

Iodice, Irene

Working Paper

Transparency as Trade Policy: Evidence from Notification Timing in TBTs

CESifo Working Paper, No. 12015

Provided in Cooperation with:

Ifo Institute – Leibniz Institute for Economic Research at the University of Munich

Suggested Citation: Iodice, Irene (2025) : Transparency as Trade Policy: Evidence from Notification Timing in TBTs, CESifo Working Paper, No. 12015, CESifo GmbH, Munich

This Version is available at:

<https://hdl.handle.net/10419/325006>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

CES ifo

**12015
2025**

July 2025

Working Papers

Transparency as Trade Policy: Evidence from Notification Timing in TBTs

Irene Iodice

CES ifo

Imprint:

CESifo Working Papers

ISSN 2364-1428 (digital)

Publisher and distributor: Munich Society for the Promotion
of Economic Research - CESifo GmbH

Poschingerstr. 5, 81679 Munich, Germany
Telephone +49 (0)89 2180-2740

Email office@cesifo.de
<https://www.cesifo.org>

Editor: Clemens Fuest

An electronic version of the paper may be downloaded free of charge

- from the CESifo website: www.ifo.de/en/cesifo/publications/cesifo-working-papers
- from the SSRN website: www.ssrn.com/index.cfm/en/cesifo/
- from the RePEc website: <https://ideas.repec.org/s/ces/ceswps.html>

Transparency as Trade Policy: Evidence from Notification Timing in TBTs

Irene Iodice

Bielefeld University, CESifo*

This version - July 23, 2025[†]

Abstract

This paper quantifies the value of timely WTO notifications for Technical Barriers to Trade (TBTs). Using French firm-level export data, I find that advance notice halves the negative impact of TBTs on export participation, by reducing temporary exits and supporting entry, particularly among small and medium-sized firms. Exploiting variation in notification delays, I show that this effect operates by reducing uncertainty about compliance costs, rather than by giving firms more time to adjust. A theoretical framework with firm heterogeneity and trade policy uncertainty formalizes this mechanism: notification lowers uncertainty, reducing firms' incentives to delay or suspend exports. The quantitative importance of this effect is equivalent to avoiding a tariff increase of up to 28 percentage points. (JEL F13, F14, D84).

*Contact information: irene.iodice@uni-bielefeld.de.

[†]I thank Lionel Fontagné, Lisandra Flach, Mathieu Parenti, Angelo Secchi, Ariell Reshef, Gerald Willmann, Luca Macedoni, Anne-Célia Disdier, Maria Bas, Paola Conconi, Gianluca Orefice, Thierry Mayer, Alessia Lo Turco, Marcus Biermann, and Peter Egger for their valuable feedback. I also thank participants at various conferences for their insightful comments. This research was supported by a public grant overseen by the French National Research Agency (ANR) as part of the “Investissements d’avenir” program (reference: ANR-10-EQPX-17, Centre d’accès sécurisé aux données).

1 Introduction

Over the past decades, technical regulations have become increasingly important, with exporters from various countries identifying them as a major obstacle to international trade (OECD, 2005; EU Commission, 2019).¹ Meeting the technical regulations of foreign markets can be challenging for exporters, as it requires a detailed understanding of market requirements and the costs associated with demonstrating compliance. If access to this information is restricted, domestic regulations can act as a hindrance to trade for foreign companies. Despite a consensus in the literature that countries can misuse technical regulations to protect their domestic industries (Trefler, 1993; Lee and Swagel, 1997; Beverelli et al., 2014; Orefice, 2017; Herghelegiu, 2018; Mei, 2018; Grossman et al., 2021), little is known about the role of transparency in these policies. This is surprising given that exporters mostly complain about procedural obstacles associated with technical measures rather than the content of these regulations (International Trade Center, 2016). For instance, UNCTAD (2015) documents that while exporters can easily access the applicable tariff rates for a particular product in a target market, the situation is different when they are searching for details about non-tariff measures (NTMs). This is due to a lack of systematic and comparable information, resulting in substantial uncertainties surrounding NTMs.

The World Trade Organization (WTO) framework, specifically the Agreement on Technical Barriers to Trade (TBT), mandates transparency procedures intended to mitigate such informational frictions. Governments are required to notify proposed technical regulations by publishing official documents detailing the requirements, ideally in advance, allowing trade partners time to understand and prepare. This notification process aims to provide the necessary information for a predictable trading environ-

¹The EU Trade and Investment Barriers Report of 2019 documents that technical barriers to trade are the second most reported trade obstacles faced by EU companies in third countries, being cited more often than "tariffs and equivalents and quantitative restrictions". Similarly, surveys of exporting firms across OECD countries show that "technical measures and customs rules and procedures . . . are [consistently] among the five most reported categories of non-tariff [trade] barriers" (OECD 2005, p. 24).

ment where firms know how to comply when a regulation enters into force. Yet, adherence to providing this documentation before implementation varies. This paper asks: What is the economic value generated when this notification process functions as intended? Specifically, I quantify how the presence of prior notification – defined here as the official documentation being available before the TBT's enforcement date – affects export outcomes compared to situations where regulations are enforced without such advance notice. Does having access to the "rulebook" beforehand significantly reduce the trade-dampening effects commonly associated with TBTs?

This paper provides the first causal estimate of the economic value of timely notification. I combine all TBTs raised as Specific Trade Concerns (STCs) at the WTO from 1995 to 2011 with highly disaggregated French customs data covering 1995–2007. Using regulatory documents, I reconstruct, for each product–country pair, the exact dates when measures were notified and when they entered into force. Strikingly, about 40% of the challenged TBTs were implemented without any prior notification.

Motivated by this empirical pattern, I develop a theoretical framework (in the spirit of [Dixit et al. \(1994\)](#) and [Handley and Limão \(2017\)](#)) focusing on firm heterogeneity and policy uncertainty. The model highlights how receiving notification before implementation clarifies the requirements and reduces uncertainty about the costs and methods of compliance. Knowing the rules of the game narrows the range of possible compliance cost outcomes, lowering the real-option value of waiting for clarity. This encourages firms, particularly less productive ones, to undertake necessary adaptations and maintain their presence in the export market, rather than pausing or exiting temporarily while seeking information.

I test the model's predictions using a differences-in-differences strategy at the product \times firm \times destination level, exploiting the implementation of TBTs across countries and time. Identification relies on comparing export dynamics following TBTs that were notified in advance with those introduced without prior notice. The empirical strategy rests on a common trends assumption: in the absence of a TBT, firms' trade margins

for products in the same narrowly defined sector and destination market would evolve similarly. The approach contrasts regulated products with comparable unregulated ones, while controlling for firm–product–destination fixed effects to absorb unobserved heterogeneity.

The central finding is that timely notification carries substantial economic value. When firms have access to official TBT documentation before enforcement, the disruption to export activity is significantly reduced. Specifically, prior notification mitigates the decline in export participation by about 4 percentage points. The effect is especially pronounced for smaller firms and is driven largely by a reduction in temporary exits—by 6 percentage points—and an increase in new entry of around 5 percentage points.

To isolate the effects of uncertainty from those of adjustment time, I exploit cases where TBTs were notified only after enforcement. If adjustment time were the main constraint, export participation would remain low even after a delayed notification. Instead, I find that participation recovers soon after firms gain clarity on compliance requirements, supporting the view that timely notification primarily reduces uncertainty.

I confirm the robustness of these findings by verifying the parallel pre-trends assumption and testing against alternative channels and estimation strategies, including the substitutability between tariffs and non-tariff barriers and the use of Poisson pseudo-maximum likelihood (PPML).

Finally, I quantify the value of transparency in tariff-equivalent terms: receiving timely notification is economically equivalent to avoiding a tariff increase of up to 28 percentage points. This highlights the critical importance of the notification process—not only as a procedural obligation but as a meaningful policy tool for reducing trade-related uncertainty.

Relation to the Existing Literature. This study contributes to several strands of research.

First and foremost, it advances the literature on how NTMs, particularly TBTs, shape firm-level export decisions. The closest empirical study is [Fontagné and Orefice \(2018\)](#), who pioneer the use of WTO STC data to identify trade-restrictive TBTs and estimate their average negative impact on French export participation. My paper departs from theirs in both focus and approach. While they ask whether challenged TBTs are restrictive, I ask how the trade impact of a TBT depends on the presence or absence of advance notification. This shifts the lens from the static costs of compliance to the dynamic effects of procedural transparency. To that end, I make several distinct contributions: methodologically, I separate TBTs introduced with prior notice from those implemented without it, allowing for a causal estimate of timely notification; conceptually, I develop a real-options framework that highlights policy uncertainty as the key mechanism; and quantitatively, I calculate the economic value of transparency in tariff-equivalent terms. In doing so, this paper builds on a literature that has documented how TBTs can raise market-entry costs ([Bao and Qiu, 2012](#); [Fontagné and Orefice, 2018](#); [Beghin et al., 2015](#)), stem from regulatory heterogeneity ([Grossman et al., 2021](#); [Iodice and Reverdy, 2025](#)), or even enhance trade via harmonization ([Schmidt and Steingress, 2022](#)), by showing that the process of implementation is a critical, and previously overlooked, determinant of these outcomes.

Second, this paper contributes to the broader literature on transparency in trade policy. While earlier work often relied on qualitative indices or treaty provisions ([Francois, 2001](#); [Helble et al., 2009](#); [Lejárraga and Shepherd, 2013](#)), and more recent studies have proxied transparency using notification propensity ([Ing et al., 2018](#)), this paper's methodology offers a more direct measure. By exploiting the exact timing of each notification relative to its enforcement, I provide a granular estimate of the value of predictability itself—an aspect emphasized by scholars ([Helble et al., 2009](#)) but rarely measured for non-tariff measures.

Finally, this paper contributes a new dimension to the literature on trade policy uncertainty (TPU). Seminal real-options models (Bernanke, 1983; Dixit et al., 1994) and their recent applications to trade show that unpredictability in tariff policy reduces trade when market entry involves partially irreversible investments, by increasing the option value of waiting (Handley and Limão, 2015, 2017; Carballo et al., 2018; Alessandria et al., 2019; Liu and Ma, 2020; Coelli, 2022). I extend this framework to NTMs, which also impose substantial sunk compliance costs—costs that are destination-specific and thus largely irreversible (Grossman et al., 2021; Macedoni and Weinberger, 2022). The key insight is that the absence of timely notification constitutes a hidden source of TPU: it raises the perceived variance of compliance costs and discourages firms from entering or maintaining presence in export markets.

The remainder of the paper is structured as follows. Section 2 provides institutional background on WTO transparency provisions. Section 3 describes the dataset construction. Section 4 presents a model of exporting under uncertainty, illustrating how timely notification reduces the perceived variance of compliance costs. Section 5 outlines the empirical strategy, and Section 6 reports the main results. Sections 7 and 8 explore mechanisms and firm heterogeneity. Section 9 quantifies the economic value of notification, and Section 10 concludes.

2 Institutional Framework

The WTO Agreement on TBTs allows members to adopt technical regulations to pursue legitimate policy goals—such as protecting health, safety, the environment, or national security—even when these regulations depart from international standards. However, this right is subject to disciplines aimed at preventing protectionism. Measures must avoid arbitrary or unjustifiable discrimination and should not be more trade-restrictive than necessary to achieve their objectives.²

²The TBT Agreement states: “Members shall ensure that technical regulations are not prepared, adopted or applied with a view to or with the effect of creating unnecessary obstacles to international

A key discipline is procedural transparency. To ensure predictability, the TBT Agreement requires members to notify proposed technical regulations in advance. This is done through a formal “Notification”—a document outlining the proposed measure—ideally allowing a 60-day comment period for trade partners to review and prepare.³

If a member believes these principles—including transparency—have been breached, it may raise a Specific Trade Concern (STC) in the WTO TBT Committee. Analysis of STCs reveals a striking pattern: while the stated objectives of challenged TBTs are often legitimate (e.g., health, safety, environment; see Figure 1a), concerns are frequently raised over procedural issues, particularly transparency and access to information (Figure 1b).⁴ This mirrors exporters’ concerns documented in UNCTAD (2019) and EU Commission (2019).⁵

For example, Mexico’s 1998 ban on chlorofluorocarbons (CFCs) in refrigerators and air conditioners aligned with international environmental commitments,⁶ but was enacted as an emergency measure on September 22nd and notified only post-implementation, on October 12th.⁷ In response, the US raised an STC in November 1998, questioning the emergency justification and highlighting uncertainty for exporters over compliance procedures, such as the lack of accredited testing labs and related costs.⁸

This case illustrates how deviations from notification procedures can generate trade frictions. Motivated by the prevalence of transparency-related STCs and such examples, this paper investigates the economic value of timely notification.

trade.” (Art. 2.2)

³A notification is “a transparency obligation requiring member governments to report trade measures to the relevant WTO body if the measures might have an effect on other Members” (World Trade Organization, 2017).

⁴Following the ITC survey (2016), I group “missing information” and “unreasonable time” as procedural implementation flaws.

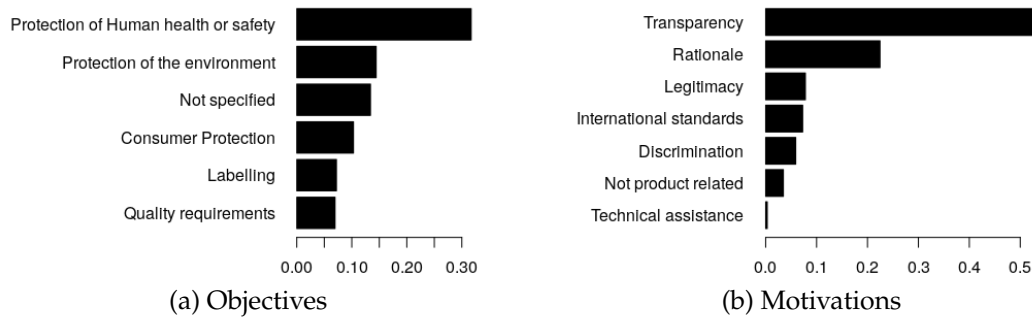
⁵Interviews with trade representatives in Holzer (2019) similarly distinguish between concerns over a measure’s implementation process and its substantive content.

⁶The Montreal Protocol (1989, strengthened in the 1990s) aimed for a global CFC phase-out.

⁷Notification identifier: G/TBT/Notif.98.485.

⁸The US delegate stated: “She questioned the nature of the emergency... US exporters were uncertain about how to comply with the regulation.” (G/TBT/M/14, par. 35)

Figure 1: Objectives and Motivations Behind WTO TBT-Specific Trade Concerns



Notes: The STC database records 598 TBT-objective and 478 TBT-motivation occurrences. I grouped "unreasonable time" and "missing information" under Transparency, consolidated "unnecessary barriers to trade" under Rationale, and broadened Discrimination to include "differential treatment."

3 Data and Stylized Facts

This section presents the data and the construction of a new dataset that recovers the implementation timelines of contested TBTs at the WTO. I first outline the limitations of the WTO's Specific Trade Concerns (STC) database in identifying notification and enforcement dates. I then describe how I supplement this with regulatory documents to track the timing of TBTs and link these data to French firm-level exports. I conclude with stylized facts on the timing of TBT notifications.

3.1 Specific Trade Concerns Database

Identifying which technical regulations act as trade barriers is inherently challenging. Some measures may promote trade, as in the case of harmonized standards (Schmidt and Steingress, 2022). Following prior studies (Fontagné et al., 2015; Fontagné and Orefice, 2018; Herghelegiu, 2018), I focus on potentially restrictive TBTs using the WTO's database of Specific Trade Concerns (STCs) raised from 1995 to 2011.⁹ The

⁹Available at https://www.wto.org/english/res_e/publications_e/wtr12_dataset_e.htm.

database lists 318 STCs covering 403 distinct TBTs, with information on the implementing country, affected products (HS codes), policy objectives, and the concerns raised by WTO members. Importantly, STCs also target measures that were never formally notified.

However, the STC database only records the timing of WTO Committee discussions, not the dates when measures were notified or enforced.¹⁰ This limits the ability to distinguish between trade effects driven by the regulation’s content and those arising from procedural opacity or lack of advance notice.

3.2 New Database on the Timelines of TBTs

To fill this gap, I reconstruct the full regulatory timeline for each measure, identifying both the official notification date and the entry-into-force date. These dates are often missing from standard STC and non-tariff measure databases.¹¹

The first source is the WTO’s Technical Barriers to Trade Information Management System (TBT IMS), which contains official notification documents. Using the unique “Document Symbol” identifier associated with many STCs, I scrape and parse these documents to extract notification and enforcement dates.¹² Where dates were missing or revised, I supplement this information by manually reviewing Revisions and Addenda.

The second source is the Minutes of the WTO TBT Committee, which summarize member discussions of each STC. These Minutes often clarify whether and when the measure was implemented, whether it had been notified, or if its entry was postponed

¹⁰Previous studies used the timing of STC discussions as a proxy for regulatory timing.

¹¹Most NTM databases provide static regulatory snapshots and lack unique identifiers needed to track timelines.

¹²See Appendix A.2.5 for extraction details. The TBT IMS is accessible at <http://tbtdms.wto.org/en/Notifications/Search>.

or accelerated. I parsed and manually coded these discussions to extract relevant timeline information.¹³

Combining these sources, I recover both notification and implementation dates for 301 of the 403 contested TBTs—about 75% of the sample. Relying solely on notification documents would bias the sample toward more transparent cases, but by incorporating Committee Minutes, which cover all measures, I mitigate this concern. Recovery rates are comparable across notified measures (77%) and unnotified ones (67%), suggesting balanced coverage of transparent and opaque cases.

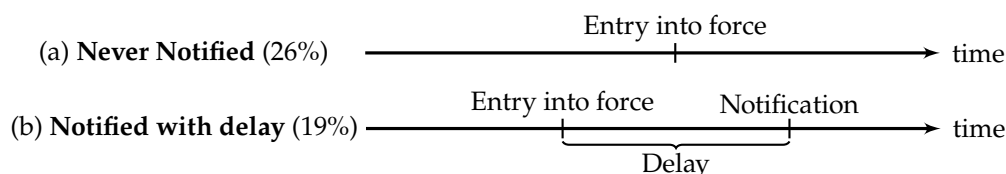
3.3 Stylized Facts about TBTs

A substantial share of TBTs are introduced without prior notice: 45% of the measures in my sample with known implementation timelines were enforced before any WTO notification. Table 1 shows that these measures are spread across multiple sectors, with chemicals, textiles, food products, and machinery most frequently affected. The sectoral composition of timely notified TBTs closely resembles that of all TBTs, suggesting that late or missing notifications are not disproportionately concentrated in particular industries.

The leading countries introducing new TBTs include the EU, China, Mexico, Korea, the US, and India (see Appendix, Table 9). China stands out due to its relatively recent WTO membership and active use of technical measures. Mexico and India, in particular, show a higher incidence of contested TBTs introduced without timely notification. An analysis of domestic industrial growth—proxied by destination-level export values from the BACI database (Appendix, Table 9)—indicates that TBTs without prior notification tend to target sectors experiencing faster export growth. However, the differences in sectoral growth rates between notified and unnotified cases remain modest.

¹³See Appendix A.2 for the data extraction process.

Figure 2: Types of TBT Implementation Without Timely Notification



I distinguish two types of TBTs without timely notice, as illustrated in Figure 2: (a) measures that are *Never Notified*, and (b) measures *Notified with Delay*. Never-notified cases include longstanding regulations, such as Mexico’s 1997 spirit labeling rule, which has never been submitted to the WTO notification system.¹⁴ Delayed notifications refer to measures implemented before being officially submitted, typically with a lag of about three months. For example, the Mexican ban on CFCs was enforced weeks before its notification. These cases reflect gaps in the timely implementation of the WTO’s transparency obligations.

Table 1: Product Coverage of TBTs by Notification Status

Sector	# TBT	% Timely Notified
Chemicals	381	50
Textiles	329	51
Vegetables	231	53
Machinery/Electrical	176	55
Foodstuffs	167	53
Animal Products	119	57
Miscellaneous	101	65
Metals	73	64
Transportation	58	57
Raw Hides, Skins, Leathers	41	56
Stone/Glass	37	32
Footwear/Headgear	36	50
Plastic/Rubbers	34	68
Wood Products	32	78
Mineral Products	17	71

Notes: A TBT is defined by a regulatory identifier paired with an HS4 code. The "% Notified" indicates the share of TBTs where official notification was provided before enforcement.

¹⁴This measure was contested by the EU, as documented in the WTO STC Database (item 20).

3.4 French Firm Level Data

The firm level data comes from two different sources: (i) the French customs, which reports exports for each firm by destination, product and month for the period between 1995 and 2007 and (ii) BRN (*Régime du bénéfice réel normal*), the French firm level administrative database which provides information on firms' balance-sheets, over the same period.¹⁵ The link to BRN, while it reduces the sample to relatively larger firms, allows to identify their principal activity. In this way, only manufacturing industries are selected, which are the ones directly interested by changes in technical requirements of production. Note that this dataset has been used in several trade related papers dealing with French data, such as [Eaton et al. \(2011\)](#) and [Mayer et al. \(2014\)](#).

I aggregate the monthly trade data at the semester level so that the final panel includes 26 periods.¹⁶ The choice of using a semestral panel comes from a trade off between the possibility to look at the specific dates (months) in which measures are enforced and the fact that there is both seasonality and lumpiness in the export behavior. For example, the median exporter ships a certain HS4 product in a destination twice a semester.

3.5 Descriptive Statistics about the Estimating Sample

Given the availability of French firm exports in the period 1995-2007, I use a sample of 123 TBTs that have been object of a STC by the European Union and that have been introduced in the same period.¹⁷ These 123 contested TBTs have been raised against a total of 31 different countries, with China being the largest contested country. [Table 2](#)

¹⁵Firms are obliged to comply with BRN status if they earn annual revenues larger than 763K €. The dataset is accessed through facilities provided by the INSEE (the French Statistical Institute) and were made available for analysis after careful screening to avoid disclosure of individual information.

¹⁶Semestral data are aggregated over two distinct six-month periods within a calendar year. The first period spans from January to June, and the second from July to December.

¹⁷Ideally, one would want to identify those TBTs that are trade restrictive specifically to French exporters, however, European countries participate as a single entity within the TBT Committee. On the other hand, technical regulation are homogeneous across EU countries and TBT measures are applied in a non-discriminatory way to all trading partners.

Table 2: Summary Statistics of TBT Coverage Across Countries and Products

	Mean	Median	Min	Max
# TBTs by Country	4	5.2	1	27
# HS4 categories by TBT	32	3	1	314

Notes: TBT is identified by a regulation identifier ("symbol"). Country is the one that implements the TBT ("maintaining country").

shows that there is a large variability in terms of HS4 categories covered by each TBT. The one that covers the largest number of products is the Mexican “Mandatory standard on Labelling of Industrial Products”, which interests several products across a large number of different HS4, from textile to food.

I limit the sample of firms to those that export to destinations outside the EU-27, as the STCs raised by the EU are directed towards non-EU countries. As for the products, since the WTO STC database typically records them at the 4-digit HS level, I group the export data at this level, which is coarser than the original 8-digit Combined Nomenclature.¹⁸ Last, I calculate total export flows by destination market, retaining markets with above-10 percentile exports. Destinations in the bottom 10 percentile of total French exports accounts for less than 0.001% of total Extra-EU French export value.¹⁹ Then, this data has been joined with tariff data from TRAINS, which contains information on the effectively applied tariffs at the HS 4-digit.²⁰

Table 3 summarizes the average number of distinct HS4–country pairs, exporting firms, and total exports per semester, distinguishing between the full set of possible export markets and the subset of markets where firms actively export. The table further

¹⁸The STC database contains 6% of HS2s products, 62% HS4s and the remaining 32% are HS6 goods. I keep the level of the analysis at 4-digit HS, aggregating the HS6 at the HS4 level.

¹⁹A similar cleaning procedure is applied in Fontagné and Orefice (2018). Note that the number of countries in the sample is reduced, by around 10%: from 223 Non-EU countries to 201. Among excluded countries: Aruba, Samoa, Tonga, Cook Islands, etc.

²⁰HS 4-digit applied tariff data is a simple average tariff within HS-4 headings of the HS-6 applied tariff level data, this aggregation is directly provided by TRAINS. Unfortunately, the database has many empty entries, in the literature there are various algorithm that have been proposed to increase the number of observations. I apply the interpolation procedure suggested in Beverelli et al. (2014)

Table 3: Descriptive Statistics of French Export Markets in the Estimation Sample

	All Possible Markets		Active Markets	
	Full Sample	TBT-Affected	Full Sample	TBT-Affected
#(HS4, Country)	44,563	705	29,460	483
#(Exporters)	23,950	2,593	13,756	1,268
Total Exports (EUR)	3.03e+10	1.27e+09	3.03e+10	1.27e+09

Notes: All figures report semester averages. “All Possible Markets” refers to all HS4–country pairs where at least one exporter is active in more than 4 semesters (out of 26). “Active Markets” further restricts to product–destination pairs with positive exports. Export values are in euros.

separates markets ever affected by a TBT.

Although markets affected by a TBT account for less than 2% of all possible product–destination pairs (705 out of 44,563), and less than 2% of all active export relationships (483 out of 29,460), they still represent an economically significant portion of French exports. Specifically, they account for around €1.27 billion in average semester exports—roughly 4.2% of total Extra-EU exports. This highlights that despite their rarity, these measures concern trade flows of considerable economic relevance.

4 Theoretical Framework

This section develops a real-options framework to highlight how timely notifications about TBTs can reduce uncertainty, thereby encouraging export participation. The analysis builds on standard partial-equilibrium models of international trade under uncertainty (Dixit et al., 1994; Handley and Limão, 2017), but it focuses on the role of *official notifications* as a channel for reducing the variance of possible regulatory outcomes.

4.1 Exporting Under Uncertain Standards

Consider a firm in a monopolistically competitive market that can choose whether to export to a foreign country. If it exports, the firm earns the profit

$$\pi(\varphi_i, d) = a d^{1-\sigma} \varphi_i^{\sigma-1}, \quad (1)$$

where φ_i is firm productivity, $\sigma > 1$ is the elasticity of substitution across varieties, a captures destination-specific demand, and $d \geq 1$ is an ad valorem “iceberg” cost that summarises the restrictiveness of the TBT (e.g., more costly inputs or processes). To serve the market, the firm must pay a sunk cost K_s to adapt its processes or products to the TBT requirements. Once paid, the firm can export and earn profits in each subsequent period with probability $\beta < 1$ of surviving.

When the TBT is fully and promptly notified (for example, meeting the WTO guideline of advance notice before implementation), exporters have relatively precise knowledge of how the measure will look once enforced. By contrast, if the TBT is announced late or not at all, significant residual uncertainty remains regarding the final level of d .²¹

4.2 Two-Period Illustration

To isolate the role of transparency in investment timing, consider a simplified two-period setting. At time 0, the cost parameter is d_0 . A new TBT is known to take effect at time 1 and will either be more restrictive (d_1) or less restrictive (d_2). Timely notification ensures that firms know *exactly* which cost will apply, whereas lack of notification leaves them uncertain. This uncertainty can be represented as a mean-preserving spread around d_0 :

$$d_1 = d_0(1 + \delta), \quad d_2 = d_0(1 - \delta),$$

²¹An alternative modeling approach would treat the TBT as a demand shifter, affecting a . The main results are robust to this interpretation.

where δ captures the degree of uncertainty. A larger δ implies greater dispersion in potential compliance costs without altering their mean, capturing the idea that lack of notification leaves exporters “in the dark” about how restrictive the TBT may ultimately be but does not affect the content of the regulation.

A firm deciding whether to serve the market in period 0 compares two payoffs. The first is the expected present value from investing immediately, paying K_s now, and earning operating profits under d_0 in period 0 and under either d_1 or d_2 in period 1 (should it survive). The second is the value of waiting until period 1 to learn the exact costs associated to the TBT in the market, then deciding whether to pay K_s . In a real-options framework, the option to wait can be valuable if the range of outcomes is large. By contrast, if δ is small—because authorities issued clear, timely notification of the new TBT—there is less benefit to waiting.

4.3 Key Equations and the Role of Notifications

Let $\mathbb{E}_0 \Pi_0(\varphi_i, d)$ denote the expected net present value if the firm invests in period 0, and let $\mathbb{E}_0 \Pi_1(\varphi_i, d)$ be the expected period-1 net payoff (discounted back to period 0) if the firm waits. The firm’s overall value of having the *option* to choose between these two strategies is

$$F_0(\varphi_i) = \max \left\{ \mathbb{E}_0 \Pi_0(\varphi_i, d), \beta \mathbb{E}_0 \Pi_1(\varphi_i, d) \right\},$$

where $\beta < 1$ is the survival factor. The difference $F_0 - \Omega_0$, with $\Omega_0 = \max \{ \mathbb{E}_0 \Pi_0(\varphi_i, d), 0 \}$, i.e. the situation in which a firm has no option to postpone its entry investment decision, represents the real-option value of waiting. Higher uncertainty (larger δ) increases $F_0 - \Omega_0$, implying that more firms prefer to delay.

A straightforward way to see this in practice is through the cutoff productivity φ_i^* above which a firm will invest in period 0 to be able to serve market d . When δ rises, the threshold φ_i^* shifts upward, meaning only the more productive exporters find it

profitable to invest immediately given the wider range of possible compliance costs. Timely notification effectively lowers δ ; hence, it reduces the option value of waiting and encourages earlier entry or adaptation.

The exact derivation of φ_i^* follows standard steps in real-options problems. For completeness, I provide these steps in Appendix [A.1](#).

4.4 Implications

Reducing the uncertainty parameter δ —for instance, by issuing a timely notification—yields four testable implications. First, extensive-margin dominance: notification lowers the real-option value of waiting by shrinking the range of possible compliance costs, raising the probability that a firm exports, while leaving the conditional export value largely unchanged. Second, a temporary-exit mechanism: notification reduces short-lived exits and accelerates re-entry but has little effect on permanent exits. Third, productivity gradient: the gains from notification are largest for low- and mid-productivity firms, whose incentives to delay are strongest. Fourth, short-lived timing effects: since uncertainty resolves when notification occurs, export participation should rebound quickly after enforcement when a delayed notification eventually arrives. Finally, the model provides a mapping from a reduction in δ to an equivalent ad valorem trade cost, allowing the economic value of timely notification to be quantified in tariff-equivalent terms.

5 Research Design

This section develops an empirical strategy to test the theoretical predictions. I exploit variation in TBT notification timing to estimate how regulatory uncertainty affects firm export decisions. The analysis proceeds in three steps: variable definitions, identification strategy, and validation.

5.1 Definition of Variables

The enforcement date of TBT regulations is denoted by E_{pd} , where pd represents the combination of a 4-digit HS product category and destination country. Since the analysis uses semester-level data, I_{pd} denotes the semester during which TBT enforcement begins. The main treatment variable is:

$$TBT_{pdt} = \mathbb{1}\{t \geq I_{pd}\}, \quad (2)$$

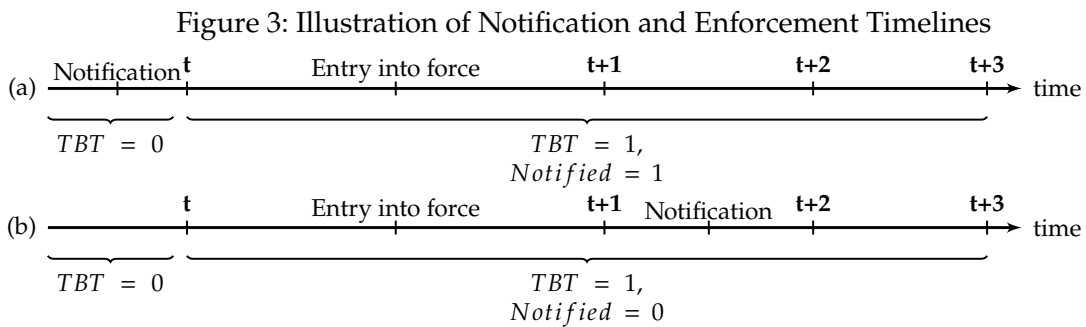
which equals one from the semester of TBT introduction onwards. In markets where no restrictive TBT has been introduced, this indicator remains zero throughout.

The notification date N_{pd} is used to define whether notification was timely:

$$Notified_{pd} = \mathbb{1}\{N_{pd} \neq \text{NA and } N_{pd} \leq E_{pd}\}. \quad (3)$$

This indicator equals one if the TBT was notified by the time of enforcement.

Figure 3 illustrates these indicators for a given country-product pair. In both panels, the TBT is enforced in semester t . Panel (a) shows timely notification ($Notified = 1$), while Panel (b) shows late notification ($Notified = 0$).



Notes: Illustration of two ideal timelines. Each timeline is product-country specific, but the index pd is dropped.

5.2 Empirical Strategy

To quantify the effect of transparency, I estimate a difference-in-differences specification of the form:

$$y_{ipdt} = \alpha \text{TBT}_{pdt} + \beta (\text{TBT}_{pdt} \times \text{Notified}_{pd}) + \mu_{ipd} + \mu_{HS2,dt} + \varepsilon_{ipdt}, \quad (4)$$

where y_{ipdt} denotes the export outcome of firm i , HS-4 product p , destination d , and semester t . I examine both the extensive and intensive margins of trade. For the extensive margin, the dependent variable is a binary indicator equal to one if the firm records any positive exports of product p to destination d in semester t , and zero otherwise. The sample is restricted to “potentially active” firm–product–destination combinations—those that register positive exports in at least four of the 26 observed semesters—following the approach in [Fontagné and Orefice \(2018\)](#). For the intensive margin, I use the natural logarithm of export value in euros.

The coefficient α captures the average effect of a TBT when it is implemented without prior notification, while β measures the incremental mitigating effect of timely notification. A negative and statistically significant β indicates that advance notice reduces the trade-disrupting impact of the regulation, consistent with the interpretation that transparency lowers uncertainty or facilitates adjustment.

The regression includes HS-2–destination–semester fixed effects ($\mu_{HS2,dt}$) to account for common demand shocks, changes in destination-specific price indices, and sector-level policies. It also includes firm–product–destination fixed effects (μ_{ipd}) to control for time-invariant characteristics such as firm productivity, product quality, or the strategic importance of a market–product combination.

Identification relies on comparing changes in firm-level trade margins before and after the enforcement of a TBT, contrasting treated product–destination pairs with untreated ones within the same (narrowly defined) sector–market context. The assumption is that

in the absence of the policy shock, treated and untreated products within the same HS-2–destination cell would have followed parallel trends. Under this assumption, α and β can be interpreted as causal effects. Standard errors are clustered at the product–destination–semester level to allow for arbitrary correlation within treatment cells (Abadie et al., 2017).

5.3 Validation of the Identification Strategy

A key concern when evaluating trade-policy effects is reverse causality: policy measures might be enacted in response to changing trade flows rather than causing them. For example, a government might introduce a TBT in response to rising imports, or the EU might challenge a TBT following poor export performance—biasing estimated effects to reflect prior trade dynamics rather than true causal impacts.

This study mitigates such concerns in two ways. First, STCs are raised at the EU level rather than by France alone, reducing the likelihood that they are driven specifically by shifts in French exports. Second, the empirical strategy incorporates rich fixed effects to account for confounding variation across products, destinations, and time.

The HS2-country-time fixed effects control for time-varying shocks affecting all products within a sector-market pair, such as sector-wide demand shifts or other unobserved country-sector-specific policy changes. Firm-product-destination fixed effects absorb time-invariant characteristics like firm productivity or product quality. These controls ensure identification comes from comparing treated and untreated products within narrowly defined industry-destination cells.

I validate this identification strategy using an event-study specification that tests for

pre-treatment trends:

$$y_{ipdt} = \alpha \text{TBT}_{pdt} + \beta (\text{TBT}_{pdt} \times \text{Notified}_{pd}) + \sum_{n=-3}^{-1} \beta_n \mathbb{1} \{ \text{TBTtime}_{pdt} = n \} + \mu_{ipd} + \mu_{HS2,dt} + \varepsilon_{ipdt}, \quad (5)$$

where $n = 0$ is the semester of enforcement and $n < 0$ denotes pre-treatment periods. The reference category includes all periods prior to 3 semesters before enforcement ($n \leq -4$). This choice accounts for the longest observed anticipation window in the data: 14 months between notification and enforcement, which spans approximately 3 semesters. By using periods beyond this window as the reference, I can clearly identify whether firms begin adjusting their behavior upon receiving notification.

If TBT timing is conditionally random, one should observe no significant differences in trade outcomes before enforcement. This specification is particularly relevant because firms can receive advance notice of TBTs and adjust behavior pre-enforcement. The approach explicitly tests for behavioral changes during the anticipation window while using truly pre-treatment periods as the baseline for comparison.

6 Estimates of Firms' Export Behavior

This section discusses the estimates of how transparency through timely TBT notifications affects firms' trade margins. The latter part of the section focuses on robustness tests for the research design.

6.1 Baseline Results

Table 4 presents estimates of the baseline specifications in Equation 4 for two export margins: participation (extensive margin) and export value (intensive margin).

Table 4: TBTs and timely notification effect - Baseline Model

DEPENDENT VARIABLE	Participation		Export Value	
	(1)	(2)	(3)	(4)
TBT	-0.039*** (0.008)	-0.072*** (0.019)	0.012 (0.035)	-0.002 (0.090)
TBT × Notified		0.042** (0.021)		0.018 (0.096)
Observations	8,155,082	8,155,082	4,492,290	4,492,290
R2	0.247	0.247	0.748	0.748
Firm-HS4-Country FE	Yes	Yes	Yes	Yes
HS2-Country-Time FE	Yes	Yes	Yes	Yes

Notes: Participation is a dummy variable for firm-product export participation (the extensive margin of exports), meaning positive trade flows into a certain product-destination market combination. The observations in cols 1 and 2 are larger than in 3 and 4 since participation accounts for trade zeros. Significance levels: * < 0.1, ** < 0.05, *** < 0.01.

Columns 1 and 3 show that the introduction of a restrictive TBT decreases the probability of exporting by 3.9 percentage points, with no significant effect on the intensive margin—consistent with Fontagné and Orefice (2018). This suggests that TBTs primarily raise fixed trade costs, prompting some firms to exit.²²

The additional role of notification emerges in columns 2 and 4. When TBTs are timely notified, the negative effect on participation is mitigated by 4.2 percentage points, while the intensive margin remains unaffected. This aligns with the model’s prediction: transparency reduces uncertainty, lowering the option value of waiting and supporting continued market participation. As expected, the impact concentrates on the extensive margin—firms choose to serve the market rather than delay entry or exit temporarily.

6.2 Robustness Checks

This subsection presents four robustness checks that validate the identification strategy and address potential confounding factors.

Testing for Pre-Existing Trends To validate the parallel trends assumption, I estimate the event study specification from Equation 5. The results, reported in Appendix

²²Chaney (2008) predicts that fixed trade costs mainly affect the extensive margin, with little impact on the intensive margin.

Table 10, show that coefficients for all pre-TBT periods are statistically insignificant, confirming the absence of pre-trends and supporting a causal interpretation of the baseline results.

Accounting for Sectoral Heterogeneity. A potential concern is that sectoral differences in trade elasticity could bias the estimates if timely notifications are systematically concentrated in sectors with different demand elasticities. To address this, I interact the TBT treatment variable with product-level elasticity estimates from Broda and Weinstein (2006) and Fontagné et al. (2022). The interaction term is negative, as expected—since products with higher elasticity are more sensitive to trade frictions—but it is small and statistically imprecise. Importantly, the main coefficients on *TBT* and $TBT \times Notified$ remain stable and statistically significant across specifications. This suggests that the mitigating effect of timely notification reflects reduced uncertainty, not sector-level differences in demand elasticities. The limited role of elasticity heterogeneity may partly reflect the inclusion of HS2–country–time fixed effects, which absorb much of the sector-level variation in demand conditions. Full results are reported in Appendix Table 11.

Controlling for Concurrent Trade Policies. Another concern is that TBTs might be introduced alongside other trade policy measures, such as tariffs, potentially confounding the estimates. Prior work suggests that TBTs sometimes substitute for tariff reductions (Beverelli et al., 2014; Orefice, 2017), raising the possibility that the observed effects reflect broader protectionist strategies rather than the informational value of notification. To address this, I augment the baseline specification with product-level applied tariff rates at the destination level. As shown in Table 12, controlling for tariffs leaves the magnitude and significance of the notification interaction unchanged. This indicates that the mitigating effect of timely notification is not driven by concurrent tariff adjustments, but rather by transparency itself.

Alternative Estimator: Poisson Pseudo Maximum Likelihood. Given the prevalence of zero trade flows in firm-level data, I re-estimate the baseline model using a Poisson Pseudo Maximum Likelihood (PPML) estimator, which accounts for heteroskedasticity and retains zero-valued export observations (Santos Silva and Tenreyro, 2006; Correia et al., 2019). Results in Table 13 confirm that restrictive TBTs significantly reduce exports when zeros are included, and that timely notification mitigates part of this decline—consistent with the extensive-margin effects observed in the OLS results. While PPML improves the handling of trade zeros, it does not fully address endogenous market participation—the central economic mechanism in this setting. Nonetheless, the consistency of results across OLS and PPML reinforces the conclusion that regulatory transparency reduces the trade-dampening effects of TBTs.

7 Channels: Investment Decisions and Export Dynamics

This section investigates the mechanisms underlying the export response to TBTs and the mitigating role of advance notification. The theoretical model suggests that trade-policy uncertainty affects firm export decisions through the real-option value of waiting. To test this mechanism, I examine how firms on both the incumbent and potential-entrant margins react when a measure is (or is not) notified in advance. I separate permanent exits, temporary exits, and entry, and then examine how export behavior evolve once information about the new standard becomes available.

7.1 Decomposition of the Extensive Margin

I decompose the extensive margin of trade into three types of export dynamics for each firm–product–destination pair. Permanent exits correspond to cases where firms cease serving a market and do not return, reflecting structural incompatibilities or

prohibitively high compliance costs. Temporary exits occur when firms suspend exports but subsequently re-enter, suggesting they delay compliance until uncertainty is resolved. Entry captures firms that had been absent from a product-destination market for at least two semesters and then resumed exports, reflecting postponed market participation.

This decomposition highlights distinct adjustment strategies. Permanent exits likely reflect fundamental barriers between firm capabilities and regulatory requirements, which advance notice cannot overcome. By contrast, temporary exits and delayed entry point to a "wait-and-see" strategy, in which firms delay costly compliance investments until regulatory uncertainty is resolved.

Table 5 reports the estimates. For short-term exits the effect of a TBT introduced without notice is 0.054, or about 5.4 percentage points. The interaction term is -0.063 , implying that when the same measure is notified in advance the net effect is essentially zero ($0.054 - 0.063 \approx -0.01$). In other words, advance notice prevents the wave of temporary suspensions that otherwise follows enforcement. A symmetric pattern appears on the entry margin: without notice, entry falls by 7.2 points (-0.072 in column 1); timely notification offsets roughly three-quarters of that decline ($-0.072 + 0.053 \approx -0.02$). These two results together indicate that firms mainly react to unannounced measures by pausing exports and delaying market entry, behaviour that disappears once compliance requirements are known *ex ante*.

Permanent exits rise when a TBT is introduced (0.062 in column 1), but the notification interaction is small and imprecise (0.040), leaving the net effect statistically unchanged. This is consistent with the idea that firms abandoning the market permanently face structural incompatibilities that information alone cannot solve.

Taken together, the estimates show that the real margin affected by transparency is timing: advance notice prompts firms to adjust immediately rather than wait, curbing

Table 5: Decomposition of Export Extensive Margins

DEPENDENT VARIABLE	Permanent Exit:		Short-term Exit:		Entry:	
	(1)	(2)	(1)	(2)	(1)	(2)
$\mathbb{1}\{\text{TBTtime} = 0\}$	0.062*** (0.019)	0.027 (0.039)	0.001 (0.014)	0.054** (0.021)	-0.025*** (0.008)	-0.072*** (0.021)
$\mathbb{1}\{\text{TBTtime} > 0\}$	0.003 (0.014)	-0.006 (0.019)	0.019 (0.013)	0.042* (0.022)	-0.001 (0.007)	0.002 (0.019)
$\mathbb{1}\{\text{TBTtime} = 0\} \times \text{Notified}$		0.040 (0.039)		-0.063*** (0.023)		0.053** (0.021)
$\mathbb{1}\{\text{TBTtime} > 0\} \times \text{Notified}$		0.008 (0.023)		-0.024 (0.026)		-0.006 (0.019)
Observations	4,584,520	4,584,520	3,866,822	3,866,822	4,241,645	4,241,645
R^2	0.507	0.507	0.422	0.422	0.279	0.279
Firm-HS4-Country FE	Yes	Yes	Yes	Yes	Yes	Yes
HS2-Country-Time FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Permanent Exit is a binary indicator set to 1 if the firm was present at least once in the last two semesters but will not ever serve the product-destination market again. Short-term exit takes value 1 if the firm was serving the market in the current semester but will not serve the market for the next two semesters, but will resume serving it afterwards. The dummy entry takes value 1 if the firm was not present in the product-destination at least for the last two semesters but it operates in the current one and will do so in the future. Standard errors in parentheses are clustered at (product, country, time). Significance levels: * < 0.1, ** < 0.05, *** < 0.01.

temporary exits and sustaining (re-)entry, while having little influence on exits driven by fundamental incompatibility.

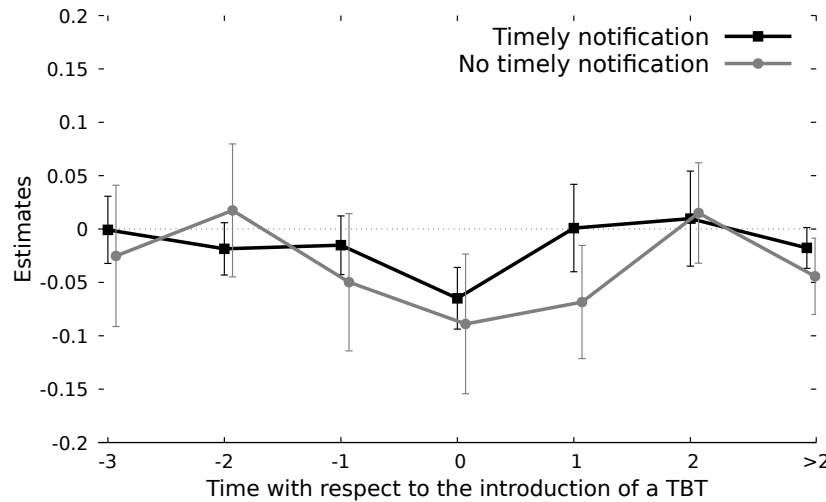
7.2 Duration of the Notification Effect

To gauge the persistence of the transparency premium, I estimate a dynamic specification similar to the one in Equation 11, including leads and lags around the enforcement semester. Figure 4 plots the estimated export-participation coefficients relative to the enforcement semester (with the benchmark being three semesters prior to enforcement), distinguishing between TBTs notified in advance and those that were not.

The results indicate that the mitigating effect of notification is concentrated in the first two semesters after enforcement and fades thereafter. This pattern suggests that absent advance notice, firms initially postpone compliance activities such as product adaptation or certification, leading to a short-lived export decline. Once the regulatory

requirements become clear, participation rebounds, converging to the path observed for timely-notified measures.

Figure 4: Export Participation Before and After TBT Enforcement by Notification Status



Notes: Coefficients from Equation 11, showing changes in export participation before and after TBT enforcement. Trade disruptions are short-lived when advance notification is provided. Full estimates are reported in Table 14 (Appendix). The difference in the first two post-enforcements semester is statistically significant at the 5% level ($F=4.25$, $p=0.0391$).

7.3 Mechanisms: Waiting vs. Adjustment Time

This section investigates whether the economic benefits of timely notification primarily stem from giving firms additional time to adjust to new technical requirements, or from resolving uncertainty about compliance. If the main role of notification is to facilitate adjustment—because firms need time to comply once a new standard is implemented—then a late notification should not trigger an immediate rebound in exports; firms would still require a lag to adapt.

By contrast, if the key benefit lies in resolving uncertainty, then export participation should recover once the notification is issued—even if it arrives after enforcement. In this case, the notification matters not because it allows more time, but because it provides the information needed for firms to make informed compliance decisions.

To test this distinction, I track export participation for up to two semesters after enforcement, comparing TBTs that were notified on time, notified with delay, or never notified. This two-semester horizon captures the full range of notification delays observed in the data. The empirical strategy extends the baseline model by interacting post-enforcement time dummies with indicators for these three notification statuses.

The results, shown in Table 6, highlight the distinct benefits of notification timing. First, the initial decline in participation at enforcement is markedly smaller for measures introduced with timely notification (around -5.4 to -6.3 percentage points) compared to those lacking prior notice (around 8 points). Second, for markets where no notification is ever issued, participation remains persistently depressed in the following semester (between -9 and -10 points), consistent with unresolved uncertainty. Third, and critically, when a notification eventually arrives (typically one semester after enforcement in the delayed cases), participation rebounds substantially, closing the gap relative to timely-notified measures.

Importantly, at the time of enforcement ($t=0$), there is no significant difference in export dynamics between measures that are eventually notified and those that are never notified.²³ This suggests that both groups of firms confront comparable initial uncertainty. The divergence in trajectory occurs only after notification is issued, strongly supporting the argument that it is the provision of concrete information—not merely the passage of time—that enables firms to resume exports.

Overall, the results point to uncertainty—not adjustment time—as the key mechanism linking notification to export dynamics. Timely notification reduces the option value of waiting by clarifying compliance requirements, prompting firms to act rather than delay. When notification is delayed, participation remains suppressed until the required information becomes available, at which point exports rebound. This pattern

²³I formally test whether firms facing delayed-notified measures and those facing never-notified measures differ at the time of enforcement. Estimating a saturated model with separate indicators for the two groups, I find no significant difference between them at $t=0$: the null hypothesis of equal effects cannot be rejected ($F(1, 974, 934) = 1.3, p = 0.3$). This supports the interpretation that both groups face similar initial uncertainty.

confirms that transparency matters not by extending calendar time, but by resolving uncertainty and enabling informed compliance decisions.

Table 6: Export Participation After TBT Enforcement, by Timing of Notification Arrival

	Dependent variable: participation	
	(1)	(2)
<i>Semester 0 (enforcement)</i>		
Timely notification	−0.054*** (0.015)	−0.063*** (0.015)
No notification yet	−0.077** (0.033)	−0.077** (0.033)
<i>Semester +1 (relative to semester 0)</i>		
Still no notification	−0.092*** (0.032)	−0.100*** (0.031)
Already notified	0.014 (0.022)	0.005 (0.021)
Notification arrives now	0.060* (0.035)	0.040 (0.034)
<i>Semester +2 (relative to semester 0)</i>		
Still no notification		0.002 (0.028)
Already notified		0.018 (0.023)
Notification arrives now		0.012 (0.032)
<i>Long-run (semester $\geq +2$ in col. 1, $\geq +3$ in col. 2)</i>		
	−0.023*** (0.008)	−0.025*** (0.009)
Observations	8,155,082	8,155,082
R^2	0.247	0.247
Firm-HS4-Country FE	Yes	Yes
HS2-Country-Time FE	Yes	Yes

Notes: The dependent variable equals 1 if firm i exports product p to destination d in semester t , 0 otherwise. “Timely notification” denotes measures whose notice preceded or coincided with enforcement. “Notification arrives now” captures measures first notified in the indicated semester. “Still no notification” refers to measures for which no notice has yet been issued. Standard errors (in parentheses) are clustered by product–destination–semester. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

8 Firm-Heterogeneous Responses

While the previous sections focused on the average export response, the theoretical framework predicts heterogeneous effects across firms. In particular, smaller and less productive firms stand to gain the most from transparency. These firms face higher real-option values of waiting: they are closer to the threshold productivity cutoff

where uncertainty makes delaying market entry or continued participation optimal. Reducing uncertainty through advance notification lowers this threshold, enabling a wider range of firms to profitably engage in trade.

Table 7 tests this idea by interacting the notification indicator with four quartiles of firm size—measured by domestic sales (col. 1) and by head-count employment (col. 2), used here as proxies for productivity.²⁴

The interaction terms reveal a clear size gradient in the mitigating effect of notification. For the smallest quartile of firms (Bin 1), advance notice is particularly worthy, raising participation by around 5 percentage points when using sales and 6 percentage points when using employment. For firms in the lower- and upper-middle size bins (Bins 2 and 3), notification still provides a significant boost to participation rates—ranging from 4 to 6 percentage points. In contrast, for the largest firms (Bin 4), the mitigating effect of notification is small and statistically insignificant, suggesting that these exporters are less sensitive to policy uncertainty, likely due to greater internal resources for compliance and higher margins.

These results are consistent across the two firm size measures and confirm the model's prediction that the value of transparency is largest where the real-option value of waiting is highest. For large firms, which are less constrained by smaller margins, the presence or absence of advance notification plays a smaller role in shaping their export decisions. In sum, the evidence demonstrates that timely notification particularly benefits small and mid-sized exporters, reinforcing the notion that transparency in trade policy disproportionately supports firms that are more vulnerable to uncertainty.

²⁴Productivity is unobserved in the customs data and requires substantial sample restriction in BRN to construct TFP, so I follow the trade-micro literature and proxy it with (i) domestic sales and (ii) full-time employment—two size indicators that are far less reactive to a destination-specific TBT shock than total export revenue itself.

Table 7: Notification Effects by Firm Size (Bins Based on Domestic Sales or Employment)

	Dependent Variable: Participation	
	(1) Sales Bins	(2) Employment Bins
TBT	-0.066*** (0.022)	-0.063*** (0.022)
TBT × Notified × Bin 1	0.049** (0.025)	0.062** (0.025)
TBT × Notified × Bin 2	0.041* (0.024)	0.060** (0.024)
TBT × Notified × Bin 3	0.046* (0.024)	0.038 (0.024)
TBT × Notified × Bin 4	0.015 (0.024)	0.008 (0.024)
Bin 2	0.131*** (0.001)	0.125*** (0.001)
Bin 3	0.250*** (0.002)	0.231*** (0.001)
Bin 4	0.356*** (0.002)	0.307*** (0.002)
Observations	6,780,420	6,973,438
R^2	0.302	0.298

Notes: Coefficients from OLS regressions of export participation on TBT measures and their interactions with firm size bins. Bin 1 is the reference category. Bin numbers increase with firm size: column (1) uses domestic sales bins, column (2) uses employment bins. Standard errors clustered at the product–destination level are reported in parentheses.

Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

9 Quantifying the Tariff-Equivalent Effect of Notification

The theoretical framework shows that reducing uncertainty through timely notification lowers the real-option value of waiting, encouraging firms to export sooner. While these dynamics operate through a reduction in uncertainty over compliance costs, the model implies that the cost of this uncertainty can be translated into an equivalent trade barrier. In particular, the real-options framework yields a mapping from a decrease in uncertainty (δ) to an equivalent reduction in an ad valorem trade cost. This section quantifies that effect empirically, providing a tariff-equivalent interpretation of the transparency premium.

In the empirical setting, trade frictions from TBTs and tariffs are both captured as iceberg-type costs that scale the effective price of exports. Extending the theoretical framework, I model export revenues for a representative variety i using a CES demand structure where both the compliance costs associated with TBTs (d) and destination

tariffs (τ) act as multiplicative trade barriers:

$$Y_{ipdt} = a_{pdt} \cdot d_{pdt}^{1-\sigma} \cdot (1 + \tau_{pdt})^{1-\sigma}, \quad \sigma > 1, \quad (6)$$

where $d \geq 1$ represents the ad valorem cost multiplier associated with TBTs, and τ is the ad valorem tariff rate, expressed as a decimal share (e.g., $\tau = 0.13$ for a 13% tariff). Both d and τ increase the effective trade cost, reducing revenues through the CES elasticity of substitution σ .

To account for both the extensive and intensive trade margins, the empirical estimation uses a standard Poisson pseudo-maximum likelihood (PPML) gravity specification, which naturally accommodates trade zeros:

$$Y_{ipdt} = \exp \left[\alpha \cdot \text{TBT}_{pdt} + \beta \cdot (\text{TBT}_{pdt} \times \text{Notified}_{pd}) + \mu_{HS2,dt} + \mu_{ipd} \right]. \quad (7)$$

The coefficient $\hat{\beta}$ quantifies the trade benefit associated with receiving advance notification when a TBT is imposed. The estimates in column (2) of Table 13 yield $\hat{\beta} = 0.450$.

To express this as an equivalent tariff change, I equate export revenues under conditions of no notification (represented by an effective tariff τ_0) and with notification (represented by an effective tariff $\tau_0 + \Delta\tau$), using equation (6):

$$(1 + \tau_0)^{1-\sigma} = \exp(\hat{\beta}) \cdot (1 + \tau_0 + \Delta\tau)^{1-\sigma}. \quad (8)$$

Solving for the compensating tariff increment gives:

$$\Delta\tau = (1 + \tau_0) \left[\exp(\hat{\beta}) \right]^{1/(\sigma-1)} - (1 + \tau_0). \quad (9)$$

If the tariff is expressed in percentage points $t = 100\tau$, the tariff equivalent in percentage points is:

$$\Delta t = 100 \cdot (1 + t/100) \left[\exp(\hat{\beta}) \right]^{1/(\sigma-1)} - t. \quad (10)$$

9.1 Illustrative Magnitudes

For CES elasticities in the empirically plausible range $\sigma \in [3, 7]$ (Broda and Weinstein, 2006; Fontagné et al., 2022), equation (9) and Table 8 report the implied tariff equivalents for two benchmark cases: the median tariff faced by French exporters in the overall extra-EU product market, and in the subset of markets where a TBT is imposed. For example, taking $\sigma = 3$ —a standard estimate in the trade literature—failing to notify in advance imposes a trade cost equivalent to raising tariffs by 26.6 percentage points in a market with a 5.5% baseline tariff, or by about 27.8 percentage points in a market already facing a 10.6% tariff.

For comparison, Looi Kee et al. (2009) estimate that the entire stock of non-tariff measures raises Europe’s MA-OTRI by approximately three times, a magnitude comparable to the tariff-equivalent increase observed here. Table 8 provides a transparent sensitivity check across alternative demand elasticities.

In sum, timely notification delivers a trade facilitation benefit equivalent to reducing tariffs by 10 to 30 percentage points—a sizeable effect, and one with clear policy relevance.

Table 8: Tariff Equivalent of Notification under Alternative σ Values

Demand Elasticity σ	Δt if $t_0 = 5.5\%$	Δt if $t_0 = 10.6\%$
3	26.6 pp	27.8 pp
4	17.2 pp	17.9 pp
5	12.7 pp	13.2 pp
7	8.3 pp	8.7 pp

Notes: Δt expresses the ad valorem equivalent of timely notification in percentage points, assuming a baseline tariff of either 5.5% (the extra-EU median) or 10.6% (the median tariff in markets where a TBT is imposed). Calculations use $\hat{\beta} = 0.450$ and equation (9).

10 Conclusion

This paper provides the first causal estimate of the economic value of transparency in the administration of Technical Barriers to Trade. By constructing a new timeline of contested measures and matching it to highly granular firm–product export data, I show that issuing a WTO notification *before* a regulation takes effect halves its negative impact on trade participation. This reduction in uncertainty, a mechanism explored within a real-options framework, enables firms—particularly small and medium-sized exporters—to sustain exports or enter new markets. Quantitatively, the benefit of timely notification is equivalent to avoiding a tariff increase of up to 28 percentage points.

These results contribute to the growing literature on trade policy uncertainty, which has so far focused primarily on tariffs (Handley and Limão, 2017). They strengthen the case for enforceable transparency provisions in modern trade agreements (Mattoo et al., 2020), and complement evidence that the institutional design of trade rules shapes firms’ responses to integration (Fernandes et al., 2021; Neri et al., 2023). In short, *how* a regulation is introduced can matter as much as *what* it requires.

For the WTO, ensuring compliance with the 60-day advance-notice guideline represents a low-cost, high-impact policy lever. By providing predictability, timely notification delivers trade facilitation benefits comparable in magnitude to substantial tariff reductions—an important consideration at a time when new liberalization commitments are politically difficult.

An open question remains why governments sometimes choose opacity over transparency. Since most contested TBTs are resolved at the *Specific Trade Concern* stage and rarely escalate to litigation (Ghodsi and Michałek, 2016), delaying or withholding notification may grant domestic industries a temporary protective window with limited risk of retaliation. Understanding this political-economy calculus—and ex-

amining whether similar transparency frictions arise in SPS measures—are promising directions for future research.

More broadly, the findings show that transparency is not merely a procedural formality but a substantive dimension of trade policy. By shaping firms' expectations, it influences their investment decisions and market participation, with real economic consequences for trade flows and supply chain resilience.

References

- ABADIE, A., S. ATHEY, G. W. IMBENS, AND J. WOOLDRIDGE (2017): "When should you adjust standard errors for clustering?" Tech. rep., National Bureau of Economic Research.
- ALESSANDRIA, G. A., S. Y. KHAN, AND A. KHEDERLARIAN (2019): "Taking stock of trade policy uncertainty: Evidence from china's pre-wto accession," Tech. rep., National Bureau of Economic Research.
- BAO, X. AND L. D. QIU (2012): "How do technical barriers to trade influence trade?" *Review of International Economics*, 20, 691–706.
- BEGHIN, J. C., A.-C. DISDIER, AND S. MARETTE (2015): "Trade restrictiveness indices in the presence of externalities: An application to non-tariff measures," *Canadian Journal of Economics/Revue canadienne d'économie*, 48, 1513–1536.
- BERNANKE, B. S. (1983): "Irreversibility, uncertainty, and cyclical investment," *The quarterly journal of economics*, 98, 85–106.
- BEVERELLI, C., M. BOFFA, AND A. KECK (2014): "Trade policy substitution: Theory and evidence from Specific Trade Concerns," Tech. rep., WTO Staff Working Paper.
- BRODA, C. AND D. E. WEINSTEIN (2006): "Globalization and the Gains from Variety," *The Quarterly journal of economics*, 121, 541–585.
- CARBALLO, J., K. HANDLEY, AND N. LIMÃO (2018): "Economic and Policy Uncertainty: Export Dynamics and the Value of Agreements," NBER Working Papers 24368, National Bureau of Economic Research, Inc.
- CHANEY, T. (2008): "Distorted Gravity: The Intensive and Extensive Margins of International Trade," *American Economic Review*, 98, 1707–21.
- COELLI, F. (2022): "Trade policy uncertainty and innovation: Evidence from China," *Available at SSRN 4169514*.
- CORREIA, S., P. GUIMARAES, AND T. ZYLKIN (2019): "PPMLHDFE: Stata module for Poisson pseudo-likelihood regression with multiple levels of fixed effects," .
- DIXIT, A. K., R. K. DIXIT, AND R. S. PINDYCK (1994): *Investment under uncertainty*, Princeton university press.
- EATON, J., S. KORTUM, AND F. KRAMARZ (2011): "An anatomy of international trade: Evidence from French firms," *Econometrica*, 79, 1453–1498.
- FERNANDES, A. M., K. LEFEBVRE, AND N. ROCHA (2021): "Heterogeneous Impacts of SPS and TBT Regulations," *World Bank, Washington, DC*.
- FONTAGNÉ, L., H. GUIMBARD, AND G. OREFICE (2022): "Tariff-based product-level trade elasticities," *Journal of International Economics*, 137, 103593.
- FONTAGNÉ, L. AND G. OREFICE (2018): "Let's try next door: Technical Barriers to Trade and multi-destination firms," *European Economic Review*, 101, 643–663.

- FONTAGNÉ, L., G. OREFICE, R. PIERMARTINI, AND N. ROCHA (2015): "Product standards and margins of trade: Firm-level evidence," *Journal of international economics*, 97, 29–44.
- FRANCOIS, J. F. (2001): "Trade policy transparency and investor confidence: some implications for an effective trade policy review mechanism," *Review of International Economics*, 9, 303–316.
- GHODSI, M. G. AND J. J. MICHAŁEK (2016): "Technical barriers to trade notifications and dispute settlement within the WTO," *Equilibrium. Quarterly Journal of Economics and Economic Policy*, 11, 219–249.
- GROSSMAN, G. M., P. MCCALMAN, AND R. W. STAIGER (2021): "The "New" Economics of Trade Agreements: From Trade Liberalization to Regulatory Convergence?" *Econometrica*, 89, 215–249.
- HANDLEY, K. AND N. LIMÃO (2015): "Trade and investment under policy uncertainty: theory and firm evidence," *American Economic Journal: Economic Policy*, 7, 189–222.
- (2017): "Policy uncertainty, trade, and welfare: Theory and evidence for China and the United States," *American Economic Review*, 107, 2731–83.
- HELBLE, M., B. SHEPHERD, AND J. S. WILSON (2009): "Transparency and regional integration in the Asia Pacific," *World Economy*, 32, 479–508.
- HERGHELEGIU, C. (2018): "The political economy of non-tariff measures," *The World Economy*, 41, 262–286.
- HOLZER, K. (2019): "Addressing tensions and avoiding disputes: Specific trade concerns in the TBT Committee," *Global Trade and Customs Journal*, 14, 102–116.
- ING, L. Y., O. CADOT, AND J. WALZ (2018): "Transparency in non-tariff measures: An international comparison," *The World Economy*, 41, 884–912.
- IODICE, I. AND C. REVERDY (2025): "Protection or Protectionism: The Effect of Technical Regulations on Input Sourcing," .
- LEE, J.-W. AND P. SWAGEL (1997): "Trade barriers and trade flows across countries and industries," *Review of economics and statistics*, 79, 372–382.
- LEJÁRRAGA, I. AND B. SHEPHERD (2013): "Quantitative evidence on transparency in regional trade agreements," *OECD Publishing*.
- LIU, Q. AND H. MA (2020): "Trade policy uncertainty and innovation: Firm level evidence from China's WTO accession," *Journal of International Economics*, 127, 103387.
- LOOI KEE, H., A. NICITA, AND M. OLARREAGA (2009): "Estimating trade restrictiveness indices," *The Economic Journal*, 119, 172–199.
- MACEDONI, L. AND A. WEINBERGER (2022): "Quality heterogeneity and misallocation: The welfare benefits of raising your standards," *Journal of International Economics*, 134, 103544.
- MATTOO, A., N. ROCHA, M. RUTA, ET AL. (2020): *The evolution of deep trade agreements*, World Bank Washington, DC.

- MAYER, T., M. J. MELITZ, AND G. I. OTTAVIANO (2014): "Market size, competition, and the product mix of exporters," *The American Economic Review*, 104, 495–536.
- MEI, Y. (2018): *Regulatory protection and the role of international cooperation*, The University of Chicago.
- NERI, M., L. G. OREFICE, AND M. RUTA (2023): "Deep Trade Agreements and Heterogeneous Firms Exports," *World Bank, Working Paper Series*.
- OREFICE, G. (2017): "Non-Tariff Measures, Specific Trade Concerns and Tariff Reduction," *The World Economy*, 40, 1807–1835.
- SANTOS SILVA, J. AND S. TENREYRO (2006): "The log of gravity," *The Review of Economics and statistics*, 88, 641–658.
- SCHMIDT, J. AND W. STEINGRESS (2022): "No double standards: quantifying the impact of standard harmonization on trade," *Journal of International Economics*, 103619.
- TREFLER, D. (1993): "Trade liberalization and the theory of endogenous protection: an econometric study of US import policy," *Journal of political Economy*, 101, 138–160.

Online Appendices

A Theory Appendix

A.1 Derivations for the Investment Problem

Section 4 solves an infinite-horizon Bellman problem and then uses a two-period “snapshot” for intuition. This appendix provides the full algebra and shows how the snapshot nests within the general model.

Step 1: Present-Value Profits After Adaptation

The setup follows [Handley and Limão \(2017\)](#). Consumers allocate expenditure between a homogeneous good (numéraire) and a CES composite. Demand for each variety is $q_i = EP^{\sigma-1}p_i^{-\sigma}$, where $\sigma > 1$ is the elasticity of substitution, E total expenditure, and P the CES price index.

On the supply side, firms draw productivity φ_i and face monopolistic competition. To export they must satisfy a technical standard that raises marginal cost by an ad-valorem factor $d \geq 1$. With constant marginal cost, equilibrium price is the usual markup: $p_i = \frac{\sigma}{\sigma-1} \frac{d}{\varphi_i}$. Per-period operating profit is therefore

$$\pi(\varphi_i, d) = a d^{1-\sigma} \varphi_i^{\sigma-1}, \quad a \equiv E \sigma^{-\sigma} (\sigma - 1)^{\sigma-1} P^{\sigma-1}.$$

Exporting requires a one-time sunk adaptation cost K_s . Conditional on survival probability $\beta \in (0, 1)$, the present value of profits after adaptation is

$$\Pi(\varphi, d) = \frac{\pi(\varphi, d)}{1 - \beta} - K_s. \quad (\text{A.F.1})$$

Step 2: Invest Now vs. Wait One Period

Assume the standard is d_0 in period 0 and becomes $d_1 = d_0(1 + \delta)$ with probability $1 - \lambda$ or $d_2 = d_0(1 - \delta)$ with probability λ from period 1 onward.

Invest immediately ($t = 0$).

$$\begin{aligned} \mathbb{E}_0 \Pi_0(\varphi) &= \pi(\varphi, d_0) + \beta [\lambda \Pi(\varphi, d_2) + (1 - \lambda) \Pi(\varphi, d_1)] - K_s \\ &= \frac{\pi(\varphi, d_0)}{1 - \beta} - K_s + \beta(1 - \lambda) [\Pi(\varphi, d_1) - \Pi(\varphi, d_2)]. \end{aligned} \quad (\text{A.F.2})$$

Wait until $t = 1$. Postponing yields nothing in period 0. In period 1 the firm invests only if exporting is profitable under the realised standard:

$$\mathbb{E}_0 \Pi_1(\varphi) = \lambda \max\{\Pi(\varphi, d_2), 0\} + (1 - \lambda) \max\{\Pi(\varphi, d_1), 0\}. \quad (\text{A.F.3})$$

Step 3: Cut-Off Productivity φ^*

Let $F_0(\varphi) = \max\{\mathbb{E}_0 \Pi_0(\varphi), \beta \mathbb{E}_0 \Pi_1(\varphi)\}$ be the firm's value with the option to wait, and $\Omega_0(\varphi) = \max\{\mathbb{E}_0 \Pi_0(\varphi), 0\}$ its value if the investment decision cannot be postponed. The entry threshold φ^* solves $F_0(\varphi^*) = \Omega_0(\varphi^*)$:

$$\varphi^* = \left[\frac{a}{(1 - \beta)K_s} \right]^{1/(1-\sigma)} d_0^{(\sigma-1)/(1-\sigma)} \left[1 - \beta\lambda - \beta(1 - \lambda)(1 + \delta)^{1-\sigma} \right]^{-1/(\sigma-1)}. \quad (\text{A.F.4})$$

Step 4: Option Value of Waiting

The real-option premium is

$$F_0(\varphi) - \Omega_0(\varphi) = \beta(1 - \lambda) \frac{a\varphi^{\sigma-1} d_0^{1-\sigma}}{1 - \beta} \left[(1 + \delta)^{1-\sigma} - (1 - \delta)^{1-\sigma} \right], \quad (\text{A.F.5})$$

which is strictly increasing in the uncertainty parameter δ and implies

$$\frac{\partial \varphi^*}{\partial \delta} > 0. \quad (\text{A.F.6})$$

Hence greater uncertainty raises both the option value of waiting and the productivity cutoff; timely notification ($\delta \rightarrow 0$) reverses these effects.

Two-Period "Snapshot"

The two-period illustration in Section 4 is obtained by truncating the horizon at $t = 1$ and replacing $\Pi(\varphi, d)$ with $\pi(\varphi, d)$ in (A.F.2)–(A.F.3). All comparative-static results with respect to δ carry over unchanged, confirming that the snapshot is a special case of the general solution.

A.2 Construction of the TBT Timeline Dataset

A.2.1 Sources and Matching Process

The starting point is the WTO's Technical Barriers to Trade Information Management System (TBT IMS), which contains all official notifications of technical regulations submitted by WTO members. Each notification is identified by a unique Document Symbol, typically formatted as G/TBT/N/[CountryISO]/[Number] (e.g., G/TBT/N/TUR/142). Using this identifier, I matched each Specific Trade Concern (STC) to its corresponding regulatory documents.

I automated the scraping of notification documents from the WTO TBT IMS website using Python scripts. The scripts queried the WTO's API and downloaded the PDF documents, which contain the date of notification, the proposed entry-into-force date, and other regulatory details.

A.2.2 Date Extraction Procedures

Most notifications follow a standardized format, which allowed me to extract notification and proposed enforcement dates automatically using regular expressions. In cases where this information was missing or later revised, I parsed Revision documents. Addenda and Corrigenda, which typically covered translations or minor updates, were reviewed as needed but rarely altered the timeline.

Overall, about 80% of dates were extracted automatically, with the remainder verified manually due to missing fields, non-standard phrasing, or inconsistencies.

A.2.3 Committee Minutes Parsing and Timeline Classification

For cases where notifications were absent or incomplete, I turned to the WTO TBT Committee Minutes ("MIN" documents), which summarize member discussions. I parsed these texts using an algorithm that extracted all potential timestamps, which were then manually reviewed to identify relevant dates (e.g., "entered into force on...", "will apply from...").

If no specific dates were mentioned, I classified the measures into three categories based on the discussion content:

- **Y**: the measure was already in force.
- **NY**: the measure was still being drafted.
- **NA**: the information was inconclusive.

For measures classified as in force (Y), I assigned the entry-into-force date as the semester when the STC was first raised—reflecting the likely timing of the measure’s adoption.

When conflicting dates appeared across sources, I prioritized the Committee Minutes, followed by any revisions, and lastly the initially proposed dates in the Notification. This reflects the fact that implementation timelines often change without formal documentation, but are discussed in WTO meetings.

A.2.4 Recovery Rate and Sample Balance

This procedure allowed me to recover the notification and implementation timelines for 301 of the 403 contested TBTs—roughly 75% of the sample. Relying solely on notification documents would bias the sample toward transparent measures, but by incorporating information from the Committee Minutes, I mitigate this concern. Recovery rates are comparable for notified TBTs (77%) and unnotified ones (67%), suggesting balanced coverage of transparent and opaque cases.

A.2.5 Illustrative Example of a Notification Document

Figure 5 shows an example of a WTO Notification, with the notification and proposed enforcement dates highlighted.

Figure 5: Example of a Notification Document

WORLD TRADE ORGANIZATION		G/TBT/N/ARG/101 23 May 2003 (03-2765)
Committee on Technical Barriers to Trade		Original: Spanish

NOTIFICATION

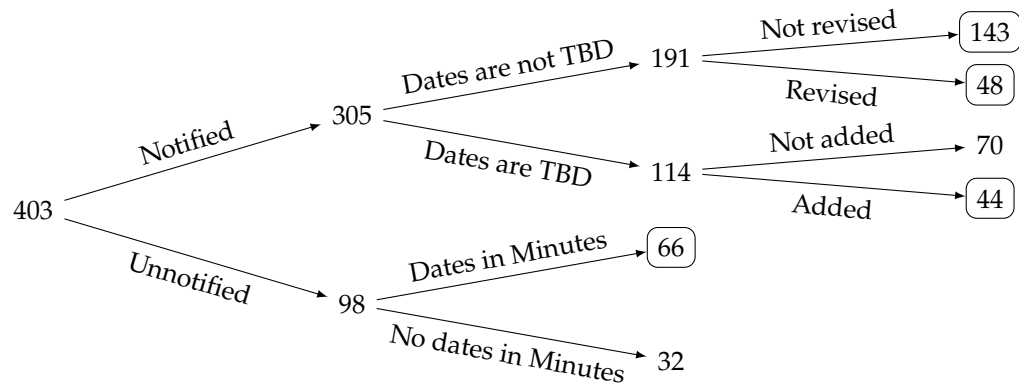
The following notification is being circulated in accordance with Article 10.6.

1.	Member to Agreement notifying: <u>ARGENTINA</u> If applicable, name of local government involved (Articles 3.2 and 7.2):
2.	Agency responsible: National Institute of Vitiviniculture Name and address (including telephone and fax numbers and E-mail and Web site addresses, if available) of agency or authority designated to handle comments regarding the notification shall be indicated if different from above: <i>Idem</i> National Enquiry Point
3.	Notified under Article 2.9.2 [X], 2.10.1 [], 5.6.2 [], 5.7.1 [], other:
4.	Products covered (HS or CCCN where applicable, otherwise national tariff heading. ICS numbers may be provided in addition, where applicable): Wine
5.	Title, number of pages and language(s) of the notified document: Wine – Sulphate Content (2 pages, in Spanish)
6.	Description of content: Establishes the maximum limits for sulphate content, expressed as potassium sulphate, both in wine that is in circulation and in wineries.
7.	Objective and rationale, including the nature of urgent problems where applicable: The need to establish, as an exporting country, the appropriate limits for these products through essential production and conservation techniques, as laid down by the International Organization of Vine and Wine (OIV).
8.	Relevant documents: INV Resolution No. 14/2003
9.	Proposed date of adoption: 30 April 2003 (Official Journal) Proposed date of entry into force: 8 May 2003
10.	Final date for comments: -
11.	Texts available from: National enquiry point [X], or address, telephone and fax numbers and E-mail and Web site addresses, if available, of other body: Punto Focal de la República Argentina Dirección Nacional de Comercio Interior (DNCI) Avda. J. A. Roca 651, Piso 4º, Sector 22 (1322) Buenos Aires Fax: 54 11 4349 4072 Tel.: 54 11 4349 4067 E-mail: focalotc@meccon.gov.ar Web site: http://www.puntofocal.gov.ar

A.2.6 Data Sources Summary: Tree Diagram

Figure 6 displays a tree summarizing the sources used to recover timelines for each measure.

Figure 6: Data sources for the database on TBT timelines



Notes: The frequency of TBTs is displayed in a tree format, organized by the source of information used to retrieve the timelines of TBTs. The edges of the tree indicate the attributes that identify the information source. Final nodes with rectangular frames indicate the cases where the timeline could be identified.

A.3 Additional Tables

A.3.1 Descriptive Statistics

Table 9: Country Coverage of TBTs and Export Growth Rates

Country	# TBT	% w/o Timely Notif.	Avg. Annual Export Growth (%)		
			All HS4	With TBT	w/o Timely Notif.
EU	1184	50.7	2.10	2.30	2.20
CN	848	46.7	6.60	5.80	5.20
MX	489	65	2.60	1.40	1.50
KR	473	20.3	2.40	3.10	2.90
US	440	46.1	1.50	1.70	1.70
IN	432	47.2	6.20	6.40	6.60
ID	299	94.3	4.50	2.40	4.10
BR	265	64.2	3.20	5.50	5.50
TW	214	78.5	N/A	N/A	N/A
JP	191	1.6	1.20	1.30	2.50
ZA	177	2.3	4	2.80	6.40
CA	174	1.7	N/A	N/A	N/A
AR	172	5.2	1.90	3.10	7
EG	171	100	5.70	1.80	1.80
NZ	167	100	2.70	2.80	2.80
MY	31	41.9	3.50	3.10	N/A
CO	28	7.1	3.50	2.70	N/A
TR	17	100	N/A	N/A	N/A
EC	10	60	3.60	2.90	N/A
IL	8	100	3.10	1.60	1.60
PE	7	14.3	5.10	6.60	6.70
KE	6	100	N/A	N/A	N/A
MD	2	100	N/A	N/A	N/A
TH	1	100	4.40	5.20	5.20
UY	1	100	-0.40	3.50	3.50
Average	228	57.3	3.40	3.30	4

Note: A product refers to an HS4 code. A TBT is a regulatory measure affecting an HS4 code. “% Without Timely Notification” refers to the share of TBTs that were either enforced before notification or never notified. Missing growth rates reflect discontinuous trade series for some country-product pairs.

Table 10: Testing for pre-trends

DEPENDENT VARIABLE	Participation:		
	(1)	(2)	(3)
TBT	-0.074*** (0.020)	-0.075*** (0.020)	-0.076*** (0.020)
TBT × Notified	0.042** (0.021)	0.043** (0.021)	0.043** (0.021)
1{TBTtime = -1}	-0.020 (0.013)	-0.021 (0.013)	-0.021 (0.013)
1{TBTtime = -2}		-0.011 (0.012)	-0.012 (0.012)
1{TBTtime = -3}			-0.007 (0.015)
Observations	8 155 082	8 155 082	8 155 082
R ²	0.247	0.247	0.247
HS2-Country-Time FE	Yes	Yes	Yes
Firm-HS4-Country FE	Yes	Yes	Yes

Notes: Participation equals 1 if a firm exports a given HS-4 product to a destination in a semester. Standard errors clustered at (HS4, country, time). Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 11: Effects of TBTs, controlling for product elasticity

DEPENDENT VARIABLE	Participation			
	(1)	(2)	(3)	(4)
TBT	-0.027** (0.012)	-0.060*** (0.021)	-0.029*** (0.010)	-0.067*** (0.021)
TBT × Elasticity (BW)	-0.003 (0.002)	-0.003 (0.002)		
TBT × Notified		0.043** (0.021)		0.049** (0.021)
TBT × Elasticity (FGO)			-0.002 (0.001)	-0.002 (0.001)
Observations	8,117,694	8,117,694	8,092,448	8,092,448
R ²	0.247	0.247	0.247	0.247
HS2-Country-Time FE	Yes	Yes	Yes	Yes
Firm-HS4-Country FE	Yes	Yes	Yes	Yes

Notes: The dependent variable is a binary indicator equal to one if a firm exports a positive amount of a product to a destination in a given year. Elasticity (BW) and Elasticity (FGO) refer to product-level demand elasticity estimates from [Broda and Weinstein \(2006\)](#) and [Fontagné et al. \(2022\)](#), respectively. Columns (1) and (3) report the baseline effects of TBTs, including interactions with product elasticity measures to control for heterogeneous trade responses. Columns (2) and (4) add an interaction with a dummy for whether the TBT was notified in advance. All regressions include HS2-country-year and firm-HS4-country fixed effects. Standard errors, clustered at the HS4-country-year level, are reported in parentheses. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 12: Effects of TBTs, controlling for tariffs

DEPENDENT VARIABLE	Participation		Export (0)		Log Exports	
	(1)	(2)	(3)	(4)	(5)	(6)
log(1+tariff%)	0.031*** (0.006)	0.031*** (0.006)	-0.121** (0.061)	-0.104* (0.058)	-0.047** (0.019)	-0.047** (0.019)
TBT	-0.039*** (0.008)	-0.073*** (0.020)	-0.396*** (0.076)	-0.761*** (0.228)	0.015 (0.035)	0.001 (0.090)
TBT × Notified		0.042** (0.021)		0.433* (0.239)		0.017 (0.096)
Observations	7,615,002	7,615,002	7,550,366	7,550,366	4,196,684	4,196,684
R2	0.248	0.248			0.745	0.745
R2 adj.	0.201	0.201			0.682	0.682
HS2-Country-Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm-HS4-Country FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The dependent variables are: participation (binary export indicator), export values including zeros (*Export (0)*), and log exports excluding zeros (*Log Exports*). Columns (3) and (4) are estimated on the full sample (export ≥ 0) using PPML; columns (5) and (6) are estimated on strictly positive exports (export > 0) using OLS. Tariff refers to the log of applied tariffs at the product-destination level. All regressions include HS2-country-time and firm-HS4-country fixed effects. Standard errors, clustered at the HS4-country-time level, are reported in parentheses. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 13: PPML with HDFE

Dependent variable:	Exports ≥ 0 (PPML)		Exports > 0 (PPML)	
	(1)	(2)	(3)	(4)
TBT	-0.396*** (0.076)	-0.776*** (0.228)	-0.148** (0.067)	-0.263* (0.156)
TBT × Notified		+0.450* (0.238)		+0.136 (0.168)
Observations	8,082,903	8,082,903	3,316,077	3,316,077
HS2-Country-Time FE	Yes	Yes	Yes	Yes
Firm-HS4-Country FE	Yes	Yes	Yes	Yes

The table reports results from Poisson Pseudo-Maximum Likelihood (PPML) regressions with high-dimensional fixed effects, estimated using the `ppmlhdfe` routine of [Correia et al. \(2019\)](#). The dependent variable is export value at the firm-product-destination-semester level. Columns (1)–(2) include all observations, including zeros; columns (3)–(4) restrict the sample to strictly positive export flows. All regressions include HS2-country-semester and firm-HS4-country fixed effects. Standard errors, clustered at the HS4-country-semester level, are reported in parentheses. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

A.3.2 Dynamic Effects of Notification on Export Participation

The table below reports the estimates corresponding to Figure 4. These estimates are obtained from the following specification:

$$y_{pdt} = \sum_{n=-A}^N (\alpha_n \text{NotifiedTBT}_{pd} + \beta_n \text{UnnotifiedTBT}_{pd}) \mathbb{1}\{\text{TBTtime}_{pdt} = n\} + \mu_{ipd} + \mu_{HS2,dt} + \epsilon_{pdt} \quad (11)$$

where NotifiedTBT_{pd} is defined as $\text{Notified}_{pd} \times \text{TBT}$, while The model builds on the identification strategy of the baseline equation and includes fixed effects μ_{ipd} and $\mu_{HS2,dt}$, thereby leveraging variation over time within firm–product–destination markets.

Table 14: Coefficients plotted in Figure 4 (dynamic specification)

Dependent variable: Participation	Estimate	Std. Error
$1\{\text{TBTtime}_{pdt} = -3\} \times \text{Notified}$	-0.001	(0.016)
$1\{\text{TBTtime}_{pdt} = -3\} \times \text{Unnotified}$	-0.025	(0.034)
$1\{\text{TBTtime}_{pdt} = -2\} \times \text{Notified}$	-0.019	(0.013)
$1\{\text{TBTtime}_{pdt} = -2\} \times \text{Unnotified}$	0.017	(0.032)
$1\{\text{TBTtime}_{pdt} = -1\} \times \text{Notified}$	-0.015	(0.014)
$1\{\text{TBTtime}_{pdt} = -1\} \times \text{Unnotified}$	-0.050	(0.033)
$1\{\text{TBTtime}_{pdt} = 0\} \times \text{Notified}$	-0.065***	(0.015)
$1\{\text{TBTtime}_{pdt} = 0\} \times \text{Unnotified}$	-0.089***	(0.033)
$1\{\text{TBTtime}_{pdt} = 1\} \times \text{Notified}$	0.001	(0.021)
$1\{\text{TBTtime}_{pdt} = 1\} \times \text{Unnotified}$	-0.068**	(0.027)
$1\{\text{TBTtime}_{pdt} = 2\} \times \text{Notified}$	0.010	(0.023)
$1\{\text{TBTtime}_{pdt} = 2\} \times \text{Unnotified}$	0.015	(0.024)
$1\{\text{TBTtime}_{pdt} \geq 3\} \times \text{Notified}$	-0.018*	(0.010)
$1\{\text{TBTtime}_{pdt} \geq 3\} \times \text{Unnotified}$	-0.044**	(0.018)
N	8 155 082	
R^2	0.771	
HS2–Country–Time FE	Yes	
Firm–HS4–Country FE	Yes	

Notes: Participation equals 1 if the firm records a positive export for product p to destination d in semester t . Robust standard errors clustered by (HS4, country, time) in parentheses. Significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.