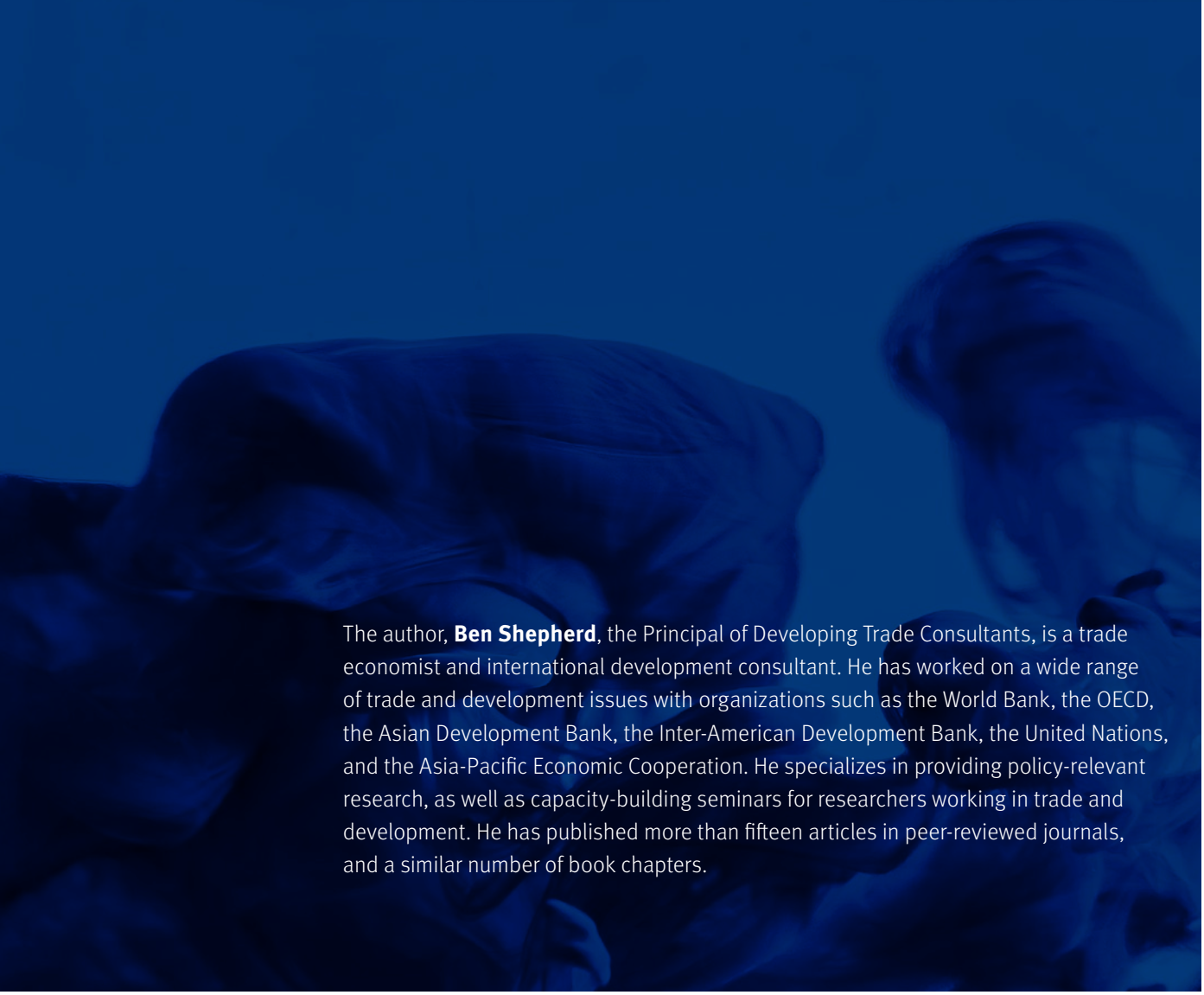
research and innovation

International standards and trade
What does the research say?

PAPERS



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Executive summary

This paper provides a selective overview of the literature on international standards and trade, focusing on peer-reviewed articles that use econometric models. While trade economists have long recognized that regulatory measures other than tariffs can affect traded quantities and prices, the difficulty of collecting data on technical regulations and product standards across a wide variety of countries has meant that only limited quantitative research is currently available on the trade effects of these measures. To reflect the use of terminology in the economics literature, this paper refers generally to "product standards" as including both (mandatory) technical regulations, and (voluntary) product standards.
From a theoretical standpoint, there is no clear prediction as to the effects of importing country standards on bilateral trade. On the one hand, standards contain important information on market conditions and preferences in the importing market, thereby allowing exporters to avoid paying high information-gathering costs. But on the other hand, foreign standards can require costly changes to products and production processes, which can increase costs for firms. The net result could be positive or negative, depending on which effect predominates (Figure 1).
A particular issue in the economics and trade policy literature relates to the insider/outsider dynamic that can arise through regional approaches to standards, which can potentially have implications in particular for excluded developing countries. The reason for focusing on developing countries is that firms there are typically constrained in terms of their ability to access finance to cover increased investment or production costs, and so may be locked out of foreign markets, if compliance with standards is very costly.

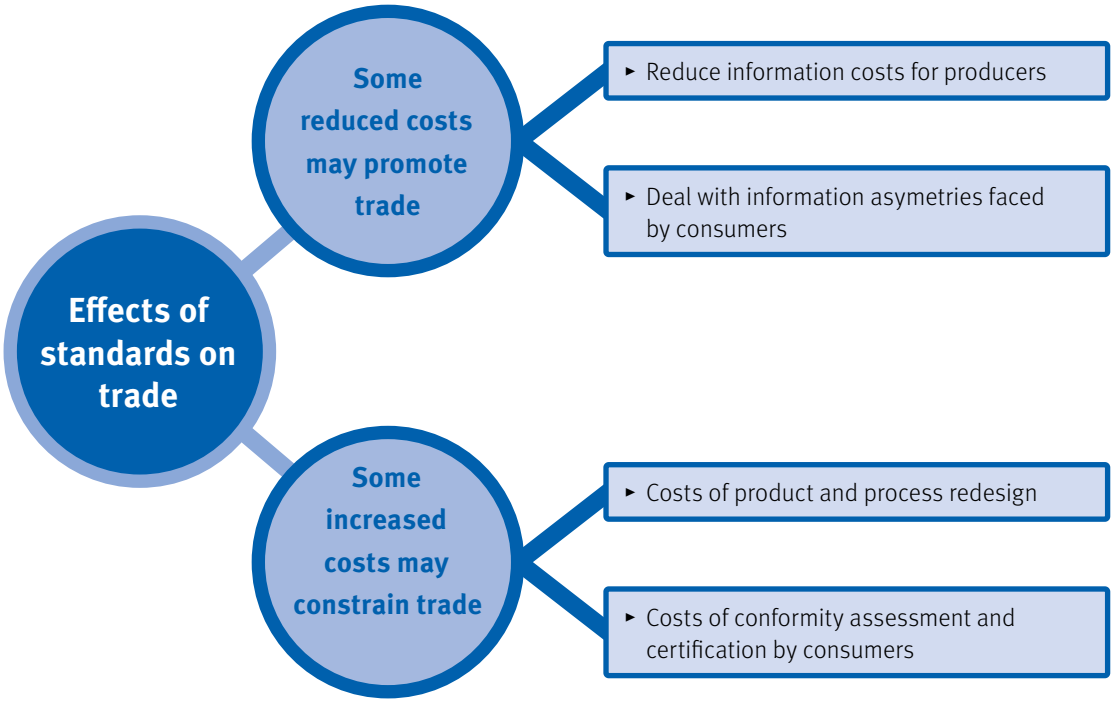

Figure 1: Summary of the trade effects of standards.

Source: Author.

In principle, the use of international standards can mitigate many of the potential cost-increasing effects described above. When a large number of countries adopts an international standard, exporters can benefit from stronger economies of scale by accessing a larger potential market.

The available empirical evidence supports the existence of mechanisms like those set out above. It uses a mixture of country-level data on trade flows, and increasingly, firm-level data on sales in different countries. The main difficulties that remain are obtaining, codifying, and quantifying data on product standards in a sufficiently broad range of countries.

Key findings from the available empirical literature, given the focus stated above, can be set out as follows:

1. Standards in importing markets can contribute to cost increases for exporters because of the need to adapt products and production processes, as well as to comply with testing and certification requirements.
2. Developing-country firms may be constrained in their ability to absorb these costs due to difficulties in financing the necessary investments.
3. The balance of evidence therefore suggests that standards in importing markets may limit the ability of some developing-country firms to contest those markets.
4. Where importing-market standards are harmonized with international standards, such as those from ISO or IEC, the negative effect on developing-country exporters is substantially lessened, or even reversed.
5. There is evidence that some standards in some sectors promote trade, likely by reducing information asymmetries between producers and consumers, and credibly signalling quality.
6. Effects of standards in importing markets differ substantially across exporting countries, sectors, and firms within each of them.
7. Even when there is an initially negative cost-impact of an importing-market standard, over time, firms and governments tend to show substantial ability to adapt and prosper in the new environment, and the standard can be the catalyst for higher productivity and quality.

A promising avenue for future research would combine a case study approach of particular standards with the use of firm-level data from exporting countries. From an econometric point of view, this combination would make it possible to make a strong claim that estimated impacts are in fact causal in nature. However, it has the disadvantage of lacking generality. To date, only a small number of papers have implemented this approach, but it could usefully be expanded in future.

In addition, standards organizations could collaborate with researchers at the World Bank which regularly collects firm-level data through its Enterprise Surveys[1] project. At present, the only standards-related data available through Enterprise Surveys relates to whether or not individual firms have an ISO 9000 series or similar quality certification. In the future, a small number of specific questions on standards could be included in the Enterprise Surveys instrument, so that this same approach could be applied at a micro-level to individual standards. Moving from simple counts of standards, or dummy variables, to properly identified measures of firm-level take up would make research findings much more robust from a technical point of view, and could potentially help re-invigorate this field of research, as well as providing valuable information for policy discussions.

1) https://www.enterprisesurveys.org/

The TBT Agreement

The General Agreement on Tariffs and Trade (GATT), which provided the legal structure for international trade as an agreement (but not an institution) until the WTO's establishment in 1994, included provisions on TBTs from 1979 onwards. The TBT Agreement resides on two main pillars: non-discrimination, and the avoidance of unnecessary obstacles to international trade. Importantly, there is a legal presumption that technical regulations that are harmonized with international standards do not constitute unnecessary obstacles to international trade. The presumption can be rebutted by appropriate evidence, but the consensus is that this approach embodies a clear preference of the multilateral trading system for the use of international standards whenever possible.

1. Introduction

Trade economists have long been interested in the links between different types of regulatory measures on the one hand, and trade flows on the other. The importance of non-tariff measures (NTMs) in the trade context became clear with the foundation of the World Trade Organization (WTO) in 1995, with the Agreement on Technical Barriers to Trade (TBTs) and the Agreement on Sanitary and Phyto-Sanitary Measures (SPS) as key components of the international trade architecture. In international trade law, technical regulations are considered to be one type of NTM, as indicated by their explicit inclusion in the WTO's legal architecture. For economists, however, product standards are also relevant, as they can have effects on international markets. Indeed, the SPS and TBT Agreements both have codes of conduct relating to standards, as opposed to technical regulations and SPS measures. This indicates the potential links between standards and trade outcomes, but also the difficulty of including standards directly within an international legal framework. Research in this area has resulted in some important insights, but only limited depth in the more than two decades since the WTO's establishment. The purpose of this note is to present a selective review of this literature with the objective of highlighting key messages, and identifying fruitful avenues for future research.

Trade economists use terminology loosely in this area. Whereas the distinction between a "standard" and a "technical regulation" is important in the standards space, as well as for international trade lawyers, economists often group the two types of measure together under the single heading of "standards". The reason is that from an economic point of view, the question of primary interest is whether the measure in question alters costs for producers, and that can be the case just as easily for standards, where compliance is voluntary as a matter of law but often important as a commercial matter, as for technical regulations, where compliance is necessary under law. This note follows the economists' convention and uses "product standards" or "standards" to refer jointly to technical regulations and (voluntary) standards, except where it is important in the context of the literature to distinguish between the two. It does not draw any distinction between technical regulations that reference standards, thus making them mandatory, and technical regulations based on some other set of criteria.

For space reasons, this note does not purport to be comprehensive in its review of the literature. It is deliberately selective, focusing on contributions that have been influential on future work, or which have been prominent in the discourse more generally, or which serve to highlight issues of substance or methodology that are important to the general presentation. The discussion is generally limited to contributions that use econometric methods to establish a connection between some measure of product standards and bilateral trade. It focuses on peer-reviewed journal articles, as well as some working papers from international organizations.

The note proceeds as follows: The next section describes, from an economic point of view, what the possible linkages between standards and trade could be in a general sense. The following two sections then provide the bulk of the selective literature review, focusing respectively on the insider/outsider dynamic that arises when standardization activity takes on a regional dimension, and on the dynamic aspects of the standards and trade debate. The final section concludes by summarizing key results, and identifying perspectives for future research, as well as the principal constraints that explain why this area remains under-researched relative to other aspects of the trade policy agenda.

2. **Standards** and trade costs: basic concepts

In the international trade literature, the factors affecting bilateral trade flows between countries are typically broken down into three categories.[2] They can be summarized as follows:

- **"Push" factors**: These are factors specific to the exporting country that tend to cause it to send more goods abroad. Key examples include competitiveness (more formally, Ricardian comparative advantage), and market size. The first factor summarizes the productivity of the exporting country's producers in one sector relative to another, and provides an indication of where the possibilities for beneficial exchange with other countries may lie. The second factor is important because a larger domestic market allows for more firms to coexist in a single sector, and hence for greater exports.
- **"Pull" factors**: These are factors specific to the importing country that tend to cause it to absorb more goods from abroad. The key example here is market size; more consumers with higher incomes means more imports in an absolute sense. Another key factor is the country's degree of openness to international trade – more open countries tend to import (and export) more than relatively closed countries.
- **"Drag" factors**: Trade costs are the key set of factors that hold back bilateral trade flows for given push and pull factors. To an economist, the concept of trade costs is a broad one. Anderson and Van Wincoop (2004) define trade costs as including "all the costs incurred in getting a good to a final user other than the marginal cost of producing the good itself" (p. 691). An equivalent way of understanding an economist's concept of trade costs is that they include all factors that drive a wedge between the producer price in the exporting country, and the consumer price in the importing country. Key examples of trade costs include: tariffs, as well as transport and freight costs, NTMs, and the performance of key gateways into a market such as port and airport infrastructure.

Where do standards, and international standards in particular, fit into this understanding of trade? Most economists would see standards as factors that potentially affect the bilateral drag on trade for given push and pull factors. The reason is that standards affect the costs faced by producers in export markets relative to domestic markets, and as such can constitute one factor among many in the economist's broad conception of trade costs. Importantly, economists do not give much attention to the question of whether or not standards are mandatory or voluntary; in other words, the terminological distinction between "technical regulations" and "standards" is typically not

2) Technically, a range of factors collapse into these three categories from a range of theoretical models of trade, thereby providing a simple but rigorous framework for empirical work based on what is termed the structural gravity model: see Arkolakis et al. (2012), and Costinot and Rodriguez-Clare (2014).

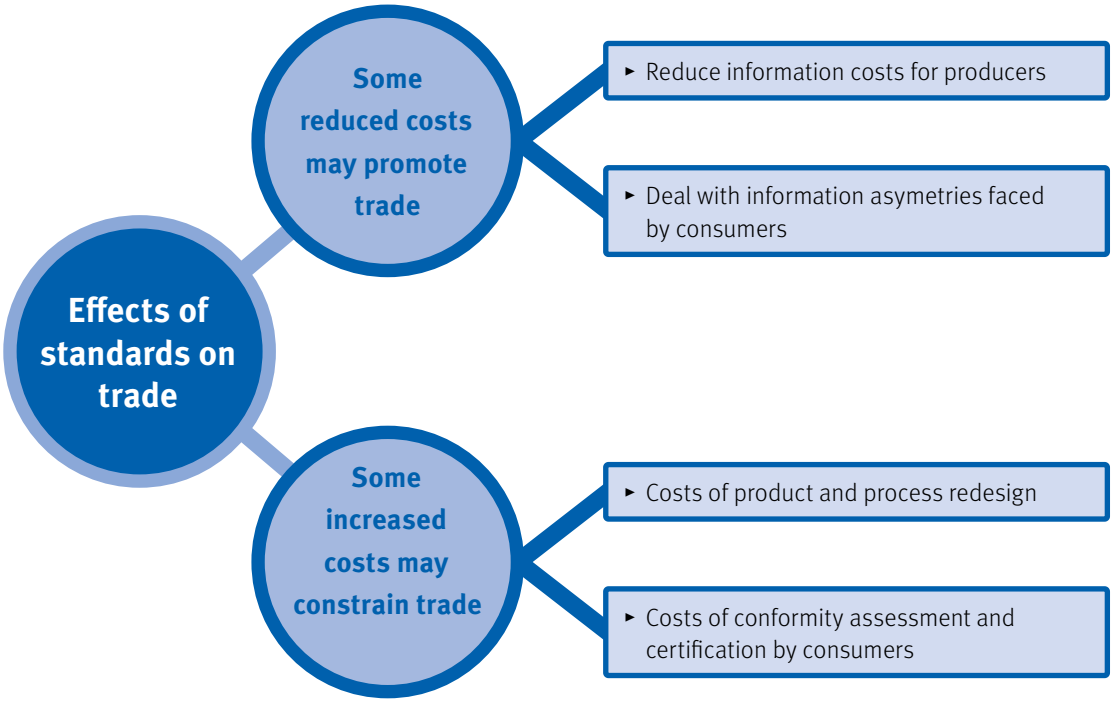

Figure 1: Summary of the trade effects of standards.

Source: Author.

How do trade economists examine the links between standards and trade empirically?

The mostly commonly used framework for empirical international trade work is the gravity model. Named because of its similarity to Newton's law of gravity in physics, the gravity model of trade is used in many contexts where economists need to model bilateral flows amongst a number of distinct entities, such as countries, regions, or cities. The model itself resembles Newton's law of gravity because the economic "mass" of the exporting and importing countries (their GDPs) tends to boost trade, while trade costs, like distance, tend to hold it back. Initially put forward as a sensible empirical regularity, the gravity model is now treated rigorously in the literature and can be derived from strong foundations in standard micro-economics. The new generation of gravity models, which corresponds strongly to theory, is referred to generally as the set of "structural" gravity models. Anderson (2011) provides a review of the key aspects of the current approach to modelling. In most cases, these models correspond to the three-point breakdown of trade determinants given above.

How do economists use this framework to look at the impact of standards on trade? The general approach consists of estimating a model with standard control-variables from the literature, and one or more variables of interest that relate to standards. Swann et al. (1996) is an early example, but it is the approach set out in Moenius (2004) that was ultimately most influential on the subsequent literature. Moenius (2004) collected standards data from the Perinorm database,[1] and mapped it to the Harmonized System used to classify internationally traded goods using a custom concordance-table. Where Perinorm indicates that standards in two countries are linked, that is recorded as a "shared" standard. The model also includes counts of total numbers of standards by sector in the importing and exporting countries. This basic approach – counting standards that satisfy particular criteria, recording links, and creating dummy variables to capture particular relationships – became the mainstay of the standards and trade literature.

What are the shortcomings of this set of methodologies? Firstly, compliance costs can differ substantially from one standard to another – and simply summing them misses that dimension of heterogeneity. Secondly, Perinorm, while an excellent data source, omits the vast majority of developing countries, which necessarily limits estimation samples. Finally, the use of dummy variables, while common in applied econometrics, leaves considerable room open to interpretation of what exactly is being captured. As a footnote, it is important to stress that much of the research conducted using this paradigm also adopted versions of the gravity model that would now be unlikely to pass peer review at a leading journal due to technical issues with their approach to econometric estimation, the type of trade data used, and varying approaches to taking account of the importance of relative prices. Results should therefore be interpreted with caution.

A more recent strand of the literature has moved from looking at country-level trade flows to considering the behavior of firms within an individual country. Fontagné et al. (2015) is an early contribution, using data on French firms. The general approach in this case is to use a model with a limited set of control variables, but which is set up so that econometric tools can control for many unobservable influences on firm export-behavior. The variable of interest is some measure of standards in importing countries; in Fontagné et al. (2015) SPS measures signalled through the specific trade concerns (STC) mechanism at WTO. The advantage of this new approach is that it makes it possible to exclude a range of other potential influences on firm export-behavior that cannot be easily excluded in country-level work. Again, the main issue is with the data capturing standards. It is not clear, for example, that the STC mechanism necessarily provides a clean and sharp estimate of importer country measures that represent potential trade barriers rather than legitimate regulatory instruments.

1) Perinorm is the result of a collaborative effort by the British, French, and German national standards bodies. It is a bibliographic database containing information on national, European, and international standards from over 200 organizations in 29 countries, **https://www.perinorm.com**

respected in the way it is in other disciplines, including international trade law. When economists talk about standards, they typically use the term to cover both types of instruments, as well as SPS measures. The reason for this approach is that from the producer perspective, it is not only technical regulations that can alter costs – as the discussion below will make clear, it is also true of voluntary standards.

Standards potentially affect trade costs in a number of ways, as summarized in Figure 2. Some of these mechanisms could increase trade costs, whereas others could reduce them. The net effect is therefore ambiguous on a theoretical level, and it is up to empirical researchers to tease out the links between standards and trade in particular cases. On the one hand, standards can contain information on consumer preferences and requirements in the importing country, which could reduce the costs foreign producers would otherwise face in learning about those taste-related factors (e.g., Moenius, 2004). Similarly, when a foreign product can be seen to comply with a domestic standard, consumers may be more likely to buy it, as it reduces information asymmetry and can signal a particular level of quality (e.g., Disdier et al., 2018). Both these factors potentially lower trade costs and promote trade, but their empirical strength is largely an open question.

There are also likely to be forces acting in the opposite direction. For example, foreign producers may need to retool in order to produce goods that comply with a local standard if their domestic market standard is different. In this case, they would effectively run two production lines. While this can increase their marginal (per unit) costs of production, the main effect is on their fixed costs of production (costs paid once, regardless of the level of production) (e.g., Maskus et al., 2005). Similarly, establishing conformity and obtaining appropriate certifications also requires payments by the firm, and would typically be seen as impacting marginal costs most heavily. Trade costs can include fixed as well as marginal components (e.g., Chaney, 2008). As such, standards in this case would represent a factor that tends to increase trade costs, and thus decrease bilateral trade. The formal evidence on the extent of these costs is very slight, but Maskus et al. (2005) surveyed firms in developing countries, and found that compliance with standards abroad is associated with an increase in fixed costs of, on average, 425 000 USD or nearly 5% of value added, while a 1% increase in investment to meet compliance costs is associated with a statistically significant, but small, increase in variable production costs of 0.06% to 0.13%.

Trade and regional standards policies – evidence from harmonization and mutual recognition

The standard economic view of policies like harmonization and mutual recognition is embodied by Chen and Mattoo (2008). The authors use bilateral trade data on 42 countries over the 1986-2001 period. They code specific variables to capture the effects of harmonization and mutual recognition of standards between country pairs over time. Their variables allow for differential effects on included and excluded countries. Consistent with the analysis above, they find that harmonization is typically trade-promoting for members. For non-members, the situation is more nuanced: excluded OECD countries typically see little effect of harmonization, and perhaps some degree of positive boost. In contrast, excluded developing countries typically see their exports fall. For mutual recognition, by contrast, effects are generally positive on included and excluded parties alike. However, this effect is reversed if the trade agreement associated with the mutual recognition arrangements contains restrictive rules of origin. These results are broadly confirmed by Baller (2007), who looks in detail at two sectors: medical devices, and telecommunications equipment. Again, a key finding is that the simple included/excluded dynamic requires nuance in practice, with the net impact for different groups of countries depending on a range of factors.

A possibility raised by these two papers is that developing-country firms are subject to some kind of constraint in upgrading production to meet foreign standards. A typical example would be a financial constraint: if it is difficult to access debt to cover the costs of upgrading, then it may not occur, and market access will become difficult. While there is no research looking specifically at the links between access to finance and standards, research such as Manova (2012) shows that credit constraints can indeed significantly affect export behavior. In addition, Chen and Mattoo (2008) raise the possibility that international standards may help mitigate the problem they identified for excluded developing countries, by first putting a constraint on the levels to which a standard can be raised in practice, and thus limiting compliance cost, and secondly maximizing the size of the target market due to widespread adoption of the same standard.

As already noted, the balance between these forces – and thus, the question of whether standards tend to be trade promoting or trade reducing – requires detailed empirical work, and cannot be answered generally. It is quite possible that specific cases are different, for instance, because quality or product attributes (such as safety) matter more to consumers in some sectors rather than others, or because compliance costs can differ substantially across countries and sectors. The remainder of this document examines key contributions from the trade literature that can be understood within this framework, focusing on substantive issues that have been highlighted and which are particularly relevant for the case of international standards.

Understood in this way, the case of international standards can be seen to offer some intriguing possibilities. If a standard is widely used in importing countries, one effect would be to reduce the burden on export producers to set up different production processes for each market served. International standardization as the basis for de facto harmonization of national standards could therefore be a cost reducing and trade-promoting factor. Similarly, it may be possible to achieve these gains without significant sacrifices in terms of the informational content of standards, provided that consumer preferences are relatively similar across markets. That condition is a major one, but the possibility is nonetheless clear that international standards potentially offer ways to enjoy substantial gains from trade without sacrificing quality or public policy objectives. This perspective explains the WTO Agreements' preference for international standards, as discussed above.

A necessary caveat to this examination is that trade economists tend to focus, as the above analysis suggests, on the issue of the potential links between standards and different types of costs. But standards can also have important social benefits, thinking outside the trade sphere. They can ensure minimum levels of quality in areas where that is important to consumers. They can also be a tool in achieving important public policy objectives, such as consumer health and safety, and environmental protection. As part of good regulatory practice, it would be important to evaluate these benefits in addition to obtaining a rigorous understanding of any costs that might be involved. Nonetheless, the international trade literature rarely embarks on such exercises; an exception is Otsuki et al. (2001). The following discussion therefore leaves to one side the important question of the social benefits of standards in spheres like health and environmental protection, and focuses exclusively on the trade effects of standards.

Trade effects of international standards on exports of textiles and clothing, and electrical equipment

Czubala et al. (2009) provide some of the first evidence on the effects of de facto harmonization with ISO standards, in the context of a study of the impacts of EU standards on African exports of textiles and clothing. Using Perinorm data, they map CEN European standards to Harmonized System product categories covering the textiles and clothing sector. Their metric of standards activity is a count of the number of standards in place by importing country and product category. They then interact this count variable with a dummy variable for standards flagged in Perinorm as identical or equivalent to an ISO standard, as an indicator of de facto international harmonization. Estimation results show that EU standards in these sectors that are de facto harmonized with ISO standards do not hold back trade in the same way as standards that are "idiosyncratic", in the sense of not being de facto harmonized with ISO standards. This mechanism suggests that the costs involved with complying with these kinds of standards can more easily be borne by firms in developing countries. However, in the sectors considered, the net effect of EU standards, even de facto internationally harmonized ones, was still to act as a slight drag on African exports.

Building on this work, Portugal-Perez et al. (2010) apply essentially the same approach to the electrical-goods sector, focusing in this case on CENELEC and IEC standards. They find a stronger result: in this case, European standards that are de facto harmonized with international standards tend to have a net trade-promoting impact. They argue that the reason for the stronger result is that information is a more critical consideration in this sector, as opposed to textiles and clothing. The contrast between these two studies highlights the extent to which cross-sectoral heterogeneity can be an issue in assessing the trade effects of standards. Both studies are suggestive, but need to be interpreted carefully due to the simple measures of standards and harmonization that they use.

3. Integration, exclusion, and the costs of standards

From an international trade perspective, a key dynamic in the global standards context is the way in which preferential integration is increasingly creating what could be termed "standards zones" in the world economy. Preferential integration means the tendency, now commonplace, for pairs or groups of countries to sign trade agreements that liberalize trade flows within the group, but maintain restrictions vis-à-vis the rest of the world. Historically, trade agreements were of two broad types. Free trade agreements (FTAs) lowered tariffs to zero among members, but left each country free to pursue its own trade policy relative to third parties. By contrast, customs unions (CUs) also lowered tariffs to zero among members, but the agreement included a common trade policy with respect to third countries. Beginning with the European Communities (now the European Union) and expanding to other parts of the world in the 1990s, the modern approach to trade agreements typically goes far beyond straightforward tariff policies to deal with many other aspects of market integration, including, in some cases, standards. As a convenient shorthand, the term preferential trade agreement (PTA) means both traditional FTAs and CUs, as well as new generation trade agreements.

As long as there have been PTAs, economists have counselled that it is important to balance their positive effects – trade creation among members – against the potential negative effect of reorienting members' demands away from low cost suppliers outside the agreement. The two effects are referred to respectively as trade creation and trade diversion, and the net effect of a trade agreement on economic welfare depends on which one dominates.

Similarly, when looking at the impacts of standards-related provisions of PTAs, trade economists' main focus has been on examining the impacts on countries within the agreement versus the effects on those outside. Many trade agreements only deal with standards in a fairly rudimentary or non-binding way, but some, like the EU, have gone further. The two mechanisms most commonly used to manage the trade effects of standards within trade agreements are harmonization and mutual recognition. The former refers to the situation where countries within the trade agreement agree to adopt the same standards. The latter can refer to different situations in different agreements. In the EU, mutual recognition of standards means that countries within the agreement agree to accept as equally valid compliance with their partners' standards, as well as compliance with their own standards. By contrast, mutual recognition of conformity assessment is a weaker obligation, where countries do not recognize each other's standards as such, but rather ancillary instruments such as test results. These descriptions are necessarily simplified in order to be general, and the way they play out in particular contexts, such as the EU's New Approach, can be much more specific.

There is a small but important empirical literature on the trade effects of standards, distinguishing impacts on "within" and "outside" countries. It can be referred to as the "standards as barriers" literature, in the sense that it tends to emphasize the potentially negative cost effects for excluded developing countries.[3] The reason for this

Trade effects of ISO 9001

Clougherty and Grajek (2008) look at the impact of one specific standard on trade integration: the ISO 9001 quality management system and its third-party certification. They argue that this particular standard can have a range of benefits for firms that become certified to it, specifically resolving some issues of information asymmetry, signalling quality, and making it easier to communicate with other similarly certified firms and to resolve disputes.

The paper uses counts of the number of ISO 9001 certifications by country as a measure of the extent to which the standard has diffused to different countries. On this basis, model results show that ISO 9001 certification indeed tends to boost trade, but the effect is not uniform across countries. There is little evidence of a positive effect for developed countries, but the data point to a stronger link for developing-country exports. This finding could be consistent with greater information asymmetry between producers and consumers in markets with very different income levels, which ISO 9001 helps resolve. The paper also finds an impact on foreign direct investment (FDI), with similar evidence of heterogeneity. If certification indeed helps attract investment, it suggests that at least some standards could help promote growth and structural change over the medium to long term in developing countries, as there is a large literature on the direct and spillover effects of FDI (e.g., Javorcik, 2004).

3) It can be distinguished from the "standards as catalysts" literature, discussed below. The terminology is due to Anders and Caswell (2009).

emphasis is that much of the early work in this area came out of the World Bank, which has a specific mandate to promote development, including through supporting the integration of developing countries into the world trading system.

The paper by Chen and Mattoo (2008) is really the potential beginning of a research programme, not its end point. For reasons discussed below, however, empirical research on the trade effects of standards has remained relatively limited in the intervening decade since that paper was written. While there have been important contributions, they typically focus on using standards to answer questions that have become of particular interest in the technical literature on trade, rather than using trade models and techniques to answer policy-relevant questions about standards.

One exception to this dynamic is a thread of the literature on the relationship between harmonization and use of ISO standards as de facto international standards. Papers such as Czubala et al. (2009), Shepherd (2015), Shepherd and Wilson (2013) and Portugal-Perez et al. (2010) examine this issue. The general finding is that the possibility left open by Chen and Mattoo (2008)—that international standards could potentially mitigate the negative effects of harmonization on excluded developing countries – seems to have genuine empirical relevance. This literature usually shows, albeit with a considerable amount of variation across sectors, that use of ISO standards as the basis for harmonized standards limits or even completely reverses the exclusion dynamic of regional standards policies referred to above. Indeed, there is suggestive evidence in this limited number of studies that de facto harmonization with ISO standards can be trade promoting. Such an outcome fits with the theoretical mechanisms discussed above, specifically the ability of standards to transmit valuable information, and the ability of exporters to access a larger market through a widely adopted standard.

French and Chinese exporters and foreign technical regulations

Fontagné and Orefice (2018) use firm-level data on French exporters to examine the impacts of foreign technical regulations at a very fine level. They use STCs raised in the WTO TBT Committee as a proxy for technical regulations that potentially represent TBTs rather than legitimate, minimum-cost regulatory measures. In line with the dynamic effects discussed above, they find that firms tend to exit export markets when additional technical regulations are imposed. However, there is evidence that those firms that stay in the market tend to increase their exports, so that for the average firm, there is no effect on the volume of exports. Larger firms often reorient their exports to third markets where technical regulations are different. There is also evidence of cross-sectoral heterogeneity, with the negative effects felt more strongly in sectors that are less differentiated.

Hu et al. (2019) take a more focused approach, this time using Chinese firm-level data. They examine the particular case of a single technical regulation in the EU, dealing with child safety requirements for lighters. They find evidence of important dynamic effects: less productive Chinese firms tended to exit that market upon introduction of the new measure, but more productive firms upgraded quality to meet the new regulation, and even move beyond it. In this case, export value declined overall for the period under consideration, but the effect was mitigated by the upgrading observed dynamically.

4. **Standards** and the dynamics of trade

The analysis in the previous section was largely concerned with what economists term "comparative statics", namely the difference between an observed state of the world and a counterfactual, in which all factors except the one of interest remain constant. Even in that simple framework, standards open rich possibilities in terms of their possible links to trade costs and trade flows. While the early literature emphasized the "standards as barriers" viewpoint, that argument was nuanced over time to allow the trade-promoting effects of standards in at least some sectors, in particular when they are harmonized with de facto international standards.

Another strand of the literature has emphasized the dynamic aspects of standards, in line with a richer set of theories of international trade that have been widely adopted in the 2000s and 2010s. Whereas the earlier literature emphasized effects at the level of sectors or countries, the more recent literature looks at a much more detailed level, namely individual firms. The basic idea is that within each sector, there are firms of different productivity levels coexisting. Only the most productive firms export, as only they can absorb the costs associated with entering foreign markets and still remain profitable. Less productive firms serve the domestic market only. The presence of standards is typically cited as one possible reason why there are significant costs associated with entering foreign markets, for the reasons listed above: most importantly, doing so can require redesign and retooling. When a standard in an importing country changes, the level of cost associated with change results in a reshuffling of exporter firms: some drop out of the export market because they cannot profitably absorb the additional costs, while others make the necessary adaptations and continue exporting. An important special case is when a producing sector is largely export oriented: in that case, most firms may conform to the new foreign standard, with the effect that those firms that cannot absorb the cost exit the market entirely.

This "shake out" mechanism associated with changes in trade costs, including those related to standards, has important economic implications. Resources freed up by exiting firms can be reallocated to more productive firms, which then grow and expand. The net result is that sectoral productivity increases—which explains why trade can often be an engine of economic growth. This dynamic is at the core of the "standards as catalysts" viewpoint: the idea that they can promote production upgrading and productivity growth over time, and can thus be a positive force for promoting competitiveness even if up-front costs are involved.

Given that this is a newer strand of the literature, evidence is still in the process of accumulating. Most of what is available is based on observations for French firms, due to the fact that the relevant dataset has been extensively used in other international trade work, and is acknowledged to be of high quality and completeness. Notable exceptions include Hu et al. (2019) for Chinese exports, and Ali (2017) for Pakistani mango exporters. Key results can be checked for replication by researchers in other countries, although the sensitivities inherent in using data on individual firm characteristics mean that access is typically limited to a small number of researchers, under relatively tightly controlled conditions, so that anonymity can be preserved.

Whereas the firm-level approach to examining the links between standards and trade can potentially be addressed at varying levels of generality, the country-level approach discussed above has typically focused on particular sectors. This level of analysis makes it difficult to see dynamic effects. An alternative approach with arguably greater potential to uncover them relies on something akin to a case study of the economic impacts of an individual standard or set of standards. Most of the literature in this area has been in the form of quantitative case studies rather than econometric models, and has focused on SPS measures rather than technical regulations or voluntary standards in manufactured-goods sectors. For instance, Henson and Jaffee (2004) look at a number of cases, such as exports of Nile Perch from Kenya, to show how governments and sectors can dynamically respond to the challenges posed by new standards in foreign markets, above and beyond any initial barrier effect that may be felt.

5. Conclusion and **policy implications**

This short review of the available research has made clear that while the literature is small relative to other parts of the trade agenda, it has nonetheless identified some important insights. The central logic can be summarized as follows:

1. Standards in importing markets can contribute to cost increases for exporters because of the need to adapt products and production processes, as well as to comply with testing and certification requirements.
2. Developing-country firms may be constrained in their ability to absorb these costs due to difficulties in financing the necessary investments.
3. The balance of evidence therefore suggests that standards in importing markets may limit the ability of some developing-country firms to contest those markets.
4. Where importing-market standards are de facto harmonized with international standards, such as ISO or IEC, the negative effect on developing-country exporters is substantially lessened, or even reversed.
5. There is evidence that some standards in some sectors promote trade, likely by reducing information asymmetries between producers and consumers, and credibly signalling quality.
6. Effects of standards in importing markets differ substantially across exporting countries, sectors, and firms within each of them.
7. Even when there is an initially negative cost-impact of an importing-market standard, over time, firms and governments tend to show substantial ability to adapt and prosper in the new environment, and the standard can be the catalyst for higher productivity and quality.

The main reason that the literature on standards and trade remains relatively small, and far from global in its coverage, can be simply stated: lack of data. It is still the case today that there is no comprehensive global database of technical regulations or product standards. While there have been major advances in trade modelling since this literature was initiated, it remains challenging to successfully apply them in the absence of comprehensive and representative data on standards. The state of play regarding SPS measures and TBTs is now significantly better than during most of the time that this literature has been active, as the United Nations Conference on Trade and Development's (UNCTAD) new version of its TRAINS[4] database contains a rigorous classification of those two sets of measures applied to the 5000+ products of the Harmonized System. However, its coverage is still not universal: it currently spans 91 countries (treating the EU as a single country), typically for one year only. This constraint will loosen over time as more countries are added. But a key requirement for improved econometric estimates is the availability of panel data, i.e. countries observed over multiple time periods.

For product standards as opposed to technical regulations, the situation remains very difficult for applied researchers. Perinorm has data on many of the most important markets, but few developing countries. It is also difficult to map to Harmonized System product categories, as the International Classification of Standards follows a completely distinct internal logic.

More fundamentally, even if the availability of raw data could be improved, it would still be necessary to develop meaningful measures of "standards" to be used as explanatory variables. The TRAINS database simply records the presence of an SPS or TBT for a particular product. It does not record any substantive information, so it is impossible to judge the level of compliance costs, or even if the measure in question is based on de facto international standards. Perinorm provides more detail on this last point, and this feature has been exploited by some researchers. However, there is no straightforward way of drawing conclusions as to the relative costs associated with different standards, in particular when they apply to different products or sectors. While this difficulty does not make it impossible to produce aggregate results – for instance by using simple counts or frequency indices – it makes results necessarily harder to interpret.

A promising avenue for future research would combine a case study approach of particular standards with the use of firm-level data from exporting countries. From an econometric point of view, this combination would make it possible to make a strong claim that estimated impacts are in fact causal in nature. However, it has the disadvantage of lacking generality. To date, only a small number of papers have implemented this approach, but it could usefully be expanded in future.

In addition, standards organizations could collaborate with researchers at the World Bank who regularly collect firm-level data through their Enterprise Surveys project. At present, the only standards-related data available through Enterprise Surveys relates to whether individual firms have an ISO 9000 series or similar quality certification. A simple piece of research that could be conducted immediately

4) TRAINS: Non-Tariff Measures (NTMs) based on official regulations, **https://trains.unctad.org**

would be to estimate the impact of this certification on export behavior, after controlling for productivity, size, and other relevant factors; it would have a stronger claim to excluding alternative explanations than existing work at the country level. But ideally, a small number of specific questions on standards could be included in the Enterprise Surveys instrument, so that this same approach could be applied at a micro-level to individual standards. Moving from simple counts of standards, or dummy variables, to properly identified measures of firm-level take up would make research findings much more robust from a technical point of view, and could potentially help re-invigorate this field of research, as well as providing valuable information for policy discussions.

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