-pair-sector fixed effects. "Other GTA policies" are dummies for each type of other policy group in the GTA database: government procurement, other (than export promotion policies) export restrictions, import restrictions, temporary import barriers, TBTs, macroeconomic policies (FDI and capital restrictions, currency and balance-of-payments measure), local content requirements, and other policies (e.g., intellectual property, migration). Col. (5) adds interactions between the intl. trade dummy and WTO, EU membership dummies, GDP (in logs), GDP per capita (in logs). Standard errors are clustered by importer, exporter and symmetric country pairs. $*$ significant at 10%; $**$ significant at 5%; $***$ significant at 1%.

[43] In the same gravity specification, we replace the dummy indicators with counts of the number of subsidy policies being in place (same is done for the other GTA policies). To attenuate the influence of outliers and keep the zeros, we take the inverse hyperbolic sine of the count variables. Results available upon request show that the coefficient on the subsidy interactions loses significance when we control for other GTA policies. However, the interpretation of these results is challenging, as the count measures imply that a higher count corresponds to stronger interventions.

Similar to the difference-in-difference analysis, we explore variations in the gravity model results across country groups. In Table 3, we replace the dummy for international trade flows with three dummies: one for trade between two countries being in the same group, one for trade between two countries where only one is in the group, and another for trade between two countries outside the group. The excluded category remains domestic trade. We consider three groups: G20, G20 AE and G20 EM. Similar to the sample split exercise conducted in the difference-in-difference estimates (refer to Figures 6 and A.3), this adapted gravity specification helps identify how subsidies impact international trade flows within and between various country groups, relative to domestic trade.

The estimates in Table 3 suggest that the pro-trade effect of subsidies is driven by trade flows between different country groups – G20 AEs and G20 EMs, as well as between each of these two groups and non-G20 countries. The estimates for G20 AEs (columns (3) and (4)) indicate that trade between those countries and others is 68 percent lower than domestic trade. When one the two countries in the pair has a subsidy in place in the industry, the difference diminishes to 64 percent. Similar effects are found for trade between G20 EMs and other countries (columns (5) and (6)). The finding that trade spillovers from domestic subsidies are the greatest between countries of different groups aligns with evidence that subsidies are associated with greater exports and imports between G20 EMs and non-G20 economies.[44]

[44]While we find that the export and imports effects for G20 AEs are concentrated on flows with other G20 AEs, the gravity estimates indicate that the subsidies have no effect on between-G20 AEs trade relative to domestic trade.

Table 3. Effects of subsidies on international relative to domestic trade flows by groups of countries

	(1)	(2)	(3)	(4)	(5)	(6)
Group:	G20		G20 AEs		G20 EMs	
Both in group ×	0.116***		0.376***		-0.793***	
	(0.147)		(0.120)		(0.155)	
Domestic subsidies		0.014		-0.029		0.051
		(0.020)		(0.033)		(0.040)
Export promotion		0.031		-0.020		-0.092**
		(0.025)		(0.042)		
One in group ×	-1.167***		-1.152***		-1.494***	
	(0.216)		(0.203)		(0.232)	
Domestic subsidies		0.114***		0.136***		0.119***
		(0.031)		(0.025)		(0.031)
Export promotion		0.007		0.011		0.080
		(0.036)		(0.035)		(0.051)
None in group ×	-1.101***		-1.764***		-0.879***	
	(0.277)		(0.262)		(0.216)	
Domestic subsidies		0.085**		0.107***		0.121***
		(0.038)		(0.033)		(0.027)
Export promotion		-0.023		-0.010		-0.024
		(0.042)		(0.036)		(0.042)
Obs	5020184	5020067	5020184	5020067	5020184	5020067

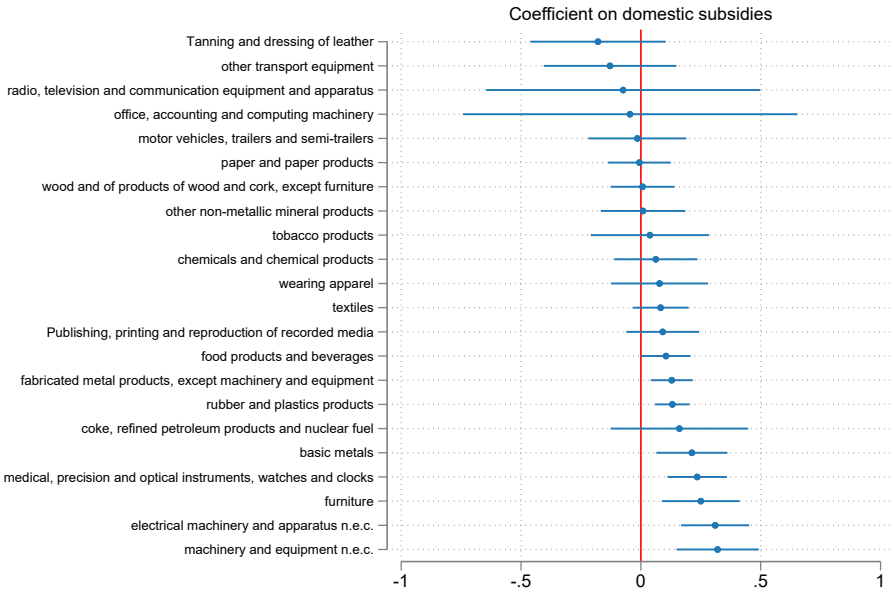
Note: Gravity estimates of bilateral exports. "Both in group" is a dummy for international trade flows between G20 countries (cols (1) and (2)), G20 AEs (cols (3) and (4)), and G20 EMs (cols (5) and (6)). "One in group" is a dummy for international trade flows in country pairs where only one country is G20, G20 AE or G20 EM. "None in group" is a dummy for international trade flows in country pairs where none of the two countries is G20, G20 AE or G20 EM. All columns include importer-industry-year and exporter-industry-year fixed effects, and dummies for FTA and WTO memberships (coefficients not reported). Cols. (1), (3) and (5) include bilateral distance (in logs) and dummies for contiguity, common official language, colonial relationship post 1945 (coefficients not reported). Cols (2), (4) and (6) include asymmetric country pair-industry fixed effects as well as interaction between dummies for each of the other GTA policies and the three international trade flows indicators. Standard errors are clustered by exporter, importer and symmetric country pair. $*$ significant at 10%; $**$ significant at 5%; $***$ significant at 1%.

Additional heterogeneity and robustness checks

We further investigate heterogeneity in the influence of domestic subsidies on the border effect across sectors and industries. Table A.10 in the Appendix reports the gravity estimates on the primary and manufacturing samples. The results are confirmed in both subsamples, with the border effect and the interaction effect with the domestic subsidy dummy being larger in the primary sector. Figure 9 illustrates the coefficient on the interaction between the interna-

tional trade dummy and the subsidy indicator in regressions by manufacturing industry.[45] In all cases, the coefficients are either positive or statistically insignificant, affirming the positive impact of subsidies on international sales relative to domestic sales. The industries with more substantial effects include machinery, furniture, and metals. While not a perfect match, some of these industries, such as electrical machinery, align with those demonstrating strong export and import effects in Figure 7.

Figure 9. Effects of domestic subsidies on international vs. domestic trade by industry



Note: Coefficient and associated 90 percent confidence interval on the interaction between the international trade dummy and an indicator for domestic subsidy in the industry. Estimates by manufacturing industry, defined as a ISIC 2-digit level. The regressions control for interactions with dummies for other GTA policies : export promotion, government procurement, other (than export promotion policies) export restrictions, import restrictions, temporary import barriers, TBTs, macroeconomic policies (FDI and capital restrictions, currency and balance-of-payments measure), local content requirements, and other policies (e.g., intellectual property, migration). All regressions include asymmetric country-pair, importer-year and exporter-year fixed effects. Standard errors are clustered by symmetric country pair, exporter and importer.

Table A.11 in the appendix presents the results of additional exercises. In the first exercise, we replace the subsidy dummy with dummies for the four main types of domestic subsidies: production subsidies, direct transfers, risk transfers, and losses in government revenue. We confirm qualitatively the finding of a similar exercise in the difference-in-difference specification: policies that entail a loss in government revenues such as tax breaks, have the largest impact on international relative to domestic trade. In the second exercise, we exclude coun-

[45]The results for the 8 primary industries are available upon request.

try pairs involving China (column (2)) and the U.S. (column (3)) from the sample. These results confirm the robustness of our baseline findings, despite the influential role of these two economies in the adoption of subsidies.

In the last two columns of Table A.11, we modify the set of GTA policies considered to construct our policy indicators. First, in column (4) we include policies classified in the GTA database as "neutral" or "liberalizing," although these represent a small share of all domestic subsidies (see footnote n. 37). In column (5), we return to our baseline definition of policies as “distortive” but also include those implemented by national financial institutions. The positive and significant coefficient on the interaction between the international trade flows dummy and the domestic subsidy dummy confirms our baseline findings.

V. CONCLUDING REMARKS

In this paper, we undertake an empirical examination of the impact of subsidies on international trade flows. Given the current trend of governments embracing state intervention and industrial policies to achieve economic and non-economic objectives, we aim to address a central question: do domestic subsidies – a prominent feature of government policies in the past decade – create spillover effects through trade flows?

We leverage information from the GTA database to measure the incidence of subsidies across countries, products and industries between 2009 and 2021 and rely on a difference-in-difference specification and a gravity model to assess the trade effects of these measures. The combined results from these two approaches highlight the potential for trade spillovers from subsidies, although there are significant differences across countries. Specifically, results for the full sample reveal that the introduction of subsidies is associated with heightened export and import levels of targeted products relative to non-targeted ones. But the evidence also suggests that subsidies fail to shape comparative advantage patterns – they target products where both exports and imports are increasing without switching the direction of changes. When we focus on different country groups, we find that subsidies lead to higher exports from G20 EMs on the intensive and the extensive margin, pointing to the fact that for these countries subsidies may have impacted comparative advantage. Trade spillovers from subsidies are thus strongest for these countries. Finally, a gravity model shows that subsidies increase international relative to domestic trade. These effects are concentrated in particular industries (electrical machinery in particular), and are the largest for trade between different countries (e.g., G20 and non-G20 members). We also find that these trade effects are most important for

tax breaks and other subsidy policies that involve losses in government revenues, surpassing the impact of state aid, grants and loans.

While significant and sizeable, the results of our analysis are only scratching the surface of a policy issue of critical importance and complexity. Our evidence illustrates how trade flows react to the implementation of subsidies by a particular country in a given product or industry and for given subsidy policies of other nations. In practice, governments chose their subsidy also in response to changes in the global economy, which may be shaped by subsidies imposed by other governments. In parallel ongoing research, we are pursuing a more theory-driven approach aimed at directly estimating the spillover effects of subsidies in a general equilibrium model where the policies implemented by one country impact on the trade flows of others and can induce a reaction.

Three additional avenues for further research can enhance our comprehension of spillovers from subsidies. Our empirical findings highlight the endogeneity of subsidies, revealing that firms experiencing export market expansion or facing heightened import competition are more prone to receiving subsidies. Further theoretical and empirical analysis is essential to unravel the political economy drivers behind this selection process and elucidate how it influences the efficacy of subsidies. Another crucial aspect deserving closer scrutiny is the size and the associated macroeconomic and fiscal implications of subsidy policies. Obtaining data on the monetary amounts involved, even if for a limited set of countries, would facilitate an assessment of the fiscal ramifications of subsidy policies and enable exploration of additional channels of spillover transmission. Finally, the strong evidence of spillover effects through trade from the use of domestic subsidies calls for a better understanding of the rules of conduct that are needed to support multilateral trade cooperation at a time of increasing state intervention.

REFERENCES

Aghion, Philippe, Jing Cai, Mathias Dewatripont, Luosha Du, Ann Harrison, and Patrick Legros, 2015, "Industrial policy and competition," *American economic journal: macroeconomics*, Vol. 7, No. 4, pp. 1–32.

Anderson, James E, and Yoto V Yotov, 2010, "The changing incidence of geography," *American Economic Review*, Vol. 100, No. 5, pp. 2157–2186.

Arkolakis, Costas, Sharat Ganapati, and Marc-Andreas Muendler, 2021, "The extensive margin of exporting products: A firm-level analysis," *American Economic Journal: Macroeconomics*, Vol. 13, No. 4, pp. 182–245.

Attinasi, MG, L Boeckelmann, and B Meunier, 2023, "Unfriendly friends: Trade and relocation effects of the US Inflation Reduction Act," *VoxEU. org*, Vol. 3.

Bacchetta, Marc, and Michele Ruta, 2011, *The WTO, Subsidies and Countervailing Measures* (Edward Elgar Publishing).

Bagwell, Kyle, and Robert W Staiger, 2001, "Domestic policies, national sovereignty, and international economic institutions," *The Quarterly Journal of Economics*, Vol. 116, No. 2, pp. 519–562.

———, 2006, "Will international rules on subsidies disrupt the world trading system?" *American Economic Review*, Vol. 96, No. 3, pp. 877–895.

Baldwin, Richard, and Paul Krugman, 1988, "Industrial policy and international competition in wide-bodied jet aircraft," in *Trade policy issues and empirical analysis*, pp. 45–78.

Baldwin, Richard E, and Frédéric Robert-Nicoud, 2007, "Entry and asymmetric lobbying: why governments pick losers," *Journal of the European Economic Association*, Vol. 5, No. 5, pp. 1064–1093.

Bartelme, Dominick G, Arnaud Costinot, Dave Donaldson, and Andres Rodriguez-Clare, 2019, "The textbook case for industrial policy: Theory meets data," Working Paper 26193, National Bureau of Economic Research.

Barwick, Panle Jia, Myrto Kalouptsidi, and Nahim Bin Zahur, 2019, "China's Industrial Policy: an Empirical Evaluation," Working Paper 26075, National Bureau of Economic Research.

Besedeš, Tibor, and Thomas J Prusa, 2011, "The role of extensive and intensive margins and export growth," *Journal of development economics*, Vol. 96, No. 2, pp. 371–379.

Beverelli, Cosimo, Alexander Keck, Mario Larch, and Yoto V Yotov, 2023, "Institutions, trade, and development: identifying the impact of country-specific characteristics on international trade," *Oxford Economic Papers*.

Blanga-Gubbay, Michael, Paola Conconi, and Mathieu Parenti, 2020, "Lobbying for globalization," Techn. rep.

Bombardini, Matilde, 2008, "Firm heterogeneity and lobby participation," *Journal of International Economics*, Vol. 75, No. 2, pp. 329–348.

Borchert, Ingo, Mario Larch, Serge Shikher, and Yoto V Yotov, 2021, "The international trade and production database for estimation (ITPD-E)," *International Economics*, Vol. 166, pp. 140–166.

Borusyak, Kirill, Xavier Jaravel, and Jann Spiess, 2024, "Revisiting event study designs: Robust and efficient estimation," *arXiv preprint arXiv:2108.12419*.

Bown, Chad P, 2023a, "Industrial policy for electric vehicle supply chains and the US-EU fight over the Inflation Reduction Act," *Peterson Institute for International Economics Working Paper*, , No. 23-1.

———, 2023b, "Modern industrial policy and the WTO," *Peterson Institute for International Economics Working Paper*, , No. 23-15.

Cherif, Reda, Marc Engher, and Fuad Hasanov, 2024, "Crouching beliefs, hidden biases: The rise and fall of growth narratives," *World Development*, Vol. 173, p. 106246.

Cherif, Reda, and Fuad Hasanov, 2019, "The return of the policy that shall not be named: principles of industrial policy," Working paper, International Monetary Fund.

Choi, Jaedo, and Andrei A Levchenko, 2021, "The long-term effects of industrial policy," Working Paper 29263, National Bureau of Economic Research.

Conte, Maddalena, Pierre Cotterlaz, Thierry Mayer, and others, 2022, *The CEPII gravity database* (CEPII).

Costinot, Arnaud, Dave Donaldson, and Ivana Komunjer, 2012, "What goods do countries trade? A quantitative exploration of Ricardo's ideas," *The Review of economic studies*, Vol. 79, No. 2, pp. 581–608.

Criscuolo, Chiara, Ralf Martin, Henry G Overman, and John Van Reenen, 2019, "Some causal effects of an industrial policy," *American Economic Review*, Vol. 109, No. 1, pp. 48–85.

Datt, Mohini, Bernard Hoekman, and Mariem Malouche, 2011, "Taking stock of trade protectionism since 2008," .

De Chaisemartin, Clément, and Xavier d'Haultfoeuille, 2023, "Two-way fixed effects and differences-in-differences with heterogeneous treatment effects: A survey," *The Econometrics Journal*, Vol. 26, No. 3, pp. C1–C30.

Disdier, Anne-célia, Lionel Fontagné, and Enxhi Tresa, 2021, "Economic drivers of public procurement-related protection," *The World Economy*, Vol. 44, No. 11, pp. 3072–3090.

Evenett, Simon, Martin Fernando, Adam Jakubik, and Michele Ruta, 2024, "The return of industrial policy in data," Working paper wp/24/1, International Monetary Fund.

Evenett, Simon J, and Johannes Fritz, 2020, "The global trade alert database handbook," *Version: October 2022*, Vol. 14.

Gaulier, Guillaume, and Soledad Zignago, 2010, "Baci: international trade database at the product-level (the 1994-2007 version)," .

Girma, Sourafel, Yundan Gong, Holger Görg, and Zhihong Yu, 2009, "Can Production Subsidies Explain China's Export Performance? Evidence from Firm-level Data," *Scandinavian Journal of Economics*, Vol. 111, No. 4, pp. 863–891.

Girma, Sourafel, Holger Görg, and Ignat Stepanok, 2020, "Subsidies, spillovers and exports," *Economics Letters*, Vol. 186, p. 108840.

Görg, Holger, Michael Henry, and Eric Strobl, 2008, "Grant support and exporting activity," *The review of economics and statistics*, Vol. 90, No. 1, pp. 168–174.

Harris, Richard, Ian Keay, and Frank Lewis, 2015, "Protecting infant industries: Canadian manufacturing and the national policy, 1870–1913," *Explorations in Economic History*, Vol. 56, pp. 15–31.

Head, Keith, and Thierry Mayer, 2014, "Gravity equations: Workhorse, toolkit, and cookbook," in *Handbook of international economics*, Vol. 4, pp. 131–195.

Heid, Benedikt, Mario Larch, and Yoto V. Yotov, 2021, "Estimating the effects of non-discriminatory trade policies within structural gravity models," *Canadian Journal of Economics/Revue canadienne d'économique*, Vol. 54, No. 1, pp. 376–409.

Hoekman, Bernard M, and Douglas Nelson, 2021, *Subsidies, Spillovers, and Multilateral Cooperation* (Brookings Institution Press).

IMF, 2024, *Fiscal Monitor*.

IMF, OECD, World Bank and WTO, 2022, *Subsidies, Trade, and International Cooperation*.

Irwin, Douglas A, and Nina Pavcnik, 2004, "Airbus versus Boeing revisited: international competition in the aircraft market," *Journal of international economics*, Vol. 64, No. 2, pp. 223–245.

Juhász, Réka, 2018, "Temporary protection and technology adoption: Evidence from the napoleonic blockade," *American Economic Review*, Vol. 108, No. 11, pp. 3339–3376.

Juhász, Réka, Nathan Lane, Emily Oehlsen, and Verónica C Pérez, 2022, "The Who, What, When, and How of Industrial Policy: A Text-Based Approach," *What, When, and How of Industrial Policy: A Text-Based Approach (August 15, 2022)*.

Juhász, Réka, Nathan J Lane, and Dani Rodrik, 2023, "The new economics of industrial policy," Techn. Rep. 31538, National Bureau of Economic Research.

Kalouptsidi, Myrto, 2018, "Detection and impact of industrial subsidies: The case of Chinese shipbuilding," *The Review of Economic Studies*, Vol. 85, No. 2, pp. 1111–1158.

Kinzius, Luisa, Alexander Sandkamp, and Erdal Yalcin, 2019, "Trade protection and the role of non-tariff barriers," *Review of World Economics*, Vol. 155, pp. 603–643.

Krueger, Anne O, and Baran Tuncer, 1982, "An empirical test of the infant industry argument," *The American Economic Review*, Vol. 72, No. 5, pp. 1142–1152.

Kucheryavyy, Konstantin, Gary Lyn, and Andrés Rodríguez-Clare, 2023, "Grounded by gravity: A well-behaved trade model with industry-level economies of scale," *American Economic Journal: Macroeconomics*, Vol. 15, No. 2, pp. 372–412.

Lampe, Markus, Kevin Hjortshøj O'Rourke, Lorenz Reiter, and Yoto V. Yotov, 2023, "The Empire Project: Trade Policy in Interwar Canada," NBER Working Papers 31238, National Bureau of Economic Research, Inc.

Lane, Nathan, 2022, "Manufacturing revolutions: Industrial policy and industrialization in South Korea," *Available at SSRN 3890311*.

Lashkaripour, Ahmad, and Volodymyr Lugovskyy, 2023, "Profits, scale economies, and the gains from trade and industrial policy," *American Economic Review*, Vol. 113, No. 10, pp. 2759–2808.

Lee, G.M., 2016, "Chapter 4 - Subsidies and Countervailing Duties," *Handbook of Commercial Policy*, Vol. 1, pp. 161–210 (North-Holland).

Lee, Soo Jeong, and Jeffrey M Wooldridge, 2023, "A Simple Transformation Approach to Difference-in-Differences Estimation for Panel Data," *Available at SSRN 4516518*.

Leromain, Elsa, and Gianluca Orefice, 2014, "New revealed comparative advantage index: Dataset and empirical distribution," *International Economics*, Vol. 139, pp. 48–70.

Liu, Licheng, Ye Wang, and Yiqing Xu, 2024, "A practical guide to counterfactual estimators for causal inference with time-series cross-sectional data," *American Journal of Political Science*, Vol. 68, No. 1, pp. 160–176.

Manelici, Isabela, and Smaranda Pantea, 2021, "Industrial policy at work: Evidence from Romania's income tax break for workers in IT," *European Economic Review*, Vol. 133, p. 103674.

McCallum, John, 1995, "National borders matter: Canada-US regional trade patterns," *The American Economic Review*, Vol. 85, No. 3, pp. 615–623.

Munch, Jakob, and Georg Schaur, 2018, "The effect of export promotion on firm-level performance," *American Economic Journal: Economic Policy*, Vol. 10, No. 1, pp. 357–387.

Navarra, Elisa, 2023, "The Effects of Corporate Subsidies Along Supply Chains," *Working Paper. Mimeo.*

Pack, Howard, and Kamal Saggi, 2006, "Is there a case for industrial policy? A critical survey," *The World Bank Research Observer*, Vol. 21, No. 2, pp. 267–297.

Piermartini, Roberta, and Yoto V Yotov, 2016, "Estimating trade policy effects with structural gravity," .

Roth, Jonathan, Pedro HC Sant'Anna, Alyssa Bilinski, and John Poe, 2023, "What's trending in difference-in-differences? A synthesis of the recent econometrics literature," *Journal of Econometrics*.

Silva, JMC Santos, and Silvana Tenreyro, 2006, "The log of gravity," *The Review of Economics and statistics*, Vol. 88, No. 4, pp. 641–658.

UNCTAD, 2019, *International classification of non-tariff measures* (UN).

Volpe Martincus, Christian, and Jerónimo Carballo, 2010, "Entering new country and product markets: does export promotion help?" *Review of World Economics*, Vol. 146, pp. 437–467.

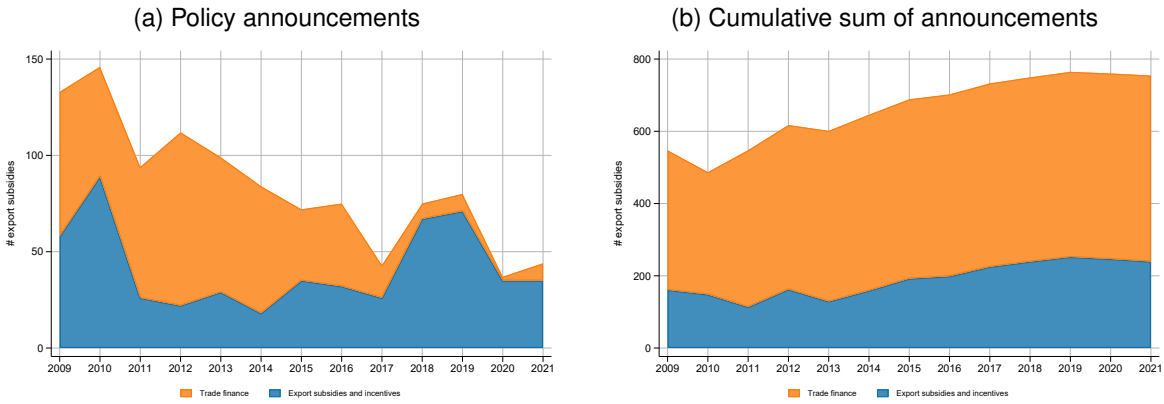
Volpe Martincus, Christian, and Jerónimo Carballo, 2008, "Is export promotion effective in developing countries? Firm-level evidence on the intensive and the extensive margins of exports," *Journal of International Economics*, Vol. 76, No. 1, pp. 89–106.

Wooldridge, Jeffrey M, 2021, "Two-way fixed effects, the two-way mundlak regression, and difference-in-differences estimators," *Available at SSRN 3906345*.

World Bank, 2023, "Unfair Advantage : Distortive Subsidies and Their Effects on Global Trade," *Equitable Growth, Finance and Institutions Insight, World Bank Group*.

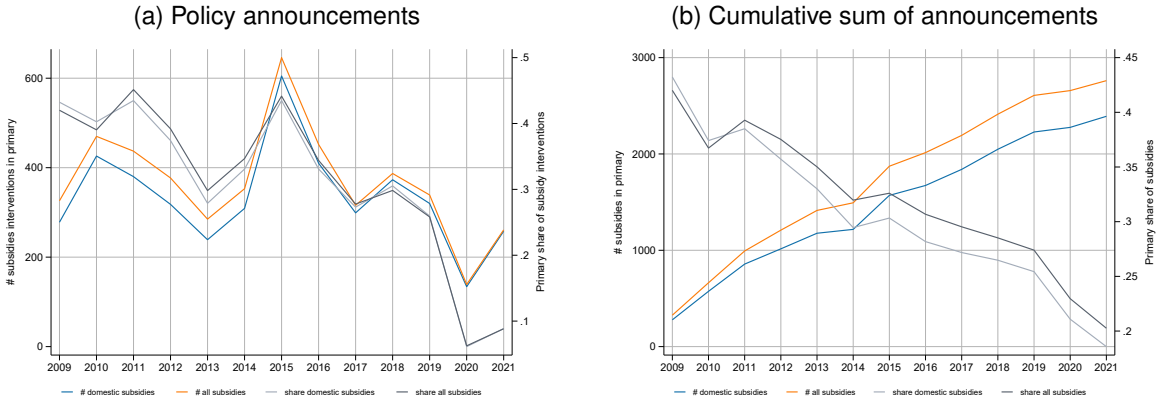
APPENDIX A.

Figure A.1. Number of export promotion policies over time



Note: In panel (a), we count the number of new policies by year of announcements. If the announcement happens on or after July 1st, the following year is the year of announcement. In panel (b) we count the number of policies introduced since 2009 and in force at a given year. A policy is a country-policy combination (e.g., policies adopted at the supranational level (EU for instance) are counted as many times as the number of countries affected), counted once regardless of the number of products affected. Direct transfers are subsidies that transfer resources to firms. Trade finance includes policies classified under the “trade finance” policy instrument category in the GTA. The export subsidy group includes policies classified as “Export subsidies”, "Tax-based export incentive" and "Other export incentive" in the GTA database.

Figure A.2. Number of subsidies in the primary sector and the primary share of subsidies over time



Note: In panel (a), we count the number of new policies by year of announcements. If the announcement happens on or after July 1st, the following year is the year of announcement. In panel (b) we count the number of policies introduced since 2009 and in force at a given year. A policy is a country-policy combination (e.g., policies adopted at the supranational level (EU for instance) are counted as many times as the number of countries affected), counted once regardless of the number of products affected. The primary sector is identified by the ISIC 2-digit code to which the targeted products belong (chapters before 15 are considered primary sector).

Table A.1. Domestic subsidies by industry

ISIC 2-digit industry	(1)	(2)	(3)	(4)	(5)	(6)	(7))
	Announcements			Announcements in force			
	2009	2015	2021	2009	2015	2021	2021-2009 change
Agriculture, hunting and related service activities	260	565	186	260	1352	1862	6.16
Forestry, logging and related service activities	3	143	66	3	168	233	76.67
Fishing, aquaculture and service activities incidental to fishing	3	121	79	3	150	223	73.33
Mining of coal and lignite	3	34	20	3	63	158	51.67
Extraction of crude petroleum and natural gas	6	33	26	6	86	188	30.33
Mining of uranium and thorium ores	0	0	1	0	0	3	
Mining of metal ores	1	25	15	1	46	87	86.00
Other mining and quarrying	9	38	46	9	100	194	20.56
food products and beverages	37	253	300	37	488	1433	37.73
tobacco products	1	119	42	1	121	155	154.00
textiles	35	153	117	35	392	975	26.86
wearing apparel	5	37	67	5	75	517	102.40
Tanning and dressing of leather	2	30	7	2	34	33	15.50
wood and of products of wood and cork, except furniture	5	31	52	5	60	467	92.40
paper and paper products	2	38	20	2	78	167	82.50
Publishing, printing and reproduction of recorded media	5	33	45	5	64	188	36.60
coke, refined petroleum products and nuclear fuel	7	35	27	7	86	206	28.43
chemicals and chemical products	18	208	381	18	451	1692	93.00
rubber and plastics products	10	57	122	10	141	771	76.10
other non-metallic mineral products	12	58	93	12	140	707	57.92
basic metals	17	79	111	17	231	934	53.94
fabricated metal products, except machinery and equipment	12	56	90	12	126	672	55.00
machinery and equipment n.e.c.	28	101	195	28	305	1224	42.71
office, accounting and computing machinery	17	75	163	17	231	1059	61.29
electrical machinery and apparatus n.e.c.	20	80	227	20	270	1200	59.00
radio, television and communication equipment and apparatus	14	76	160	14	223	1051	74.07
medical, precision and optical instruments, watches and clocks	6	39	123	6	59	632	104.33
motor vehicles, trailers and semi-trailers	36	100	143	36	369	1246	33.61
other transport equipment	21	79	73	21	253	606	27.86
furniture	7	39	72	7	71	531	74.86

Note: Each policy is counted once for each industry it targets. Announcements in force include those made since 2009. Column (7) reports the difference in the number of announcements in force between 2021 and 2009, relative to the count in 2009.

Table A.2. Summary statistics for the variables used in the difference-in-difference specifications

	(1) Obs	(2) Mean	(3) Std. dev.	(4) Min	(5) 25th p.	(6) 75th p.	(7) Max
Exports	9931350	21.11	520.88	0.00	0.00	0.55	262674.56
Imports	9931350	21.08	495.95	0.00	0.01	3.19	314813.66
Exports>0	9931350	0.62	0.48	0.00	0.00	1.00	1.00
Imports>0	9931350	0.86	0.35	0.00	1.00	1.00	1.00
Subsidies (all)	9931350	0.06	0.25	0.00	0.00	0.00	1.00
Domestic subsidies	9931350	0.06	0.23	0.00	0.00	0.00	1.00
Production subsidies	9931350	0.00	0.04	0.00	0.00	0.00	1.00
Direct transfers	9931350	0.02	0.12	0.00	0.00	0.00	1.00
Risk transfers	9931350	0.00	0.06	0.00	0.00	0.00	1.00
Revenue-losing policies	9931350	0.04	0.20	0.00	0.00	0.00	1.00
Export promotion	9931350	0.01	0.11	0.00	0.00	0.00	1.00
Gov. procurement	9931350	0.00	0.05	0.00	0.00	0.00	1.00
Export restrictions	9931350	0.00	0.05	0.00	0.00	0.00	1.00
Import restrictions	9931350	0.15	0.35	0.00	0.00	0.00	1.00
Technical Barriers to Trade	9931350	0.00	0.05	0.00	0.00	0.00	1.00
Temporary import restrictions	9931350	0.01	0.07	0.00	0.00	0.00	1.00
Macro restrictions	9931350	0.01	0.09	0.00	0.00	0.00	1.00
Local content requirements	9931350	0.00	0.04	0.00	0.00	0.00	1.00
Other restrictions	9931350	0.00	0.02	0.00	0.00	0.00	1.00

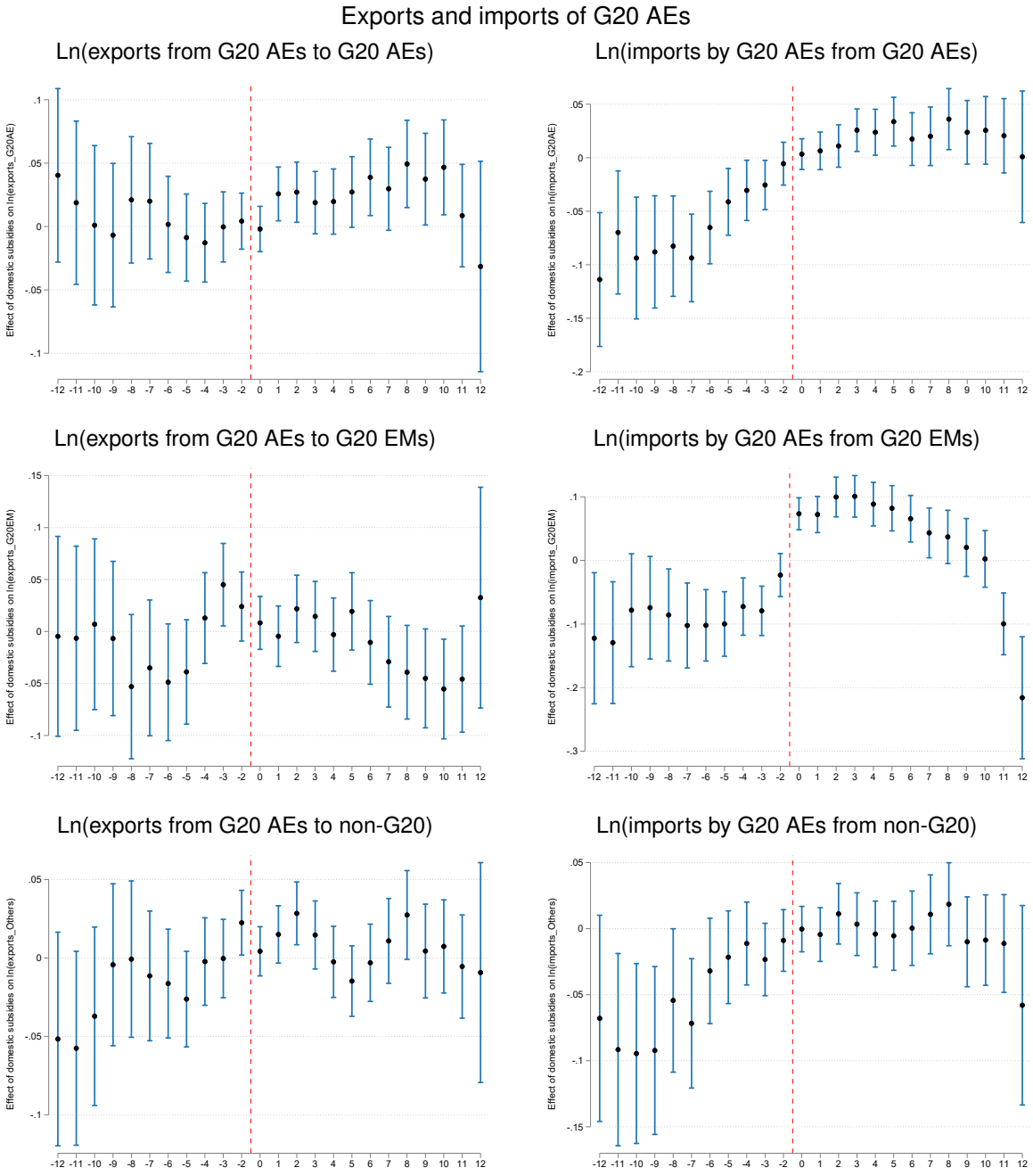
Note: Summary statistics for the main variables used in the difference-in-difference specifications. An observation corresponds to a country-product-year combination. Number of nonmissing observations, mean, standard deviation, minimum value, 25th percentile, 75th percentile and mximum value are reported for each variable. Exports and imports are in millions of current US$.

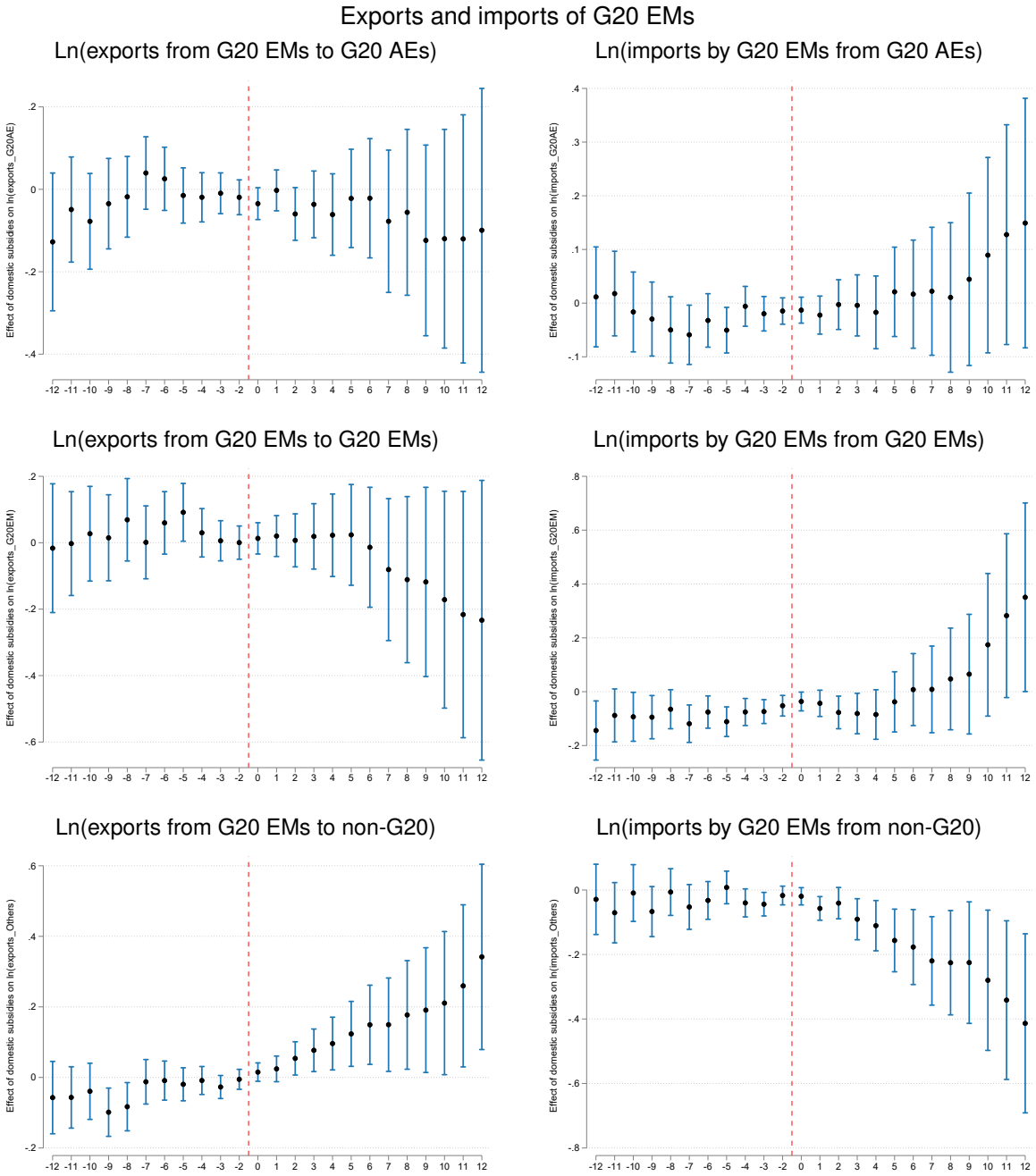
Table A.3. Effects of subsidies and other GTA policies on product-level trade

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dep. variable	ln(exports)				ln(imports)			
Subsidies (all)	0.074**	0.029***	0.020***		0.018	0.048***	0.038***	
	(0.031)	(0.010)	(0.006)		(0.021)	(0.008)	(0.006)	
Domestic subsidies				0.019***				0.039***
				(0.006)				(0.006)
Export promotion				0.013				0.002
				(0.021)				(0.011)
Gov. procurement				0.005				-0.035
				(0.029)				(0.024)
Export restrictions				-0.139***				0.004
				(0.032)				(0.019)
Import restrictions				0.000				-0.013
				(0.007)				(0.008)
Technical barriers to trade				-0.013				-0.060**
				(0.035)				(0.027)
Temporary import restrictions				-0.014				-0.034**
				(0.014)				(0.013)
Macro restrictions				0.008				-0.081***
				(0.050)				(0.024)
Local content requirements				-0.027				-0.020
				(0.036)				(0.025)
Other restrictions				-0.075				-0.091**
				(0.081)				(0.038)
Country-product FE	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	N	N	N	Y	N	N	N
Product-year FE	N	Y	Y	Y	N	Y	Y	Y
Country-sector-year FE	N	Y	Y	Y	N	Y	Y	Y
Country-product time trend	N	N	Y	Y	N	N	Y	Y
Obs	6138611	6137007	6137007	6137007	8540375	8539683	8539683	8539683
R^2	0.86	0.88	0.91	0.91	0.88	0.89	0.92	0.92

Note: Subsidies and other GTA policies are dummies equal to one if there is at least one active intervention targeting a product in a country and year. Sectors are defined as ISIC 2-digit level. Standard errors are clustered by country and product. $*$ significant at 10%; $**$ significant at 5%; $***$ significant at 1%.

Figure A.3. Effects of domestic subsidies on trade flows by country group and destination





Note: The horizontal axis denotes time before and after a country-product is targeted by a domestic subsidy. The time variable is reset if a product exits and then re-enters treatment. Estimates and 90 percent confidence intervals on the domestic subsidy dummy interacted with periods before and after the treatment, by country group (exporter and importer) and partner group. The specification includes dummies for other GTA policies, country-product fixed effects, country-product linear time trends, product-year and country-ISIC 2-digit-year fixed effects. “G20 AEs” include: Australia, Canada, Republic of Korea, France, Germany, Italy, the United Kingdom, Japan and the United States. “G20 EMs” include: Argentina, Brazil, China, India, Indonesia, Mexico, Russia, Saudi Arabia, Türkiye and South Africa. Non-G20 economies are countries that are not in the G20.

Table A.4. Effects of subsidies on product-level trade – imputation method

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. variable:	Ln(exports)			Ln(imports)		
	Full sample	G20AE	G20EM	Full sample	G20AE	G20EM
Domestic subsidy	0.004	0.014	0.033*	0.026***	0.021**	-0.008
	(0.005)	(0.012)	(0.020)	(0.006)	(0.010)	(0.020)
F-stat Pre coefficients=0	4.05	1.31	1.21	27.32	7.17	10.83
	(0.00)	(0.20)	(0.27)	(0.00)	(0.00)	(0.00)

Note: Difference-in-difference estimates from the imputation method of Borusyak, Jaravel, and Spiess (2024). Average across observation-specific treatment effects computed as differences between the dependent variable and its predicted values from a regression on dummies for other GTA policies, country-product, country-sector-year and product-year fixed effects in the non-treated sample. Subsidies and other GTA policies are dummies equal to one if there is at least one active intervention targeting a product in a country and year. Sectors are defined as ISIC 2-digit level. Standard errors are reported in parentheses and computed from a clustered (country-product) bootstrap algorithm with 500 replications. The average treatment effect (ATE) of domestic subsidies is computed in each replication. The standard errors equal: $se = \sqrt{\frac{\sum_{i=1}^{500}\left(\widehat{ATE}_i - \overline{ATE}\right)^2}{500}}$, where $\widehat{ATE}_i$ is the subsidy effect in the ith bootstrap replication and $\overline{ATE}$ is the effect in the baseline sample. $*$ significant at 10%; $**$ significant at 5%; $***$ significant at 1%. In a separate regression, the dependent variable is regressed on dummies for each of the "pre"-subsidy periods (up to 12), dummies for other GTA policies, country-product, country-sector-year and product-year fixed effects in the non-treated sample. Standard errors are clustered by country and product in the full sample and by country-product in the G20AE and G20EM samples. "The "F-stat" is the F statistic associated to a test that all the pre coefficients are equal to zero. P-values are reported in parentheses.

Table A.5. Effects of subsidies on product-level trade by sector

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Manufacturing				Primary			
Dep. variable	Ln(exports)		Ln(imports)		Ln(exports)		Ln(imports)	
Subsidies (all)	0.023***		0.041***		-0.012		-0.002	
	(0.006)		(0.006)		(0.022)		(0.018)	
Domestic subsidies		0.020***		0.043***		0.005		0.001
		(0.006)		(0.006)		(0.021)		(0.015)
Export promotion		0.026		0.008		-0.120**		-0.059
		(0.019)		(0.011)		(0.050)		(0.051)
Obs	5571871	5571871	7816673	7816673	565136	565136	723010	723010
R^2	0.91	0.91	0.92	0.92	0.90	0.90	0.91	0.91

Note: Subsidies and other GTA policies are dummies equal to one if there is at least one active intervention targeting a product in a country and year. The primary sector includes ISIC 2-digit industries with codes lower than 15. All columns include country-product, product-year, and country-sector-year fixed effects, country-product linear trends and indicators for the presence of other GTA policies. Sectors are defined as ISIC 2-digit level. Other GTA policies are : government procurement, other (than export promotion policies) export restrictions, import restrictions, temporary import barriers, TBTs, macroeconomic policies (FDI and capital restrictions, currency and balance-of-payments measures), local content requirements, and other policies (intellectual property and migration). Standard errors are clustered by country and product. $*$ significant at 10%; $**$ significant at 5%; $***$ significant at 1%.

Table A.6. Effects of domestic subsidies on product-level trade – robustness checks

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Dep. Variable:	Ln(exports)					Ln(imports)				
	RCA<1	RCA>1	No US	No CHN		RCA<1	RCA>1	No US	No CHN	
Domestic subsidies	0.009	0.022***	0.020***	0.020***		0.040***	0.041***	0.041***	0.041***	
	(0.012)	(0.006)	(0.006)	(0.006)		(0.008)	(0.007)	(0.006)	(0.006)	
Export promotion	0.012	0.003	0.013	0.015	0.014	0.024	-0.003	0.004	0.000	0.003
	(0.023)	(0.026)	(0.022)	(0.021)	(0.021)	(0.018)	(0.014)	(0.012)	(0.012)	(0.012)
Production subsidies					0.015					-0.030
					(0.021)					(0.021)
Direct transfers					-0.024**					-0.020***
					(0.010)					(0.007)
Risk transfers					0.018					-0.018
					(0.013)					(0.011)
Revenue-losing policies					0.027***					0.059***
					(0.008)					(0.007)
Obs	2140082	3738078	6070837	6071109	6137007	3572192	4627284	8473717	8474152	8539683
R^2	0.88	0.92	0.91	0.91	0.91	0.9	0.93	0.92	0.92	0.92

Note: Log of product-level exports and imports are the dependent variables. Subsidies and other GTA policies are dummies equal to one if there is at least one active intervention targeting a product in a country and year. Sectors are defined as ISIC 2-digit codes. All columns include country-product, product-year, and country-sector-year fixed effects, country-product time trends, and dummies for other GTA policies. Columns (1), (2), (6) and (7) limit the sample based on the value of a revealed comparative advantage index (RCA) akin to the one of Leromain and Orefice (2014), estimated over the 2002-2009 period. Columns (3) and (8) exclude the U.S. from the sample. Columns (4) and (9) exclude China from the sample. Standard errors are clustered by country and product. $*$ significant at 10%; $**$ significant at 5%; $***$ significant at 1%.

Table A.7. Effects of domestic subsidies on product-level trade – additional robustness

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All policy changes				National Financial Insitutions			
Dep. variable:	ln(exports)		ln(imports)		ln(exports)		ln(imports)	
Subsidies (all)	0.018***		0.035***		0.018***		0.035***	
	(0.006)		(0.007)		(0.006)		(0.006)	
Domestic subsidies		0.018***		0.037***		0.019***		0.035***
		(0.006)		(0.007)		(0.006)		(0.007)
Export promotion		-0.005		-0.005		-0.001		0.006
		(0.022)		(0.010)		(0.019)		(0.010)
Obs	6137007	6137007	8539683	8539683	6137007	6137007	8539683	8539683
R^2	0.91	0.91	0.92	0.92	0.91	0.91	0.92	0.92

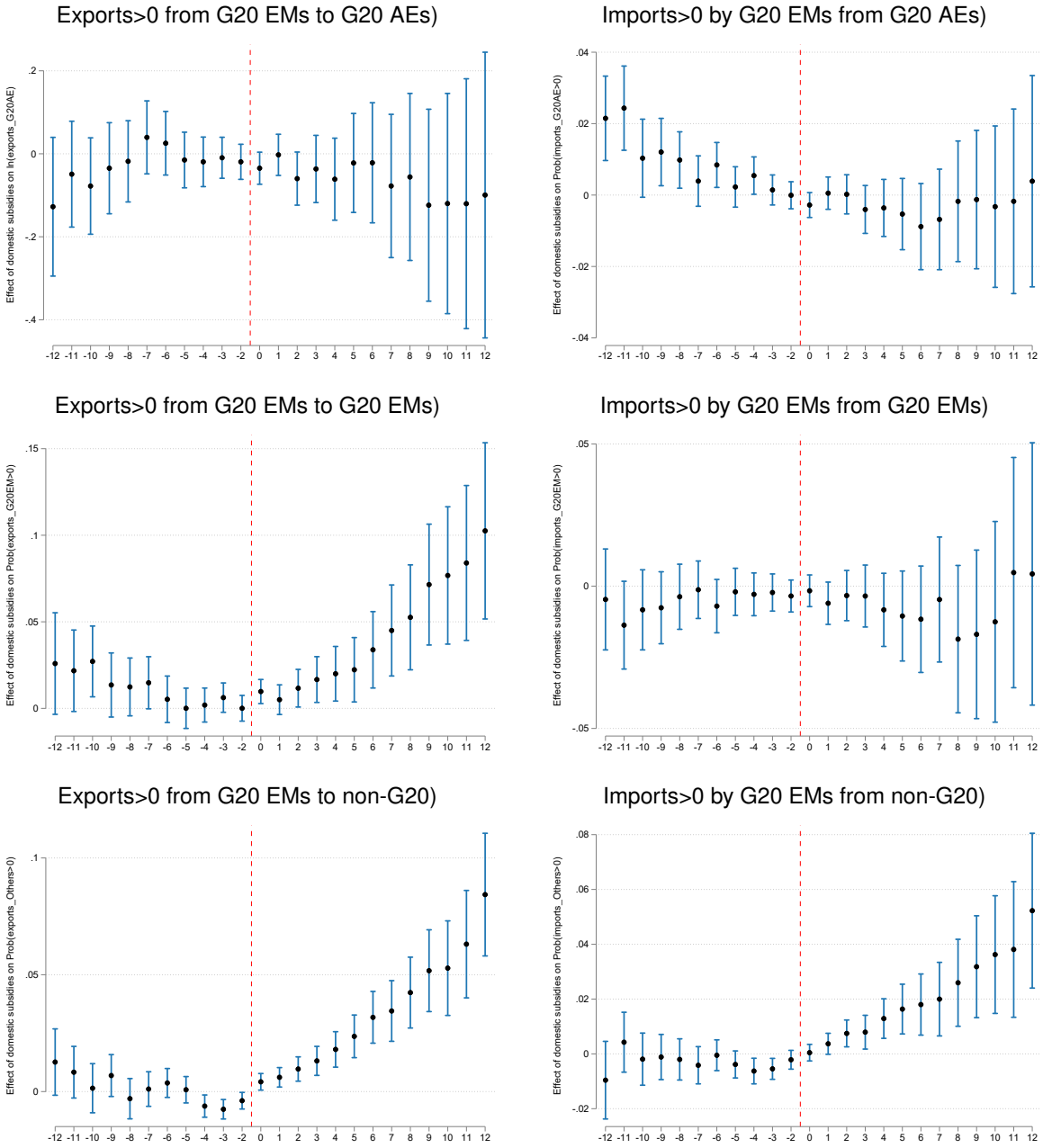
Note: Log of product-level exports and imports are the dependent variables. Subsidies and other GTA policies are dummies equal to one if there is at least one active intervention targeting a product in a country and year. Sectors are defined as ISIC 2-digit codes. All columns include country-product, product-year, and country-sector-year fixed effects, as well as country-product time trends. Columns (1) to (4) considers policy changes in the GTA database regardless of the how the direction of the change has been coded by the GTA exports (distortive, neutral or liberalizing). Columns (5) to (8) goes back to the use of distortive policies as the only relevant ones, but includes also policies from national financial instiutions. Standard errors are clustered by country and product. $*$ significant at 10%; $**$ significant at 5%; $***$ significant at 1%.

Table A.8. Effects of subsidies on export and import probabilities

	(1)	(2)	(3)	(4)
Dep. variable:	Exports>0		Imports>0	
Subsidies (all)	-0.001*		0.002***	
	(0.001)		(0.001)	
Domestic subsidies		-0.001		0.003***
		(0.001)		(0.001)
Export promotion		-0.002		-0.000
		(0.001)		(0.001)
Obs	9931350	9931350	9931350	9931350
R^2	0.77	0.77	0.74	0.74

Note: Dummies for strictly positive export and import values dependent variables. Estimates are from linear probabiltiy models. Subsidies and other GTA policies are dummies equal to one if there is at least one active intervention targeting a product in a country and year. All columns include dummies for other GTA policies, country-product fixed effects, product-year fixed effects, country-sector-year fixed effects and country-product linear trends. Other GTA policies are : government procurement, other (than export promotion policies) export restrictions, import restrictions, temporary import barriers, TBTs, macroeconomic policies (FDI and capital restrictions, currency and balance-of-payments measures), local content requirements, and other policies (intellectual property and migration). Sectors are defined as ISIC 2-digjt level. Standard errors are clustered by country and product. $*$ significant at 10%; $**$ significant at 5%; $***$ significant at 1%.

Figure A.4. Effects of domestic subsidies on export and import probabilities of G20 EMs by destination



Note: Dummies for strictly positive exports and imports flows are the dependent variables. Linear probability estimations. The horizontal axis denotes time before and after a country-product is targeted by a domestic subsidy. The time variable is reset if a product exits and then re-enters treatment. Estimates and 90 percent confidence intervals on the domestic subsidy dummy interacted with periods before and after the treatment, by country group. The specification includes dummies for other GTA policies, country-product fixed effects, country-product linear time trends, product-year and country-ISIC 2-digit-year fixed effects. “EMEs” includes: Argentina, Brazil, China, India, Indonesia, Mexico, Russia, Saudi Arabia, Türkiye and South Africa.

Table A.9. Summary statistics for the variables used in the gravity specifications

	(1) Obs	(2) Mean	(3) Std. dev.	(4) Min	(5) 25th p.	(6) 75th p.	(7) Max
Bilateral exports	5032232	83.20	4436.25	0.00	0.00	0.72	1815773.19
Subsidies (all)	5032232	0.30	0.46	0.00	0.00	1.00	1.00
Domestic subsidies	5032232	0.27	0.45	0.00	0.00	1.00	1.00
Production subsidies	5032232	0.03	0.18	0.00	0.00	0.00	1.00
Direct transfers	5032232	0.09	0.28	0.00	0.00	0.00	1.00
Risk transfers	5032232	0.04	0.19	0.00	0.00	0.00	1.00
Revenue-losing policies	5032232	0.22	0.42	0.00	0.00	0.00	1.00
Gov. procurement	5032232	0.03	0.17	0.00	0.00	0.00	1.00
Export restrictions	5032232	0.09	0.28	0.00	0.00	0.00	1.00
Import restrictions	5032232	0.56	0.50	0.00	0.00	1.00	1.00
Technical barriers to trade	5032232	0.06	0.23	0.00	0.00	0.00	1.00
Temporary import restrictions	5032232	0.24	0.43	0.00	0.00	0.00	1.00
Macro restrictions	5032232	0.04	0.18	0.00	0.00	0.00	1.00
Local content requirements	5032232	0.03	0.18	0.00	0.00	0.00	1.00
Other restrictions	5032232	0.01	0.09	0.00	0.00	0.00	1.00
PTA	5029436	0.19	0.40	0.00	0.00	0.00	1.00
WTO	5032232	0.80	0.40	0.00	1.00	1.00	1.00
ln(distance)	5029436	8.56	0.87	1.61	8.13	9.18	9.90
Intl. trade flows	5032232	1.00	0.06	0.00	1.00	1.00	1.00
Contiguity	5029436	0.04	0.19	0.00	0.00	0.00	1.00
Common language	5029436	0.14	0.35	0.00	0.00	0.00	1.00
Past colonial relationship	5029436	0.01	0.12	0.00	0.00	0.00	1.00

Note: Summary statistics for the main variables used in the gravity specifications. An observation corresponds to a country-pair-industry-year combination. Industries are defined as a the 2-digit ISIC Rev. 3 code. Number of nonmissing observations, mean, standard deviation, minimum value, 25th percentile, 75th percentile and mximum value are reported for each variable. The GTA policies are interacted with the dummy for international trade flows. Bilateral exports are in millions of current US$.

Table A.10. Effects of subsidies on international relative to domestic trade flows (manufacturing and primary sectors)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Manufacturing				Primary			
Intl. trade flows ×	-0.682***				-1.036***			
	(0.064)				(0.098)			
Subsidy (all)		0.237***				0.326***		
		(0.030)				(0.051)		
Domestic subsidy			0.105***	0.086**			0.240***	0.134***
			(0.032)	(0.038)			(0.042)	(0.046)
Export subsidy			0.003	-0.021			-0.016	-0.080*
			(0.043)	(0.046)			(0.070)	(0.047)
Country-pair-industry FE	N	Y	Y	Y	N	Y	Y	Y
Intl. trade x Other GTA policies	N	N	Y	Y	N	N	Y	Y
Intl. trade x country variables	N	N	N	Y	N	N	N	Y
Obs	4353502	4353395	4353395	4221260	666682	666672	666672	652169

Note: Gravity estimates of bilateral trade flows at the industry level (ISIC 2-digit). Cols (1) to (4) include manufacturing industries only, cols (5) to (8) include primary (agriculture and mining) industries only. All columns include importer-industry-year and exporter-industry-year fixed effects, and dummies for FTA and WTO memberships. Col. (1) includes bilateral distance (in logs) and dummies for contiguity, common official language, colonial relationship post 1945 (coefficients not reported). "Other GTA policies" are dummies for each type of other policy group in the GTA database: government procurement, other (than export promotion policies) export restrictions, import restrictions, temporary import barriers, TBTs, macroeconomic policies (FDI and capital restrictions, currency and balance-of-payments measure), local content requirements, and other policies (e.g., intellectual property, migration). Cols. (4) and (8) adds interactions between the intl. trade dummy and WTO, EU membership dummies, GDP (in logs), GDP per capita (in logs). Standard errors are clustered by importer, exporter and symmetric country pairs. $*$ significant at 10%; $**$ significant at 5%; $***$ significant at 1%.

Table A.11. Effects of subsidies on international relative to domestic trade flows – additional results

	(1)	(2)	(3)	(4)	(5)
		No CHN	No USA	All GTA	NFIs
Intl. trade flows $\times$:					
Domestic subsidies		0.132***	0.141***	0.110***	0.119**
		(0.027)	(0.030)	(0.029)	(0.027)
Production subsidies	0.071***				
	(0.021)				
Direct transfers	0.048**				
	(0.020)				
Risk transfers	-0.013				
	(0.043)				
Revenue-losing policies	0.109***				
	(0.024)				
Export promotion	0.017	-0.001	0.022	0.047	0.009
	(0.036)	(0.040)	(0.034)	(0.052)	(0.036)
Obs	5020067	4925320	4927083	5020067	5020067

Note: Gravity estimates of bilateral trade flows at the industry level (ISIC 2-digit). All columns include importer-industry-year, exporter-industry-year and asymmetric country pair-industry fixed effects, dummies for FTA and WTO memberships, and interactions between the international trade flows dummy and dummies for each of the other GTA policies (government procurement, other (than export promotion policies) export restrictions, import restrictions, temporary import barriers, TBTs, macroeconomic policies (FDI and capital restrictions, currency and balance-of-payments measure), local content requirements, and other policies (e.g., intellectual property, migration)). Column (2) exclude country pairs where at least one country is China. Column (3) exclude country pairs where at least one country in the pair is the U.S. Column (4) includes all GTA policy changes (distortive, neutral and liberalizing) that have been implemented by national (government) or supranational authorities. Column (5) considers distortive ("red") GTA policy changes that are implemented by national financial institutions. Standard errors are clustered by importer, exporter and symmetric country pairs. $*$ significant at 10%; $**$ significant at 5%; $***$ significant at 1%.

PUBLICATIONS

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