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Agricultural Trade Costs

John C Beghin (UNL) and Heidi Schweizer (NCSU)¹

Abstract: This article tracks the recent evolution of salient trade costs in agricultural and food markets. We review ways to measure costs and conditions for policy prescriptions to reduce them when feasible. We pay attention to transportation costs, border measures, and standard-like nontariff measures. By pointing out limitations in current approaches and recent developments, we hope to improve our understanding of their effects. We suggest promising directions for further research and investigation of agricultural trade costs, including on the emerging debate on gene-editing and trade, transportation costs, and mainstreming recent approaches in disentangling effects of trade costs on supply, demand, trade, prices, and welfare.

JEL codes: F14, Q17

Keywords: Agricultural trade costs, transportation, tariffs, nontariff measures

1. Introduction and summary

This article looks at trade costs in agriculture and allied food markets and their recent evolution. By trade cost, we mean that a border is present between parties producing, moving, exchanging, and consuming goods. First, we take stock on what we know so far on major trade costs affecting these markets, and what can be done to reduce them, including guidance from international trade theory. Second, we provide practical suggestions for applied economists to account for these trade costs in economic analysis of agricultural and food markets.

We also indicate interesting data sources and suggest recent methodological approaches to capture and measure trade costs in economic analysis. Finally, the article also points out fruitful areas of future inquiry focusing on trade costs affecting these markets. A special emphasis is dedicated to transportation costs. With a few notable exceptions (for example,

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Blonigen and Wilson; Hummels; Hummels et al.; and Korinek and Sourdin) applied trade economists have neglected the wealth of information available on trade costs associated with transportation. We provide this information for agricultural trade with the hope of raising awareness about these data and fruitful future use of them.

Trade in agricultural and food goods is special in the sense that moving agricultural goods across markets is costly (Hummels) relative to farmgate value. These goods tend to be bulky and/or perishable and can affect human and plant health broadly defined if they do not meet quality standards. These trade costs, expressed as a share of the total value of the shipped agricultural good are high. This in contrast to the cost of shipping high-value manufacturing goods, such as a smartphone over the ocean (a few dollars in hundreds of dollars of the phone value landed in most OECD markets). In ad valorem form, agricultural trade costs are substantial but decreasing.

In addition to physical costs, protectionism lurks in these markets, both using traditional tariffs, tariff rate quotas (TRQs), and nontariff measures (NTMs). In contrast, manufacturing trade has been extensively liberalized in the last 70 years. The trade integration in manufacturing was achieved through multiple General Agreement on Tariffs and Trade (GATT) WTO rounds of multilateral negotiations and regional agreements. Agricultural policy and trade distortions were majorly addressed in the WTO’s Uruguay Round Agreement on Agriculture (URAA) starting in 1995. A few piecemeal agricultural policy changes came through the GATT before the URAA, but the URAA was the first comprehensive approach to address the many distortions present in these markets. The uncompleted Doha Round has been essentially stuck with no conclusion in sight. Little progress has been made in a multilateral fashion after the implementation period of the URAA, which ended in 2005. WTO negotiations on maritime transport services (used for agriculture trade) are also stalled.
Regional and bilateral trade agreements have significantly substituted for the lack of progress in multilateral liberalization and have provided a patchwork of unevenly lower tariffs, with some TRQs and the usual few remaining bastions of high protection in dairy, sugar, and cotton fiber. TRQs exist under regional and bilateral agreements, providing restricted access to particular U.S. trade partners like Australia and Dominican Republic-Central America Free Trade Agreement (CAFTA-DR) members, among others, and restricting access to other countries. Trade diversion remains. Gains in transparency have also been obtained on NTMs and via the WTO’s Sanitary and Phytosanitary Measures (SPS) and Technical Barriers to Trade (TBT) Committees and the trade-concern process (Orden; and Grant and Arita).

In contrast to this secular trend, since 2017, substantial trade policy disruptions have taken place creating substantial trade costs, using aggressive unilateralism, primarily in the United States. Predictably, the unilateralist policies have been followed by retaliations from trade partners targeted by these measures. Manufacturing sectors were targeted by the United States, but retaliatory tariffs hit U.S. agriculture substantially. Similarly, the temperamental renegotiation of NAFTA and hasty withdrawal from the Trans Pacific Partnership (TTP) agreement have had a disruptive effect on complex supply and value chains in agriculture and food markets (Bellora and Fontagné, 2019). The disruptions could lead to hysteresis from trade costs, with permanent loss of some foreign markets, as explained later. The United States has become a less dependable trade partner with new uncertainty-related costs for our trade partners. The topic of agricultural trade costs is timely.

The structure of the paper is as follows. We first set up a simple approach to characterize trade costs. Then the article reviews transportation policies and costs (policies, freight, insurance), and price and quantity-based trade distortions (tariffs, TRQs, export restrictions) and standard-like measures (NTMs, nontariff barriers, and transparency measures). For each of these
trade costs, we review prescriptions from economic theory to reduce them. Following the sequence, we provide some directions for fruitful research on agricultural trade cost. Appendix 1 contains detailed data sources for the trade costs covered in the article.

2. **A simple approach**

To set the stage, we start with a simple approach, paralleling Calvin and Krissoff, using a simple price transmission equation to express the law of one price between two locations ($A$ and $B$) across a border. We account for the exchange rate ($ER$) between the two currencies, per unit transportation costs (broadly defined) between the two locations ($TC$), price-based market-access impediments in both countries ($Tariffs$), nontariff measures ($NTM$), cost of uncertainty (hedging and insurance for exchange rate, transportation, and other risk), corruption and red tape cost in both countries, subsumed into an aggregate other trade cost ($OTC$). We have:

$$p_B = ER \times (p_A + TC_{AB}) + Tariffs_{AB} + NTM_B + OTC_{AB}.$$  

(1)

This simple approach is elaborated by incorporating imperfect substitution between the goods in origin ($I$) and destination ($D$) countries (Yue et al.; and Liu and Yue) with a simple CES approach of the form:

$$Max_{D,I} U(D, I, AOG) = \left(\alpha D^\rho + (1 - \alpha) I^\rho\right)^{1/\rho} + AOG,$$

with $AOG$ being an aggregate all other good, and parameters $\alpha$ and $\rho$ expressing preferences and the substitution between $I$ and $D$ ($\sigma = \frac{1}{1 - \rho}$). This leads to the following price transmission between the source country (good $I$ from $A$ to $B$) and the close substitute in the destination country (good $D$ in $B$) priced at price $p_D$:

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2 Border duties and other price based distortions can be expressed in ad valorem equivalent (in percent of the border price) or in specific form (in local currency units per physical unit added to the border price). Trade bans (import or export) have a tariff equivalent.
\[
p_D \frac{1-\alpha}{\alpha} \left( \frac{D}{I} \right)^{\frac{1}{\sigma}} = ER \ast (p_A + TC_{AB}) + Tariffs_{AB} + NTM_B + OTC_{AB}.
\]  

(2)

This approach allows us to derive trade and welfare implications, using the resulting demand and expenditure function from the CES structure in a consistent manner. One recovers the law of one price in (2) when \( \sigma \) goes to infinity and \( \alpha = 1/2 \). The CES structure also lends itself to the gravity framework used in many investigations of trade costs and their impact on trade and welfare. The price \( p_A \) itself could be affected by policies in \( B \), say, some SPS requirements. Equation (1) and (2) can be amended to reflect these additional costs to export to destination \( B \), and then \( p_A \) would reflect a general export price to any destination plus the additional cost to the specific destination \( B \).

Note that this approach focuses on variable trade costs and does not address fixed costs or prohibitive cost, such as those involved in the extensive margin of trade with new products or new partners (Scoppola et al.; Hejazi et al.). An average fixed cost can be added to the average variable trade costs, and it is scale dependent (Scoppola et al.). This addition is especially relevant for shipping cost as explained below and when thinking of the extensive margin of trade in new markets. Prohibitive trade costs can be accommodated econometrically applying the Kuhn-Tucker approach of Wales and Woodland to corner solution (Yue and Beghin). We briefly mention more elaborate approaches when needed.

Each component of these trade costs in equations (1) and (2) can incorporate a policy subcomponent. As we cover extensive ground already, we stay away from approaches using cointegration methods and thresholds to estimate “non-observable” trade costs, which obfuscate arbitrage between markets (Goodwin and Piggott; Lence et al.; and others). We also abstract from trade cost induced by distortions associated with domestic support via farm programs. We refer readers to the analyses of Smith et al., Orden and Brink, and Orden to learn of distortive
effects of these programs and compliance with WTO commitments to reduce these distortions.

3. Transportation costs

It is well established that bilateral trade decreases as geographic distance increases, and distance is a common independent variable within gravity models (Disdier and Head 2008). However, the circumstances where geographic distance is a good proxy for transportation costs ($T_{CA}$) is less understood and not straightforward (see Martinez-Zarzoso et al.; and Halaszovich and Krina). Given knowledge of transportation systems, it is possible to be more precise about the transportation costs both captured and uncaptured by geographic distance - even when direct transportation cost data are unavailable. The main components of transportation systems and costs are mode, infrastructure, technology, and policy, which are explained in sequence.

3.1. Transportation Mode

For measuring transportation costs, it is important to identify the transportation mode when more than one mode is probable. For example, ocean freight is the only relevant cost for shipping bulk grains from the United States to Europe or Asia (we need not consider air travel). Bulk shipping from the United States to Mexico or Canada may take place with any of the 3 primary modes (truck, rail, boat). Generally, economies of scale are captured with greater distances because the fixed cost of shipping via truck is less than rail, and shipping via rail is less than boat. Depending on data availability, mode choice is possible to assess though aggregate demand (modal split and behavioral) and disaggregate demand (behavioral and inventory) models.

Freight Analysis Framework data from 2012 - 2018 allows us to compare a bulk versus a

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3 Sources of direct transportation costs are listed in the appendix.
perishable refrigerated commodity, and internal versus external transportation mode choices. Figure 3.1 compares cereal grain and meat transportation modes of U.S. exports to exit zones, showing that rail and water transportation is more often used to transport cereal grains. Although the trucking may be more expensive than water or rail transportation of bulk commodities, trucking offers higher transportation service quality in terms of speed and reliability, which bears greater importance for meat. Also, the fact that meat needs to be refrigerated means that capturing economies of scale occurs differently.

Figure 3.1: Cereal grain and meat internal movements to U.S. exit zones by mode 2012-18

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4 The Freight Analysis Framework is a database that provides estimated historical flows and forecasted future flows of U.S. freight movements. Origin and destination, commodity, and transportation modes are specified. The primary data source is the Commodity Flow Survey, but agricultural movements are estimated using supplemental data (from USDA and Bureau of Census) since agricultural shipments are out-of-scope of the survey. See https://faf.ornl.gov/fafweb/

5 Reefer ships with meat in breakbulk are now obsolete, in the modern era meat is containerized and refrigeration occurs at the level of the container. Reefer containers have their own cooling system but need access to the ship power supply. Insulated units do not have their own cooling system, and must be plugged into the ship cooler system. This allows the environmental requirements to be different for each container depending on whether it needs to be frozen, chilled, or controlled (fruit).
Figure 3.2 compares cereal grain and meat transportation modes of exports from the United States also using data from the Freight Analysis Framework. Both products destined for countries non-contiguous to the United States are almost always exported via boat. However, most meat exports to Mexico and Canada are shipped via truck, while most cereal grains are exported to Mexico and Canada via water or rail. These graphs illustrate that (1) transportation mode shares for each good vary over time internally and externally, and (2) transportation modes vary based on country-pairs.

Figure 3.2: Cereal Grain and Meat Movements from U.S. Exit Zones by Mode 2012-2018

Gravity models provide the intuitive result that trade flows decrease when trade friction (specifically transport costs here) increases, however agricultural products have a variety of geographic, physical and market characteristics that can lend themselves to distinctive transportation profiles. Whereas transportation demand is derived demand for an agricultural

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6 Low volumes of higher value meats (such as fish) can be shipped via air to ensure freshness.
good, transportation supply consists of terminal costs, linehaul costs, and capital costs. Terminal costs include the handling at the origin, destination, and transloading. Linehaul costs include items such as fuel and equipment maintenance; and capital costs include equipment and infrastructure. These costs are heavily dependent on transportation mode choice and the measurements of transportation supply often address a single supply component for a specific mode. Measurements of physical capacity can include the number of lanes on a highway, which applies to linehaul costs, and the number of cranes at a port, which applies to terminal costs. Similarly, speed measurements apply to linehaul efficiency, while dwell time relates to terminal efficiency. Finally, there are inventories of capital stock in the road/rail/ocean freight networks. These measures can indicate congestion at a terminal or along a route, and transportation equipment availability.

The usual indirect measures correlated with transportation costs included in gravity models are distance (continuous), adjacency (dummy), island (dummy), and landlocked (dummy). Each of these independent variables give insight to transportation mode choices and transportation cost. Islands are only accessible via water or air, landlocked countries are not accessible via water, and every transportation mode will require greater fuel to travel greater distance.\footnote{A landlocked country may have access to a canal system, but the goods will still need to be transloaded onto a different type of vessel before it reaches the destination country.}

We ideally hope to capture how additional distance or changes to transportation costs affect marginal trade flows as transportation profiles and transportation system performance vary. For example, the marginal change in flows between two countries due to increased fuel prices will differ based on the transportation profile of the commodity. Information about mode can be used to further accuracy, even in the absence of direct cost measurements. Data are often
available for transportation mode, or reasonable assumptions can be made, for internal transportation mode of the exporting country, the transportation mode between countries, and the transportation mode of the importing country. Given that transportation costs vary over time and by mode, the information can be used to build a panel with transportation information that varies over time and by country pair.

3.2. Infrastructure

Because infrastructure determines which inland modes are possible, as well as affecting both the fixed and marginal costs of each possible mode, the quality and quantity of infrastructure can significantly affect trade flows. Often, authors will use or create an index to quantify many facets of infrastructure. Commonly used indices are listed in appendix 1 and most include elements such as the number of distribution facilities, hub throughput and capacity, road/track density, as well as qualitative assessments from industry. Ultimately, these indices reflect the contribution of infrastructure on the supply of transportation services.

While infrastructure is a main component of transportation systems, infrastructure variables are not as conveniently incorporated into panel data analysis compared to other transportation data. First, due to the nature of infrastructure projects, there is often little variation year-to-year. Second, the indices readily available are not specific to the infrastructure facilities relevant to certain agricultural goods (for example bulk or cold chain). Third, specific to the context of trade, expanding transportation infrastructure and increasing trade flows often occur simultaneously, and the direction of causality is ambiguous. For example, Bensassi et al. show infrastructure increases Spanish exports while Nguyen and Tongzon find that growth in trade with China results in Australian transport sector growth.

Complicating analyses for agricultural goods is the fact that agriculture is seasonal, which results in peak-demand times for transportation services. Highly seasonal production strains
storage, processing, and transportation facilities causing congestion when transportation demand exceeds transportation system capacity.\footnote{Likewise, supply disruptions can cause congestion, such as Mississippi River flooding halting barge traffic.} The pressure seasonality puts on infrastructure is difficult to capture on an annual basis, but could be used to weight annual transportation prices, or provide annual variation on infrastructure availability. Though it is usually more feasible to capture seasonality within a general equilibrium, partial equilibrium, or multi-market model, infrastructure can still provide important insights for agricultural goods if there exists information on the status of critical infrastructure or within-year flows.

3.3. Distortions/Policy

As with the previous components of transportation systems, policies that distort transport costs can be applied at the origin region, along a route between an origin and destination, and in a destination region. Origin (or destination) specific policies may affect internal transportation costs, external transportation costs, or both. External transportation costs may also be affected by trade and environmental agreements.

Examples of U.S. policies that distort internal transport costs – through all three types of transport cost – include the Foreign Dredge Act of 1906 and the USDOT electronic logging device mandate that went into effect in 2017. The Foreign Dredge Act of 1906 prohibits foreign dredgers from dredging in the United States. Rivers and ports require dredging for both maintenance and improvements, and reduced competition among dredging firms ultimately increases the costs of waterway and port infrastructure. Navigation restrictions due to foregone waterway improvements result in excess freight traveling via more expensive modes. Compare this type of policy to the electronic logging device mandate which requires nearly all commercial
trucks to have electronic devices recording hours-of-service in addition to other data.\(^9\) Although
this policy was not a change in hours-of-service rules per se, it was a large change in the
enforcement of these rules. With electronic logs, drivers have less flexibility over how their
dwell time at terminals is recorded, increasing terminal costs. Despite the divergent nature of
these policies, they both result in mode-specific changes to internal transportation costs.

Along with the Foreign Dredge Act of 1906, the 1920 Merchant Marine Act (also known
as the Jones Act) is an example of national policy that increases external costs. The main
segments of the 1920 Merchant Marine Act specify that goods shipped between U.S. ports must
be shipped on vessels that are U.S. built, U.S. flagged, owned by a company that is at least 75
percent U.S. owned, and crewed by a minimum of 75 percent U.S. sailors. This policy applies
specifically to domestic shipments, but limits options to reposition containers used in
international trade.\(^{10}\) Without a feeder-ship market, containers are shuffled on land resulting in
more expensive terminal costs (Bain and World Bank; Frittelli; and Smith et al.).

Finally, the International Maritime Organization (IMO) changed external trade costs for
nearly all maritime trade partners with new emissions regulations effective January 2020. The
regulation prohibits vessels from using high sulfur fuel oil. The main shipowner compliance
options are to switch to marine gasoil or liquefied natural gas, install scrubbers, or scrap the
vessel. More expensive fuel directly increases linehaul costs, while converting engines to use
alternative fuels and installing scrubbers increase the costs of capital stock. This policy is likely
to affect segments of maritime markets differently depending on fleet composition, the
possibilities for alternative routes, and the degree to which member states enforce the regulation

\(^{9}\) There are some exemptions to hours-of-service rules for agriculture. [https://www.fmcsa.dot.gov/hours-service/elds/eld-hours-service-hos-and-agriculture-exemptions](https://www.fmcsa.dot.gov/hours-service/elds/eld-hours-service-hos-and-agriculture-exemptions)

\(^{10}\) There is an exemption for empty containers.
In general transportation-specific policy will vary most by country rather than over time. As demonstrated in the examples provided in this subsection, the policies for an importer or exporter can have a direct effect on any of the three main types of transportation costs for both internal and external trade costs. Also note that these distortions will influence behavior within transportation systems.

3.4. Technology

Technology improvements take many forms and may reduce any cost component mentioned in 3.1 – however, some developments in technology have the potential to reduce several cost components at once. This type of technology underscores the system aspect of transportation by allowing for holistic views of transportation movements (and supply chains more broadly). Both private industry and policymakers are placing increased scrutiny on agricultural supply chains following the 2020 coronavirus pandemic and in expectation of increased frequency of extreme weather events. When transportation systems fail to meet demand for an extended period of time, these are defining moments – and these moments are partly responsible for the widespread movement away from just-in-time inventory and supply chain management strategies towards strategies with more robustness and resilience (Behzadi et al.).

Although new technology for transportation equipment is quickly advancing, the innovations that have the greatest promise for reducing costs related to transportation are being made in the inventory and supply chain management spaces. Often overlooked by those outside the industry, freight forwarding firms play an important role in reducing bureaucratic and price discovery costs in transportation markets. Freight forwarders are experts in the complete process of moving freight from an origin to a destination. They manage negotiation of rates, payment, customs paperwork, insurance, and delays. There can be specialization by region, transportation
mode, and type of good. The proliferation of tracking and management technologies being applied to improve supply chains provide firms in transportation and these adjacent spaces opportunities to improve their service quality. Examples of these technologies include distributed ledgers and remote sensors, which can speed up customs paperwork, verify environmental conditions throughout the journey, and facilitate cross-border contract enforcement.

Measures related to institutions and corruption, such as those available from the World Bank or Transparency International (see appendix 1 for these data sources), relate to bureaucratic costs that occur during transportation and handling that tracking and sensor technologies are targeted towards reducing. Although faster and more reliable border processing can benefit any type of good, perishable products especially benefit from reduced spoilage. Time delays as measured by requirements to export and imports in Doing Business (World Bank) have been shown to reduce trade flows of perishable agricultural goods (Liu and Yue). We expect that implementation of technologies especially relevant to time delays in agriculture trade will improve these estimated effects. In addition to direct measures of technology, measures of institutional quality and importer/exporter dummies can control for some of the variation in transportation technology.

4. The reduction of agricultural tariffs and associated border distortions

4.1. Tariffs

Tariffs are a brunt and untargeted policy instrument, which have historically been a major source of trade costs (Anderson and van Wincoop). Tariff reduction has been a robust policy

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11 Freight Forwarders will often accept and organize less-than-truckload shipments not accepted by major carriers. However, this is not the case for perishable products as opportunities are infrequent. These firms are not to be confused with brokers, because forwarders often do handle freight in their warehouse facilities. They are also not to be confused with carriers, because they typically do not own transport equipment. There is some overlap between freight forwarders and third party logistics providers (3PLs) who will also handle supply chain tasks, such as inventory management, in addition to shipping.

12 Other variables that may control for some portion of transportation technology are largely context-dependent, for an example see Pascali (2017).
recommendation to increase trade and improve welfare, both on theoretical and empirical grounds. For example, early work by Hatta and others paved the way to a large theoretical literature identifying sufficient conditions for welfare-improving piecemeal reforms involving tariffs alone and tariffs with other distortions including those affecting agricultural trade (Hatta; Falvey; Neary; Beghin and Karp; and Anderson and Neary). Empirical exercises have also established the welfare gains and distributional consequences of tariff reductions in agriculture and other sectors (Goldin and van der Mensbrugghe; and Anderson et al., 2006).

Agricultural tariff structure is complicated and highly heterogeneous across goods and countries. Tariffs can be specific (x dollars per physical unit) or ad valorem (in percent of unit price $p_A$) or both combined. In addition, WTO member countries commit to tariff bindings (not to be exceeded) within the WTO. Then they define Most Favored Nation (MFN) tariff which can be applied to transactions with other member countries, or with countries having MFN status without being a WTO member (e.g., China before its WTO membership received MFN status in the United States, renewable yearly).

Further, applied MFN tariffs are often superseded by preferential tariffs established in regional trade agreements (RTAs), such as the US-Mexico-Canada (USMCA) agreement. These RTAs often have their own bindings and applied rates. Many RTAs have reciprocal zero tariffs on many trade flows. Frequently, tariff concessions are subject to rules of origin to preserve the trade diversion created by the RTA, which benefits producers within the RTA and hurt consumers/users in the RTA through higher prices than would prevail with global free trade. This trade diversion also hurts exporters outside of the RTAs. Trade diversion has decreased given the multiplicity of RTAs and the lowering of tariffs in most countries.

Despite the complex and heterogeneous structure, tariffs on agricultural trade are now low on average compared to pre-1995 levels. However, they remain higher than those on
manufacturing goods. To illustrate, the United States has MFN bound tariffs averaging 4.9% (ad valorem equivalent) in agriculture (simple average), and 3.2% in manufacturing. Applied MFN tariffs are 3.9% on average in agriculture (trade weighted average in 2017), and 2.2% in nonagricultural sectors. To provide perspective, Gibson et al. estimated that in 2000, U.S. agricultural tariffs were around 12%. Bureau et al. (2019) also show the substantial global decrease in agricultural tariffs from 2001 to 2013.

The distribution of agricultural tariffs indicates that roughly 39% of U.S. agricultural imports enter duty-free, 40.5% enter at rates between 0 and 5%, and 13.5% enter at rates between 5 and 10%. Table 4.1 shows these bound and applied MFN tariffs by sector for the United States, dairy products, sugar and confectionery, and beverage & tobacco remain protected, with limited imports entering duties free. Tariff data are available for most countries (see Appendix 1).

<table>
<thead>
<tr>
<th>Product groups</th>
<th>Final bound duties</th>
<th>MFN applied duties</th>
<th>Imports</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AVG Duty-free in %</td>
<td>Max Binding in %</td>
<td>AVG Duty-free in %</td>
</tr>
<tr>
<td>Animal products</td>
<td>2.4</td>
<td>30.8</td>
<td>26</td>
</tr>
<tr>
<td>Dairy products</td>
<td>19.2</td>
<td>0.3</td>
<td>127</td>
</tr>
<tr>
<td>Fruits and vegetables, plants</td>
<td>5.0</td>
<td>20.2</td>
<td>132</td>
</tr>
<tr>
<td>Coffee, tea</td>
<td>3.0</td>
<td>53.5</td>
<td>23</td>
</tr>
<tr>
<td>Cereals &amp; preparations</td>
<td>3.6</td>
<td>21.0</td>
<td>47</td>
</tr>
<tr>
<td>Oilseeds, fats, &amp; oils</td>
<td>4.5</td>
<td>23.9</td>
<td>164</td>
</tr>
<tr>
<td>Sugars and confectionary</td>
<td>13.1</td>
<td>2.9</td>
<td>67</td>
</tr>
<tr>
<td>Beverages &amp; tobacco</td>
<td>15.1</td>
<td>27.7</td>
<td>350</td>
</tr>
<tr>
<td>Cotton</td>
<td>5.0</td>
<td>38.3</td>
<td>19</td>
</tr>
<tr>
<td>Other agricultural products</td>
<td>1.2</td>
<td>58.9</td>
<td>51</td>
</tr>
</tbody>
</table>

4.2. Tariff rate quotas (TRQs)

To further complicate matters, several of these imports, often deemed “sensitive products” are regulated with tariff-rate quotas (TRQs), a two-tier tariff scheme. To increase market access, the
WTO created TRQs to replace quotas by structuring a low tariff (in-quota tariff) for imports up to the existing or former quota and a much higher tariff (out-of-quota tariff) for imports above the quota (Boughner et al.; and Moschini). TRQs continue to create inefficiencies as former quotas did. The hope was that in subsequent WTO negotiations, two-tier tariffs could be reduced, and quotas expanded. This has not taken place, although quota allocations have expanded through RTAs and preferential trade agreements (PTAs). The administration of TRQs has been a recurrent issue in some countries (Boughner et al.; Chen et al.; and Orden), but not all (e.g., see Barichello on Canadian dairy TRQs). TRQs remain unfilled because rights to exports were allocated to uncompetitive exporters. Rights to import are often allocated inefficiently when there is no mechanism to re-allocate the rights when they are not used, leading to quota under-fill. In some cases, protectionism is the motive to systematic under-fill of the quota, such as found in the US-China dispute (DS517) on Chinese TRQ management for grains (Orden).

In their simplest form, TRQs introduce a discontinuity in equations (1) and (2) with the tariff change once the quota is filled (Moschini; and Boughner et al.). Out-of-quota tariffs are often prohibitive. This possibility complicates the computation of the trade cost element of the TRQs, since the out of quota tariff will overstate the cost of the price-equivalent effect of the TRQ when it is binding. In addition, quality upgrades can occur when exporters face managed trade or when shipping cost per unit is fixed, reducing the relative price of the higher quality good (Ramos et al.). These reasons can lead to “shipping the good apple” out (Ramos et al.; and Hummels and Skiba). TRQ data are widely available from the WTO and other sources.

4.3. Regional and preferential trade agreements

The key reason agricultural tariffs have fallen globally reside in RTAs and PTAs. For example, when looking at trade with RTA partners, the United States has much lower tariffs on its imports than the applied MFN tariff rates suggest. Specifically, most agricultural imports coming from
Canada and Mexico enter duty-free (92.3% of agricultural tariffs lines for Canadian exports and 97.5% of tariff lines for Mexican agricultural exports) representing 99% of agricultural trade value with these countries (WTO, 2019). Here again, a few agricultural trade flows within the USMCA are restricted by TRQs (e.g., Canada dairy imports) and managed trade (sugar flow from Mexico to the US). Despite these exceptions, agricultural trade flows have been greatly and globally liberalized with RTAs, such as the USMCA and continue to be with new agreements such as the Comprehensive and Progressive Trans Pacific Partnership (CPTTP).

Beyond tariff schedules, countries use safeguards and countervailing duties (CVDs) in some special situations, in general, involving some injury or disruption test. The latter can be subject to political pressure, as it was the case for rising sugar imports from Mexico to the United States in 2013-14, leading to U.S. anti-dumping and countervailing duties on Mexican sugar coming into the United States. These duties were later suspended in favor of a managed trade regime capping Mexican exports to the U.S. market (Beghin and Elobeid). The reliance on safeguards and CVDs has not led to major trade impediments. To illustrate, from 1995 to end of 2019, 185 safeguard measures have been notified to the WTO (see 550a) on safeguard measures). When compared to other policy notifications, this number is small. India, Indonesia, and Turkey are the largest initiators of safeguards. 18 dispute cases have mentioned safeguards in agriculture and food markets. A single contentious safeguard often leads to multiple dispute cases by different WTO members.

Many OECD and other advanced economies have been entering a series of RTAs since the early 1990s, at a steady pace (see WTO Regional Trade Agreements Database). In addition, the coalitions of members in some of these RTAs have become large (e.g., eleven countries in the CPTPP, various EU-27 agreements with other countries).

Tariffs have also decreased through unilateral decreases, outside of agreements as
documented by Bureau et al. (2019). Finally, tariffs have fallen via various PTAs, which provide non-reciprocal tariff concessions, many of them to least developed or developing countries. These PTAs have increased market access in many OECD countries. Rules of origin constrain these concessions, however. Major agricultural tariff concessions have been made with PTAs as illustrated in Table 4.2 for the United States, with many tariff lines being tariff-free, under Generalized System of Preferences (GSP) and the African Growth Opportunity Act (AGOA) (Tadesse, and Fayissa; and Williams). The EU made comparable concessions under the Everything but Arms Initiative (EBA) (Brenton).

These tariff concessions have had a more limited impact on agricultural exports of less developed countries (LDCs), because of rules of origin, TRQ exclusions, SPS requirements, and other supply chain constraints in countries eligible for the tariff concessions. To illustrate these tariff patterns, in 2018 the United States imported about $128 billion of agricultural goods, of which 39% entered MFN duty free; $20 billion came from countries beneficiaries of GSP extended by the United States, 80% of which entered under PTA or RTA benefits; agricultural imports from LDC-beneficiaries amounted to $1 billion, 80% of which entered under PTA or RTA benefits (WTO PTA database). Over time, tariff preferences under PTAs have eroded relative to prevailing tariffs outside of the PTAs, because countries entered RTAs or gained market access under MFN tariff concessions under the URAA (Bouët et al.; Bureau et al., 2006).

An important element of most RTAs and PTAs is the expectation and commitment to transparency. WTO members provide sufficient information on the various concessions they make on tariffs, the associated rules of origins, NTMs, such that trade partners can take advantage of these concessions. Transparency is addressed more in depth in the section on NTMs.

With these two trends (larger and more numerous RTAs), agricultural tariffs have
continued to fall globally, despite the lack of progress in the Doha Round of negotiations of the WTO for further agricultural tariff cuts, and despite the trade policy departures initiated by the Trump administration and the resulting higher tariffs facing U.S. commodity exports.

4.4. The Trump trade integration hiatus

The U.S. departures in trade policies include exiting the Trans Pacific Partnership agreement (TPP) in early 2017, raising tariffs on trade partners in a return to “aggressive unilateralism,” not seen since the Reagan era, in the last three years (Elliott and Richardson; Elliott and Bayard; Fajgelbaum et al.; and Orden). The hiatus also includes stalling the Transatlantic Trade and Investment Partnership (TTIP) negotiations with the EU, and making the WTO dispute settlement and appeal processes nearly inoperable (Orden; and Bown and Irwin). The latter was undertaken by blocking the appointment of judges of the WTO Appellate Body. As reported by Elliott and Bayard and Elliott and Richardson, unilateralism in the 1980s rarely led to trade wars and was moderately successful at gaining market access. In contrast, the trade war with China and other partners on metallic and other products has been bruising for U.S. agricultural commodities (and other sectors), with no end in sight. The unraveling of the phase-one US-China agreement and unmet agricultural export targets are new realities (Balistreri et al.; Chepeliev et al.; and Orden). Many retaliatory agricultural tariffs remain in place and market access has not improved significantly, especially under the disruption brought by the global pandemic.

In addition, Mexico was pressured by the Trump administration to renegotiate NAFTA with threats of tariffs being re-imposed on its trade flows as late as June 2019. The negotiation has taken place in the context of Mexico having 14 FTA/RTAs in place with 50 countries including the EU-27 and EFTA countries, the 2018 11-member CPTPP, and the upgraded USMCA (Villarreal, 2017; WTORTA, 2020). In the last two decades, Mexico has signed a series of RTAs with Central and Latin American countries to integrate into the Americas beyond the
USMCA. An implicit objective has been to diversify its export prospects and decrease its dependence on the U.S. market for its exports. The actual gains to U.S. agriculture and economy from the USMCA are modest (Chepeliev et al.) relative to the original NAFTA.

Finally, the Trump administration’s early decision to not ratify and leave the TPP agreement was a major blunder, which has penalized U.S. agricultural exports through trade diversion (Bown and Irwin). The remaining eleven TPP partners concluded the CPTPP, which provides preferential market access to its members. U.S. exports are penalized by tariff differentials in these countries unless an agreement exists with that country. For example, Australian beef gets into Japan at a lower tariff rate than U.S. beef does. The United States has agreements with Canada, Mexico, and Japan, which mitigate the trade diversion. Nevertheless, a major opportunity has been lost.

4.5 Export distortions, and bans

Agricultural export distortions were much restricted under the URRA and eventually eliminated through a multilateral agreement in 2015 (Orden). The EU removed most of its agricultural export subsidies with its EU Common-Agricultural-Policy reforms, which became unsustainable under the EBA initiative and commitments under the WTO. Implicit export subsidies remained an issue through other components of farm policies distorting world trade. For example, the former U.S. cotton program, which led to the long US-Brazil dispute at the WTO (DS 267), provided implicit export subsidies and distorted world cotton prices. The current U.S. cotton program is potentially as distortive as the older one, with a negative effect on world prices (Smith and Glauber). Fortunately, this type of egregious case is uncommon.

The topic of export distortions has re-emerged in the ramping up of world prices in 2005-10 but with a twist. Export restrictions were the new issue rather than subsidies. Countries with large grain production, especially rice, imposed export restrictions attempting to secure cheaper
domestic supplies. These restrictions actually exacerbated the original price increases (Martin and Anderson) and induced further price volatility and uncertainty by lack of collective action. With the 2020 global coronavirus pandemic, worries were voiced again that some countries might re-iterate with grain export restrictions (Martin and Glauber; WTO, 2020b; and OECD, 2020), although so far these trade impediments have been limited. Ample world supplies temper the concerns of price increases.

5. Nontariff measures (NTMs)

5.1. Trade costs related to standard-like NTMs

Standard-like NTMs have proliferated in the last twenty-five years as suggested by annual reports of the SPS and TBT committees of the WTO. For example, In excess of 26,000 SPS notifications have taken place at the WTO since 1995 (SPSIMS WTO). An even larger amount of TBT notifications has taken place (see WTO IMS). Perishable agricultural products tend to be subject to more regulations and standards (Disdier and van Tongeren; Grant and Arita). These measures have created trade frictions, and concerns among trading partners, many officially reported at the WTO. For example, 469 SPS-specific trade concerns have been logged with the WTO SPS Committee (as of July 2020) and 49 formal disputes have been initiated citing the SPS agreement, leading to 19 fully developed cases. Similarly, official concerns and disputes have been caused by TBTs, many of them affecting trade of agricultural products. So on face value, standard-like measures have been a major source of trade costs.

Many of these concerns have remained unresolved (see Figure 5.1, and Grant and Arita for a detailed analysis of SPS concerns up to 2017). Specifically, out of the aforementioned 469 SPS concerns, 267 of them remain unresolved. Only 168 (36%) of them were fully resolved, and 34 were partially resolved. Similarly, the Dispute Settlement mechanism at the WTO offers a slow resolution to disputes, especially on SPS matters. Disputes are long enough to cripple any
foreign firm with unfair practices for years. Even when disputes reach a conclusion, the condemned practice may remain in place at a small price. To illustrate, the US-EU dispute on growth hormone took 13 years to be resolved and the EU market is still closed to U.S. beef, which comes from animals having received growth hormones. The EU is willing to face U.S. duties on selected products for not opening its market, and has allowed some hormone-free U.S. beef to enter the EU.

Frictions and disputes on SPS and TBT measures related to food also reflect cultural differences with respect to food, beyond protectionist motives. Josling, and Heumueller and Josling have offered a lucid disambiguation of these two motives as they looked at food labelling requirements for GMO-free products. They explain how to consider ethical considerations such as the desire to eat GM-free food and the right to avoid deceptive practice. Simultaneously, protectionism can be minimized by requiring evidence of consumer preferences for a label or characteristic.

![Pie chart showing WTO SPS concerns from 1995-2019 and their resolution (Source: WTO 2020)]

**Figure 5.1. WTO SPS concerns from 1995-2019 and their resolution (Source: WTO 2020)**

Despite these NTM frictions, agricultural trade has expanded vastly during the same period, as noted earlier. Hence, the frictions have not constituted prohibitive barriers, except for outright import bans, many of them during epizootic episodes. Back-of-the-envelope estimates
by Grant and Arita suggest that SPS concerns have had large negative effects. However, more formal analysis would be enlightening. Transparency requirements and periodic consultations in many trade agreements have helped to contain trade costs associated with SPS concerns, as we explain below.

The remainder of this section describes the trade costs associated with these standard-like measures and their impact on trade and welfare. We first review the simple economics of these standards, then we address their potential protectionism. We then discuss transparency requirements present in many trade agreements and their impact on trade costs associated with NTMs.

5.2. The economics of standard-like NTMs

The economics of standard-like NTMs have been extensively covered, notably by Josling et al. (2004), and in earlier investigations (e.g., see Bureau et al., 1998; and Tian). Standard-like NTMs include technical barriers to trade (TBTs) and SPS regulations, as well as other “technical” NTM policies affecting the quality or the way goods are produced and marketed to final users. See the MAST classification for more details on these policies (UNCTAD). These NTMs have common effects on markets, which allow economists to use a common economic approaches to analyze them.

Broadly speaking, they affect the supply of a good by increasing its cost at the margin, by using extra resources to meet the standard or requirements of the policy. This often has a negative impact on domestic supply and competing imports in the sense of increasing their marginal cost, sometimes asymmetrically, depending on the relative ability of domestic and foreign suppliers to meet the standard. In addition, the standard may affect the demand for the good, as consumers may react to the standard if they know about it. For example, lower pesticide residue levels may induce consumers to consume more of a good. A warning label may deter
consumers and shift demand to the left. These effects of standards are summarized for a small country case (with an exogenous world price, \(wp\)) in Figure 5.2 borrowed from Beghin et al. (2015a).

In the Figure, domestic supply \(y\) shifts to the left to \(y'\) once the policy NTM is in place. World supply also shifts up to reflect the additional cost of meeting the new standard. The new additive cost is expressed in ad valorem equivalent, \(t(NTM)\). The new world supply is now at \(wp + t(NTM)\). In the same figure demand \(x\) is shown to have shifted to the right to \(x'\), presumably with a policy measure, which encourages consumers to consume more, say, because the product is now known to be safer or more nutritious. What is the trade cost effect of this NTM policy? The answer depends on what impact is being measured. The unambiguous impact on prices is a higher border price (from \(wp\) to \(wp + t(NTM)\)).\(^{13}\) The impacts on trade and consumption are often ambiguous. Imports could increase because domestic supply has shifted to the left and because demand has shifted to the right. These two effects have to be compared to the impact of the higher price on imports. Similarly, the effect on net consumption may be ambiguous, comparing the price impact and the demand shift to the right.

\(^{13}\) See Cadot et al. for a discussion of the increase in price induced by NTMs. One could come up with some extreme counterexample of a world price decreasing because of a new standard, but this is farfetched in most cases.
Figure 5.2. The impact of a standard-like policy on supply, demand, price, and trade

This simple framework strongly suggests that inferring trade cost from the impact of the NTM on trade flows will be complicated if not erroneous, if the impact is not decomposed into a price effect and the respective impacts on domestic supply and demand. This problem has plagued many investigations of standard-like NTMs, which have found positive, negative and insignificant effects on trade. Significant negative effects are often posited without rigorous justification or imposed on data from misguided intuition, using the analogy of tariff and border taxes.

The majority of empirical investigations have focused on the net trade impact without decomposing the separate impact on supply and demand. For details on these various estimated effects, see the meta-analyses of Li and Beghin (2012), and Santeramo and Lamonaca, and the review of Beghin et al. (2015b).

This is not to say that other NTMs are not trade restrictive or protectionist (See Hillman for an example of such a case). The UNCTAD MAST taxonomy and NTM database provide an extensive list of NTM distortions, other than technical NTMs (the standard-like measures discussed here) (UNCTAD; and de Melo and Nicita). Figure 5.2 also suggests that market imperfections, such as externalities and asymmetric information can be remedied by these standards (e.g., the shift of demand reacting to information). In general, one needs a more complex framework to address the market imperfection (see Disdier and Marette; van Tongeren et al.; and Wilson and Anton for partial equilibrium approaches; and Beghin et al., 2015a for an economy-wide approach).

Beyond getting rid of protectionist standard-like NTMs, international trade theory does not provide guidance on welfare improving policy reforms. This is unlike for taxes and tariffs. Establishing protectionism takes place at two levels, one easy one, and one more complex. The
easy tests of protectionism deal with the violation of basic tenets of WTO agreements (Hooker and Caswell). Standards have to be based on a risk assessment and proper science, or address potential informational asymmetries (Wilson and Anton; and Grant and Arita); they have to meet domestic treatment (no discrimination between domestic and imported of like-products). Precautionary measures cannot last without establishing the science; and all measures should be least-trade restrictive for a given correction level of a market imperfection (see Marette for the analysis of the choice of instruments).

The WTO also encourages but does not require use of international standards, such as those established by CODEX Alimentarius. As countries face specific conditions, a standard could deviate from international ones without being presumably protectionist. However, systematic deviations from international norms to impose more stringency than that implied by international standards should be met with skepticism. Li and Beghin (2014) provide such investigation on pesticides and veterinary drug residues. They show that the EU, Taiwan, Australia, and Turkey systematically exceed the stringency of CODEX when they set their standards. Beyond the issue of level of the NTM policy instrument, the enforcement of these policies could also be protectionist, say, using arbitrary inspection criteria leading to refusals (Grundke and Moser; and Baylis et al.).

Beyond these simple tests, establishing protectionism is more complex, in the presence of market imperfections. The presence of market imperfections justifies the presence of a standard-like NTM, but its exact level of stringency has to be determined. Baldwin (1970) and (2000), and Fisher and Serra define the non-protectionist standard as the one maximizing global welfare. A domestic social planner maximizing just domestic welfare could set up the optimum standard at a protectionist level, inducing a barrier to imports and hurting importers (Fisher and Serra). The criterion is conceptually clear but difficult to implement empirically for at least two reasons.
First, many standards and policies are set at once leading to the issue of how to account for their interactions and optimum levels. Second, what “global” means is quite subjective in terms of the country and market coverage (close substitutes, cross-price effects).

In addition, several authors have added political economy dimensions to the analysis of protectionism of technical measures. This addition generates more ambiguity in results. The standards can actually be set below their optimum level and be anti-protectionist, depending on rent-seeking influence and the ease of meeting the standard for example (Swinnen and Vandemoortele, 2008 and 2011).

The last element to integrate is the transparency of standard-like NTMs. Non-transparent standards act as a tax on trade and reduce welfare, independently of their level of stringency. We discuss transparency next.

5.3. Transparency and trade costs

Transparency is an intuitive yet vague concept. In the context of the WTO, it means clarity in regulating economic activity and trade. The objective is to achieve a greater clarity, predictability and information about trade policies, rules and regulations of WTO Members. A pivotal element is the use of notifications. Under the SPS Agreement, notifications are used to inform other Members about new or changed regulations that may significantly affect their trading partners. Transparency under the SPS Agreement also includes answering reasonable questions, and publishing regulations. Trade costs induced by these NTMs can increase when these policies are not notified properly or not spelled out properly.

Beyond the WTO, many RTAs have transparency clauses or chapters on proper notifications, approval processes for biotechnology innovations, reciprocity, and other measures to reduce unnecessary transaction costs to meet these NTMs.

RTAs with “deep integration” objectives do reduce the price wedge ($t(NTM)$) (shown in
Figure 5.2) created by standard-like NTMs, as shown by Cadot et al., and Cadot and Gourdon. The latter authors decompose the impact of NTMs on prices and supply and demand in a unique framework combining price differential created by NTM policies, and the framework of Xiong and Beigbin to decompose the impact of standard-like NTMs on supply and demand. They find that RTAs with more extensive transparency measures reduce the price wedge created by NTMs. Transparency remains difficult to measure, despite some attempt to formally conceptualize what it is (van Tongeren).

While it is difficult to pin down an estimate of the cost of the lack of transparency, recent studies (Ing, et al., 2017; Lejárraga et al., 2013)) have estimated the implicit reduction in trade cost from transparency efforts in nontariff measures, often achieved through deep integration. Several studies rely on a gravity approach using variation in perceived government transparency broadly defined. Lejárraga et al. (2013) reviewed a large number of RTAs and collected their transparency provisions (e.g., notification requirements for SPS and TBT). The collected variables are incorporated in a gravity framework to gauge their effects on bilateral trade flows. Not surprisingly, the transparency provisions do facilitate trade with RTA members.

Ing et al. follow Wolfe and his 3-levels of transparency requirements in the WTO (early requirements through notification obligations in the GATT, monitoring through countries policy reviews, and finally dissemination of information through web-based instruments and portals). Portals are mandated by the 2014 WTO Trade Facilitation Agreement (from the “Bali” agreement). The latter information allows for direct measurement of transparency measures rather than perceptions using NTM inventories. Ing et al. construct a transparency index for 187 countries, available in the appendix of Ing et al. The index is currently a cross section index but could be updated into a panel indicator as time elapses. The WTO Trade Facilitation Agreement (TFA) entered into force in 2017. The authors show unsurprisingly that OECD countries tend to
have the highest level of transparency given their institutional capacity. Several measures included in their index could be easily updated over time from 2017 on, such as the existence of a TFA portal to provide a partial measure of transparency.

The measures developed by Ing et al. correlate imperfectly among themselves and with government transparency scores from the World Economic Forum for its global competitiveness index and the World Bank’s policy and institutional assessment (see appendix 1 for sources). These new transparency measures and index of Ing et al. could be used in the typical gravity framework to characterize the impact of transparency on trade flows. The lack of time variation is an issue. The Global competitiveness index of the World Bank and the Country Policy and Institutional Assessment indices have time variation as an asset. Transparency measures are important for agriculture in the case of approval of biotech products for example. It features prominently in new trade agreements like the China-US phase one agreement (USTR).

6. Promising research directions on trade costs

6.1 Gene editing and trade

A promising area of research on agricultural trade cost originates with biotechnology and new plant breeding technologies (NPBTs). New and more precise biotechnology tools have emerged to create novel food or attributes in a more targeted way (Qaim, 2020). These new tools seemed to be able to avoid the missteps, which plagued GMO innovations in agriculture and food markets and their low acceptability among consumers in many countries, including the United States. These NPBTs are key to maximize agriculture’s productivity, profitability and sustainability, to supply a continually increasing world demand for protein and oil for feed, fuel and food (Anderson et al., 2019; Qaim, 2020). NPBTs are more precise tools to change the genome of plants. They often use the plant’s own genome or the genome of related plants
through cisgenesis. Despite the safety of these “gene-editing” techniques, new evidence suggests they may be controversial with environmental groups, and consumers, although not as much as GMO were (NAS; Caputo et al.; and Marette et al.). These apprehensions are internationally present (Marette et al., 2020; Qaim, 2020; and Schmidt et al.).

There are emerging frictions over NPBTs used to innovate in agriculture and food markets (Bain et al.; Bunge and Dockser Marcus; NAS; Martin-Laffon et al.; Qaim, 2020; and Schmidt et al.). Novel food and attributes in agricultural goods have to be assessed for the potential risk they may create for human health and the environment. Regulations in many countries are process-oriented rather than product oriented, and legacies of GMO regulation (Schaefer; and Schmidt et al.). Even in the United States, novel foods obtained through transgenic biotechnology are regulated differently than the same novel foods obtained through conventional breeding or gene-edited techniques assimilated to mutagenesis. Despite this similarity, some consumers may view these novel foods as different and may want to see them labeled. Given the vast differences across countries and culture and regulations, asynchronous approvals and heterogeneous regulations will prevail. A redux of the GMO scenario is predictable with import refusals, foregone trade and welfare opportunities for consumers, innovators, and farmers because of asynchronous and slow approvals or approvals for different uses (Qaim; Disdier and Fontagné; de Faria and Wieck,; and Henseler et al.). This area is ripe for more case studies as new foods and varieties are emerging using NPBTs.

6.2. Integrating components of transport systems

In section 3 we have proposed a series of enhancements to the traditional use of distance as a proxy for the cost of transportation, depending on context and the data available. Needed topics of research in agricultural transportation that could be used to improve our understanding of agricultural markets and trade are how recently imposed transportation policies might affect
agricultural shipments, and if performance improvements to transportation systems as a whole provide benefits (or detriments) to agricultural shipments.

Both the U.S. electronic logging device mandate for trucks and the International Maritime Organization’s 2020 low sulfur fuel mandate for marine shipping are thought to increase the costs of their respective modes (Roka et al.; Thayer et al.; and Kass et al.). There is likely some incidence between shippers and carriers, and the relative costs of U.S. internal and external transportation costs compared to other countries have changed. While research does exist for these policies in general, there is little research currently available evaluating the effects on agricultural exports and agricultural markets in general.

Transportation system performance has improved over time whether the measurements are speed, volumes, or the quality of the journey itself. However, agricultural shipping rates are often less than those of manufacturing goods by weight or volume. Carriers have less incentives to focus performance improvements on lower revenue shipments beyond the efficiency gains within their own operations. Alternatively, smart systems record and send data to carriers about transportation conditions and events which allows carriers to monitor service quality and performance more closely. They also improve communication among customs agents, shippers, and carriers. Therefore, these systems might provide larger returns to perishable agricultural goods by improving safety and quality than dry manufactured goods. Heterogeneous returns to smart technologies and system-wide performance improvements have implications for both trade in agricultural goods as well as a better understanding of the benefits of smart technologies in supply chains more generally.

6.3. Mainstreaming and improving estimation methods

Advances in gravity-based analyses of trade flows could be more routinely applied to agricultural trade cost issues. For example, Duan and Grant estimated trade costs in agricultural
trade using Novy’s approach to bilateral trade and border effect (Novy). Novy uses an approach developed by Head and Ries, and Head and Mayer to measure “free-ness” or “phy-ness” and a proper measure of internal trade cost (within a country) and those trade costs crossing a border between two countries, called the border effect. Using the approach one can derive an average implied bilateral trade cost factor between countries just using observed panel trade data and CES elasticities. The trade cost factor can be used as a left-hand side variable in a regular gravity framework using the usual trade cost determinants. The main drawback of this approach is the potential sensitivity of the trade cost estimate to the value of the CES elasticity values.

Another recent improvement in gravity equations is the development of relative transportation costs into an internal and international transportation element using an approach reminiscent of Novy, with a focus on internal distance and allowing the bilateral distance effect to vary over time (Yotov; and Yotov et al.). This approach could readily be used in agricultural trade cost analysis using a gravity approach.

Estimates of trade cost based on gravity equation approaches tend to yield large trade cost estimates, which can appear implausible when introduced in calibrated models for a validation exercise (Balistreri and Hillberry). The implied resources devoted to trading goods are extremely large. Validating agricultural trade cost estimates in calibrated models could be an enlightening exercise to gauge their plausibility.

There is still a lack of attention on separate and distinct effects of NTMs on import unit cost, supply and demand. Their impact on welfare is not sufficiently investigated, as authors focus on trade effects, which we have argued are not that informative or could actually be misleading. Health/environmental costs and benefits should be more systematically incorporated into analyses. The disentanglement proposed by Cadot et al. identifies the separate effects on import unit value, supply and demand of NTMs. The method requires panel data, which have
become increasingly available. They do not consider welfare, however. The welfare analysis proposed by Disdier and Marette, van Tongeren et al., and Wilson and Anton are clearly feasible and could be more frequently implemented. They account for market imperfections and/or risk and are more informative.

Finally, the aggregation of various standard-like NTMs remains a major challenge. Various measures such as frequency and counts of NTMs are inadequate to capture stringency, regulatory heterogeneity, or the cumulative effect of various measures. This topic is challenging, in the higher risk-higher payoff category. A major breakthrough on meaningful aggregation and without requiring heaps of data would advance the field.

7. Conclusions
Agricultural trade costs are significant as many agricultural goods are low-value, bulky and perishable. Trade cost are hard to measure for at least two reasons. Transportation cost is difficult to generalize and capture in a realistic way, because it is heterogeneous across goods, transportation modes and time. Second, standard-like NTMs are hard to account for in an exhaustive way with limitations on aggregation, data availability and the difficulty to measure their effects on consumers and market imperfections. Tariffs have fallen dramatically and except for the anti-trade stance of the Trump administration, their global levels will continue to converge to nearly negligible levels through large RTAs.

Nevertheless, as discussed here, much progress has been achieved in measuring the extent of these costs. Promising directions exist to better gauge their magnitude and effects. In particular, we suggested several ways to improve estimates of trade costs from transportation, with available data sources and methods. The field of transportation economics has much to contribute to trade analysis (Blonigen and Wilson).
We provided several policy insights and implications. Transportation distortions remain large and unaddressed. Much could be gained by liberalizing transportation services. Addressing NTMs remain complex given the difficulty to empirically estimate optimal standards. Too few investigations have attempted to incorporate welfare measures in their analysis of standard-like NTMs. Transparency remains difficult to measure but the available evidence suggests that transparency reduced trade cost and is welfare-improving in that sense. Many countries remain deficient on their transparency requirements with the WTO, for example.

We are hopeful our research directions will find some interested readers and takers.
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Appendix 1. Trade cost data sources for agricultural trade analysis

Distance, cultural distance, business-based trade costs and transportation-related data

The Bureau of Transportation Statistics and Federal Highway Administrations provides the Freight Analysis Framework (FAF) estimating U.S. freight flows at:
https://ops.fhwa.dot.gov/freight/freight_analysis/faf/

The Baltic Exchange provides indices of ocean shipping prices by vessel types and route:

Both Lloyd’s List and Drewry do have data ocean shipping costs for agricultural products by route (including reefer containers), however these are must be custom ordered and are expensive.

The world port index created by the National Geospatial Intelligence Agency includes information about port facilities and services: https://msi.nga.mil/Publications/WPI (nga.mil currently not working?)

Statistics Canada have a freight analysis framework:

Trans-Tools freight model offers data/forecasts for European freight, including cost information:
http://www.transportmodel.eu/

USDA AMS provides direct transportation costs for many domestic agricultural shipments, refrigerated and bulk, including some export routes:
https://www.ams.usda.gov/services/transportation-analysis/data

The GeoDist database of the CEPII offers a series of distance bilateral distances, colonial links, contiguity and other geographical measures:


OECD data on maritime rates are useful but are limited in panel format:
https://stats.oecd.org/Index.aspx?DataSetCode=MTC (not working on 8/9/20 but was 2 weeks ago)

CIF/FOB ratios are available from the OECD for a 1995-2016 panel:
https://stats.oecd.org/Index.aspx?DataSetCode=CIF_FOB_ITIC#

The World Bank Doing Business covers a wide range of trade costs related to doing business included for trading across borders with panel data:
https://databank.worldbank.org/source/doing-business

The World Bank’s Logistics Performance Indicators (LPI) provides a large panel dataset on quality of infrastructure and other variables: https://lpi.worldbank.org/

The World Economic Forum provides various measures of infrastructure quality in panel format:

Transparency International provides measures of corruption perception index in panel format useful to proxy associated trade costs: https://www.transparency.org/en/cpi

RTAs, FTAs and associated tariffs

WTORTA has the full list of preferential trade agreements for each WTO member and the comprehensive list of preferential tariffs at HS-6 digit for these countries on a bilateral basis.

CPB (US International Trade Administration) has the following FTA tariff rate search tool by FTA partner and HS code for the US, https://beta.trade.gov/fta/tariff-rates-search
See also https://www.cbp.gov/trade/priority-issues/trade-agreements/free-trade-agreements

USDA has its FTA ag tariff tracker: https://apps.fas.usda.gov/agtarifftracker/Home/Search

WTO I TIP and SPSIMS on SPS regulations http://sims.wto.org/
WTO on tariffs and WTORTA on preferential trade and preferential tariffs

Tariffs and market access
The WTO with its TAO webpage provides data on tariffs, TRQs, and export subsidies:
https://tao.wto.org/welcome.aspx?ReturnUrl=%2f%3fu%3d1&ui=1
or http://tariffdata.wto.org/
The World Bank provide the TRAINS database on tariffs and trade flows
The World Bank offers Doing Business on ease of doing business, delays, and quality of institutions:
https://databank.worldbank.org/source/doing-business
MacMap is another popular dataset on market access and tariffs: https://www.macmap.org/
OECD’s AMAD dataset focuses on agricultural market access: https://www.oecd.org/site/amad/
Safeguard measure notifications are available with the WTO at:
https://www.wto.org/english/tratop_e/safeg_e/safeg_e.htm

TRQ
CBP.gov: https://www.cbp.gov/trade/quota/guide-import-goods/commodities
CPB also has a tool kit using Descartes CustomInfo. https://www.customsinfo.com/
See also AMAD above for detailed data on TRQs

NTMs
The WTO’s I-TIP webpage provides NTM and other policy notifications data:
https://www.wto.org/english/res_e/statis_e/itip_e.htm
Bryant Christie Inc provides a series of SPS data, some in panel form for pesticides and veterinary drugs MRLs, food additives and contaminant limits: https://www.bryantchristie.com/
SPS and TBT concerns are provided by the WTO at http://spsims.wto.org/ and http://tbtims.wto.org/
The World Bank has TRAINS: https://databank.worldbank.org/source/unctad-%5e-trade-analysis-information-system-(trains)
CEPII offers various measures and indicators of NTMs win its NTM-MAP dataset:
Trade Monitoring from the WTO provides information on trade facilitation and trade restrictive measures for many policy instruments:
https://tmdb.wto.org/en/explore#page=1&members=&g20=0&measure_type=&after_dt=&before_dt=&affected_members=&product_chapters=