POLICY RESEARCH WORKING PAPER 2512

Quantifying the Impact of Technical Barriers to Trade

A Framework for Analysis

Keith E. Maskus
John S. Wilson
Tsunehiro Otsuki

The application of product regulations and standards is becoming increasingly contentious as an implicit nontariff barrier to trade. This overview of the policy debate and methodological issues surrounding product standards and technical barriers to trade proposes concrete steps to move forward empirical analysis of regulations and trade.

The World Bank
Development Research Group
Trade
December 2000

POLICY RESEARCH WORKING PAPER 2512

Summary findings

There has been increasing use of technical regulations as instruments of commercial policy in the context of multilateral, regional, and global trade. These nontariff barriers are of special concern to developing countries, which may bear additional costs in meeting mandatory standards. Many industrial and developing countries express frustration with regulations that vary across their export markets, require duplicative conformity procedures, and are continually revised to exclude imports.

Maskus, Wilson, and Otsuki provide a comprehensive overview of the policy debate and methodological issues surrounding product standards and technical barriers to trade. They begin with a review of the policy context driving demand for empirical analysis of standards in trade, then provide an analytical overview of the role of standards and their relationship to trade. They then review methodological approaches that have been used to analyze standards and their impact on trade.

Their main interest lies in advancing techniques that are practical and may be fruitfully extended to the empirical analysis of regulations and trade. They discuss concrete steps that could be taken to move forward a practical, policy-relevant program of empirical research. Such steps would include:

- Administering firm-level surveys in developing countries.
- Devising methods for assessing how much standards restrict trade.
- Establishing econometric approaches that could be applied to survey and microeconomic data, to improve understanding of the role of standards in exports.

This paper—a product of Trade, Development Research Group—is part of a larger effort in the group to study new issues in international trade. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Lili Tabada, room MC3-333, telephone 202-473-6896, fax 202-522-1159, email address ltabada@worldbank.org. Policy Research Working Papers are also posted on the Web at www.worldbank.org/research/workingpapers. The authors may be contacted at keith.maskus@colorado.edu, jswilson@worldbank.org, or totsuki@worldbank.org. December 2000. (51 pages)

Quantifying the Impact of Technical Barriers to Trade

A Framework for Analysis

Keith E. Maskus*

John S. Wilson**

Tsunehiro Otsuki***

*Department of Economics, University of Colorado at Boulder, Campus Box 256, Boulder Colorado 80309-0256, and World Bank, email: Keith.Maskus@colorado.edu.
**Development Research Group, World Bank, 1818 H Street, NW, Washington, D.C. 20433, email: jswilson@worldbank.org.
***Development Research Group, World Bank, 1818 H Street, NW, Washington, D.C. 20433, email: totsuki@worldbank.org.

1. Introduction

The impact of standards and technical regulations on trade is at the forefront of global policy discussions.[1] This is particularly true in relation to challenges confronting developing nations as they seek to increase production for export markets. In regard to voluntary standards, such as those in the International Organization for Standardization (ISO) 9000 series on quality, developing nations face constraints in absorbing best-practice information on standards and mobilizing resources necessary to adopt appropriate process and production methods (World Bank 2000b). In addition, as traditional trade protection measures such as tariffs, quotas, and voluntary export restraint (VER) agreements have been liberalized, barriers to trade reflected in domestic technical regulations have become more important channels through which trade is blocked.[2]

The successful conclusion of the Uruguay Round in 1994 highlighted the importance of national standards as non-tariff barriers (NTBs). Not all market-access commitments in the World Trade Organization (WTO) Agreements have been fully implemented or enforced.[3] Neither have other barriers to trade, such as subsidies to agricultural production or prohibition on foreign investment in services, been completely eliminated. It is clear, however, that domestic regulation affecting imports through technical requirements, testing, certification, and labeling represent one of the most important new areas of focus in continuing liberalization efforts. This paper outlines why this is the case and presents an approach to empirical analysis of the impact of technical regulations on trade.

Mandatory regulations imposed by governments at the border can produce serious distortions in commercial markets. For example, domestic regulatory systems may restrain trade and limit market entry through environmental, health, or safety mandates not based on international norms. These requirements may also be discriminatory within the context of WTO disciplines, including commitments undertaken by WTO members in the Agreement on Technical Barriers to Trade (TBT) or the Agreement on the Application of Sanitary and Phytosanitary Standards (SPS).

---

[1] This paper focuses on product or process standards related to goods and agricultural commodities. It does not address standards as they may be applied in the service sector or labor standards.

[2] A number of recent studies assess changes in barriers to trade in non-tariff areas, including those of particular importance to developing countries. See Hertel and Martin (1999) and Hertel, Hoekman, and Martin (2000).

[3] For an overview of the status of implementation of Uruguay Round commitments of particular importance to developing countries see Finger and Schuler (1999). Wilson (2000) outlines specific implementation difficulties faced by developing countries in the Agreement on Technical Barriers to Trade. See also "Technical Barriers to Trade: Challenges and Opportunities for Developing Countries," Statement of the World Bank to the Technical Barriers to Trade Committee, World Trade Organization, Geneva, 24 February 2000.

In sum, technical regulations imposed on traded goods and agricultural products affect trade patterns, the ability of producers to enter new export markets, and consumer costs. While these claims are valid in principle, there is relatively little empirical evidence about technical regulations and trade. Such regulations include specific performance requirements, such as how much pressure break pads in automobiles can withstand before replacement. They also involve conformity assessment rules, which involve testing, certification, laboratory accreditation, and related labeling requirements for products.[4] Few rigorous empirical attempts have been made to determine the economic impact of differing regulations and conformity assessment requirements. Important questions remain unanswered and evidence about them would directly affect trade policy choices and the success or failure of liberalization efforts in which developing countries have a direct stake. Adding to this context, requests by industry to focus on costs of regulatory barriers to trade have accelerated over the past decade. For example, the Transatlantic Business Dialogue (TADB) and much of the work in the Asia Pacific Economic Cooperation (APEC) talks has been focused on finding ways to reduce technical barriers.[5]

The World Bank is beginning a multi-year, multi-country study of these questions. As a first harvest on this project, the Bank held a workshop on April 27, 2000 in which several economists presented current research on aspects of standards, regulations, and trade. Authors were also asked to draw conclusions about the potential for empirical research in the area and to note particular difficulties that the Bank's project might be aimed at resolving. This paper uses concepts from those studies to set out a framework for the World Bank study.

We start with an analytical overview of the policy debate and methodological issues surrounding product standards and technical barriers to trade. This is presented as a step toward providing a framework for new empirical work on standards. In the next section we discuss essential motivations for performing the research project. While the information to be gathered in the study should be of considerable value in itself, the ultimate objective is to make that information useful for national policymakers and international trade negotiators.

In the third section we examine the policy context driving the need for new data and empirical evidence. We discuss the rising incidence of technical regulations as instruments of commercial policy in trade disputes and the particular concerns of developing countries in the debate over regulations. Developing countries must shoulder additional costs in meeting mandatory government standards to serve export markets. In addition, developing countries have in place domestic regulatory policies affecting imports that continue to act as protectionist barriers shielding inefficient domestic producers from competition.

---

[4]. For a comprehensive discussion of these procedures see National Research Council (1995).

[5] For additional information on APEC see, www.apecsec.org and for TABD see www.tabd.org.

In the fourth section we review the role of standards in international trade and discuss policy justifications for reaching voluntary standards and imposing mandatory technical regulations. These justifications rest on the need to address such market failures as asymmetric information about product quality, inadequate provisions to safeguard public health, and the risk of network incoherence. We note particular issues that arise in the cross-border context. Standards have impacts on both static and dynamic market failures, suggesting there are subtle efficiency and welfare tradeoffs.

In the fifth section we review the scarce empirical literature on standards and trade. This is followed in the sixth section by discussion by an extensive discussion of the particular difficulties that exist in attempting to quantity regulations or their impacts. Data collection techniques are laid out in the seventh section, while in the eighth section we set out intended empirical approaches for the World Bank study. Our ultimate purpose is to identify techniques that are practical and may be fruitfully extended to the empirical analysis of standards and trade. Such steps would include administering firm-level surveys in developing countries and establishing econometric and simulation approaches that could be applied to micro data for understanding the role of regulations in influencing exports. We provide brief concluding remarks in the final section.

2. Reasons to Quantify the Effects of Standards and Regulations

As we discuss in the following section, there is considerable interest within the global policy community in solid empirical work on the impacts of technical regulations affecting trade. In the main, this interest reflects the belief that regulations often constitute important non-tariff barriers to trade and that their use is proliferating. Many observers claim that the trade-restricting effects of technical regulations in the developed countries are particularly costly for exporters in developing nations. These arguments arise from anecdotal examples and case studies. However, there is little systematic evidence about them. Thus, a primary motivation for the project is simply to shed light on such claims. How pervasive are technical regulations that affect trade? How do exporters and importers alter their cost structures and production lines to accommodate such requirements? Are technical barriers a reason that firms choose not to enter export markets? Are inspection procedures and labeling requirements discriminatory? Evidence on these and related questions, gathered from detailed firm-level surveys, would be of great interest to firm managers, researchers, and policymakers. For example, firm managers could use the catalogue of information developed to assess their own strategies in dealing with standards and regulations.

Ultimately, however, what matters are the policy uses to which the information will be put. We envision the techniques and results of the analysis to become inputs into programs to make more rational the complex tapestry of domestic and international regulations and standards. The key concept is "rationalization" in preference to "elimination". The former approach may be designed to facilitate trade without sacrificing important social and economic objectives. The latter approach, in some cases, may be economically inappropriate and socially costly.

To see this, consider that standards and regulations differ fundamentally from taxes and quotas on trade. Such classic trade barriers are inefficient and discriminatory taxes on foreign sources of economic activity. As such, they raise costs to consumers and input users, inefficiently allocate resources, and protect entrenched domestic market power. Economic analysis demonstrates that countries mutually benefit from negotiating their removal or reduction. For their part, regulatory barriers exist in principle to achieve important objectives that would go under-served in the private market, such as public-health maintenance or environmental protection. Elimination of such regulations could produce social losses in excess of any economic efficiency gains.

In fact, this distinction is more subtle. Tariffs and quotas may well exist for purposes of economic and social regulation. However, because they are indirect means and embody a protectionist and discriminatory element, they erect costs that would not arise from non-discriminatory regulations aimed directly at the underlying goals. Thus, it has been relatively straightforward for WTO members to establish the principle that border restraints are inappropriate methods of regulation and should be removed if there are more direct means available for achieving regulatory purposes.[6]

In principle, standards and regulations directly aim at overcoming market failures, as we discuss in Section 4. Thus, unless they discriminate between sources of supply, they do not embody secondary trade costs and may be the least-trade-restricting policies available. Indeed, under some circumstances, standards could expand trade. Any efficiency costs of standards are the investment societies make in achieving beneficial regulation. In consequence, it is not clear that the trade impacts of technical barriers are inefficient or that they should be the subject of multilateral negotiations. Put another way, removing technical regulations on trade would not necessarily achieve efficiency gains sufficient to overcome losses from weaker social protection. There is no standards analogue to the claim that free trade in goods is globally optimal.

Despite this benign view of technical regulations in the abstract, history demonstrates that countries may use them for questionable purposes in practice. Thus, regulations may discriminate against foreign suppliers, both in their construction and in their outcomes. They may be used to gain strategic international trade advantages for domestic firms over foreign competitors. They may be non-transparent and needlessly force firms to duplicate certification costs. They may be written to exclude both domestic and foreign entrants into a particular market, serving to support entrenched monopolies. Finally, they may be stronger than necessary to achieve a particular level of social protection, imposing excess costs on consumers and using industries.

Thus, rationalizing costly regulations can be beneficial. Such rationalization would entail ending discriminatory treatment, removing duplicative testing requirements, recognizing that foreign standards could achieve the same level of social or consumer protection as domestic standards, making regulation more transparent, and scaling them at levels that do not impose excess costs on consumers and firms.

[6] See Baldwin's chapter in this volume for further discussion.

In this context, the results of serious and extensive empirical inquiry could facilitate work on a number of important trade questions, beyond the fundamental one of discovering how pervasive and costly regulations are in practice. First, quantification of trade effects and production costs should provide an initial step toward supporting calculation of the welfare costs and efficiency impacts of standards and regulations. Such computations should determine whether regulations are more or less costly than classic border restraints. Second, the results should help inform governments as to whether their regulations depart significantly from the least-trade-restricting standards available for a given policy objective. In turn, governments could be urged to adopt less restrictive policies. Third, the information should provide a framework within which governments can assess the damages to their country's trade benefits from foreign regulations that may violate associated WTO obligations. In turn, they could serve as a basis for calculating compensation claims and for buttressing arguments in panel disputes. Finally, more information on how regulations operate could help resolve and limit future trade disputes. These ideas are developed further in the next section.

3. Standards and the New Trade Agenda: Why Economic Analysis Matters

There are a number of reasons why empirical work on technical and regulatory barriers to trade is particularly important in relation to the new trade agenda. Demand for such analysis and data is driven in part by the significant curtailment of tariffs and traditional non-tariff barriers (NTBs). We know considerably more about how tariffs and protective barriers such as quotas affect trade than we do about how technical barriers influence trade. For example, it is estimated that reducing by 40 percent tariffs and export subsidies in agriculture would produce a $60 billion per year rise in real global income (Hertel, et al 1999). Moreover, Hertel and Martin (1999) found that reducing applied tariffs on manufacturers by 40 percent would increase the volume of world trade by $380 billion. These data help inform policy tradeoffs and negotiating priorities.

There are demonstrable benefits for developing nations from liberalizing barriers to goods trade, including NTBs related to regulation at the border. Developing countries account for 20 percent of world total exports in goods, with manufacturing goods totaling approximately 70 percent of their overall exports. Reforming duplicative or discriminatory technical barriers, either through changes in the mandatory standards themselves or through alterations in testing and certification requirements, should increase trade and economic efficiency.

The importance of empirical work on standards is also reflected in the rising incidence of technical regulations as instruments of commercial policy. Examples of disputes brought to the WTO and other institutions highlight this fact. It is evidenced further by increased calls for harmonization of standards and negotiation of Mutual Recognition Agreements (MRAs) covering product testing and certification systems. In both these areas developing countries have a special stake, as they have had little involvement in the development of international standards and lack much of the

infrastructure necessary to support the modern testing procedures that mutual recognition of testing results requires.

3.1. The Multilateral Trade System: Standards as a Priority for Debate

There was a marked rise in the number of trade disputes over standards brought to the WTO during the past five years. The majority centered on trade in agricultural products and obligations under the Agreement on Sanitary and Phytosanitary (SPS) Agreement. The highest-profile standards cases were in agriculture, such as the dispute between the European Union and United States over hormone treated beef.[7] The use of genetically modified organisms (GMOs) in agriculture also has raised tensions that must be addressed. Among the central questions in this debate are what constitutes an "international" standard and what is "least trade distorting" within the context of WTO disciplines.

Claims that countries have violated provisions of the Technical Barriers to Trade (TBT) Agreement have also increased since 1995. Disputes over domestic regulations affecting process and production methods through which goods are manufactured are becoming more frequent. The U.S. and European Union, for example, have been debating EU draft regulations on waste from electronic and electrical equipment which would affect the use chemicals and other inputs used to produce a wide range of consumer electrical products. As a consequence, the viability of WTO disciplines to address areas where domestic regulation affects trade is being tested. This situation will undoubtedly become more pronounced as economic activity disperses further around the world and exports from developing countries of finished goods continue to grow. These countries already have status to bring complaints in the WTO, as will new entrants over the next few years such as China, Russia, and Ukraine.

As of the end of January 1999 the WTO Dispute Settlement Body had considered a total of 25 disputes that referenced either the SPS or TBT Agreements (Wilson 1999). These cases are listed in Table 1. In procedural terms these cases ranged from requests for consultations through panel and appellate body rulings. Nine of the disputes centered on food safety regulations, five cases involved technical regulations tied to customs requirements, and the remaining cases were in areas such as quotas, import bans, and disputes over environmental laws. It is important to note that although the majority of complaints brought to the WTO to date were from developed countries (19 cases), developing countries exercised their rights in six instances. Developing countries also were respondents in three cases. Finally, disputes between developed members, such as the United States and the EU, bore obvious market access implications for developing country exporters. Two cases illustrate this situation and are next reviewed briefly.

---

[7] An overview of all WTO dispute settlement cases may be accessed via the WTO website at www.wto.org/wto/dispute/bulletin.htm. and through the WTO Document Distribution Facility at www.wto.org/ddf. The U.S.-EU case on hormone treated beef is cataloged under WT/DS26 & WT/DS48.

The United States requested consultations with Japan on April 7, 1997, concerning the requirement imposed by Japan to test and confirm the efficacy of quarantine treatment for each variety of eight agricultural products: apples, cherries, peaches (including nectarines), walnuts, apricots, pears, plums and quince. Japanese regulation prohibits the importation of these products from the United States on the grounds that they could potentially serve as hosts for the codling moth, a pest considered harmful to plant life. The import ban could be lifted, however, if the exporting country proved that an alternative quarantine treatment achieved the required level of protection.

In 1987, Japan's Ministry of Agriculture, Forestry and Fisheries issued the varietal testing requirement at issue in the dispute. The law prohibits the importation of products requiring quarantine treatment until it has been tested on that particular variety. This is true even if the treatment has proven effective for other varieties of the same product. The United States maintained that these measures were inconsistent with Articles 2, 5, and 8 of the SPS Agreement. A WTO panel issued its report in October 1998, finding that Japan had acted inconsistently with Articles 2.2, 5.6, 7, and Annex C of the SPS Agreement. Japan appealed the panel's ruling.

In February 1999 the Appellate Body upheld the Panel's conclusion that Japan's varietal testing requirement, as it applied to apples, cherries, nectarines, and walnuts, was maintained without sufficient scientific evidence. The law was found inconsistent with Article 2 of the SPS Agreement. The Appellate report stated that there had to be a rational relationship between the SPS measure and the scientific evidence invoked to support the measure. It further noted that the existence of such a relationship had to be determined on a case-by-case basis, and would depend upon the particular circumstances of the case, including the characteristics of the measure and the quality and quantity of the evidence. It also concluded that the varietal testing requirement, as applied to apricots, pears, plums, and quince, was inconsistent with Article 5.1, noting that the risk assessment for codling moths conducted in 1996 did not refer to the requirement. In addition, it found that Japan had not reviewed any of its varietal testing requirements, as it was obligated to do.

Table 1. Provisions of the TBT and SPS Agreements

Referenced in Consultations before WTO Dispute Settlement Body (1995-2000)

Case	Measure	Complainant*	SPS	TBT
DS2	U.S.: Gasoline Standards	Venezuela		2
DS3	Korea: Testing and Inspection Requirements	United States	2, 5	5, 6
DS4	U.S.: Gasoline Standards	Brazil		2
DS5	Korea: Shelf-Life Regulations – Frozen Meat	United States	2, 5	2
DS12	EC:Trade Description Rules – Scallops	Peru		2, 12
DS14	EC: Trade Description Rules – Scallops	Chile		2, 12
DS18	Australia: Import Ban – Salmon	Canada	2, 5	
DS20	Korea: Shelf-Life Regulations – Bottled Water	Canada	2, 5	2
DS21	Australia: Import Ban – Salmon	United States	2, 5	
DS26	EC: Import Ban – Hormone-Treated Beef	United States	2, 3, 5	2
DS41	Korea: Testing and Inspection Requirements	United States	2, 5, 8	2, 5, 6
DS48	EC: Import Ban – Hormone-Treated Beef	Canada	2, 3, 5	2
DS56	Argentina: Customs Duties	United States		2
DS61	U.S.: Ban on Shrimp Harvested by Nets	Philippines		2
DS72	EC: Exclusion from Tariff Schedule	New Zealand		2
DS76	Japan: Quarantine Regulations	United States	2, 5, 8	
DS85	U.S.: Changes to Rules of Origin	European Community		2
DS96	India: Import Quotas	European Community	2, 3, 5	2
DS100	U.S.:USDA Decision on Poultry Product Safety	European Community	2-5, 8, Ann. C	2, 5
DS133	Slovak Republic: Transit Requirements	Switzerland	5	
DS134	EC: Import Duties – Rice	India	2	2
DS135	U.S.: Changes to Rules of Origin	European Community		2
DS137	EC: Import Restrictions – Wood of Conifers	Canada	2-6	2
DS144	U.S.: State Trucking Regulations	Canada	2-6, 13, Ann. B,C	2, 3, 5, 7
DS151	U.S.: Changes to Rules of Origin	European Community		2

**Does not include countries who subsequently requested to join consultations*

In another case, Canada requested consultations with the European Community (EC) in May 1998 regarding a decree issued by the French government in 1996. The law banned imports of asbestos and of products containing asbestos. Canada contended that

this import ban on asbestos violated articles 2, 3, and 5 of the SPS Agreement and Article 2 of the TBT Agreement. In addition, Canada claimed nullification and impairment of benefits accruing under these agreements. Resolution at the consultation stage proved unsuccessful and Canada requested that the Dispute Settlement Body establish a panel, which was formed in November 1998. The United States reserved its rights as a third party. The final panel report issued on July 25, 2000 upheld the ban by the EC rejecting the claim by Canada that the ban on asbestos constituted an unnecessary obstacles to trade. The case is noteworthy for a number of important reasons, including the fact that the panel found the ban was incompatible with national treatment provisions of the General Agreement on Tariffs and Trade (GATT), but that the EC could apply the ban under GATT Article XX. This provision of the GATT states that nothing prevents members from imposing measures necessary to protect human, animal or plant life or health.

This was the first case brought to the WTO primarily on the basis of violations of the TBT Agreement and these findings raise important issues for the future debate on trade and product standards. Among these are whether intermediate inputs to final goods, such as asbestos used in construction materials, are covered under the TBT Agreement. The ruling that they are covered provides a wider scope of coverage for TBT disciplines in potential trade disputes on product standards. It also may provide a precedent in future environmental cases at the WTO, with other exemptions for environmental standards that may restrict trade, are allowed under Article XX. In the case of asbestos, there has been a rise in use of this in developing countries for construction and other applications, such as brake pads for autos. Extending a ban on

Both of the cases outlined above raise questions about the interests of developing countries. In disputes over agricultural standards, developing countries have special difficulties and higher costs in demonstrating compliance with import regulations. As Finger and Schuler (1999) noted, the costs to developing nations of implementing requirements under the SPS Agreement in order to comply with obligations and exercise their rights are extremely high relative to development budgets. Costs of implementing the TBT Agreement are likely equally high. Moreover, technology-intensive testing and certification systems are often needed to assure that products meet required standards, especially in areas of health and safety such as asbestos. Lacking this infrastructure poses clear problems for developing countries in meeting import requirements in conformity assessment and in defending their practices in WTO cases.

As noted above, the WTO experience indicates the need for empirical analysis to inform future deliberations. In areas where there are existing trade disciplines in the TBT and SPS Agreements, data on the quantitative trade effect of government regulations are lacking. A close review of cases brought to dispute settlement at the WTO, for example, reveals that little economic analysis was used to underpin decisions.

The WTO process would benefit from such economic analysis and empirical data. Basing trade-policy dialogue and decisions largely on administrative interpretations of trade law alone is increasingly problematic in areas of highly charged health, safety, and

environmental laws. The WTO agreements require that regulations reference, where available, international norms and in the case of the SPS Agreement, that regulations in areas of risk to health and safety be assessed on available scientific evidence. While this approach is valuable as a foundation in building the rule of law in trade, as noted in Messerlin and Zarrouk (2000), reliance on scientific evidence alone to evaluate disputes may not provide adequate guidelines for their settlement.

This may be especially true in disputes over the use of environmental standards, eco-labeling requirements, and regulations for packaging and recycling. There is no clear international consensus on net costs or benefits of these regulatory rules or their specific impact on exports of developing countries.[8] Evidence does suggest that labeling requirements do pose significant obstacles for developing countries to meet (Jha, Markandya, and Vossenaar 1999). Environmental standards and labeling are increasingly, however, a source of trade friction. For example, the EU has proposed mandatory labeling for packaging material to indicate whether the packaging is suitable for recycling. The regulation would differ from international standards and those in place in other markets. Informed analysis based on quantitative data would be beneficial to understanding the impact of regulations, such as these, as well as building consensus and identifying specific implications of future trade-policy decisions in this area.

Policy disputes and lack of international consensus on how standards should be addressed in trade rules underpin the growing demand for deeper understanding of the relationship between standards and trade, both within the context of current "discriminatory" definitions in the WTO and "non-discriminatory" standards. Quantitative evidence on technical barriers would have particular relevance for developing countries. They must absorb information on international standards to meet their WTO obligations and face pressures to align national standards with international ones. Developing countries have limited resources to participate in these processes. Moreover, there is little empirical evidence that alignment or harmonization of regulatory standards in each case facilitates trade. Objective evidence would assist in understanding the precise nature of WTO obligations.

Developing members of the WTO consider standards and technical barriers a priority item in the post-Seattle trade agenda. A review of the formal and informal submissions by developing countries to the WTO in advance of the Seattle Ministerial in November 1999 reveals strong interest in addressing trade-related aspects of technical barriers and standards (Wilson 1999). This interest was expressed by large developing countries, such as India, high-income countries, such as members of the Association of East Asian Nations, and least developing nations in Sub-Saharan Africa and Central America. These members raised two critical issues among many. First, they need technical assistance in implementing WTO obligations on standards and conformity assessment. Second they are concerned about use of environmental regulations by developed countries to block imports.

[8] For a discussion of the specific links between the TBT Agreement, eco-labeling programs, and trade see Chang, (1997).

In particular, as China joins the WTO in 2000, it will be required to engineer deep reforms in domestic regulatory systems and import rules. This situation makes critical the development of new quantitative measures of the role of standards in trade if conflicts are to be avoided. A recent review of Ukraine's regulatory system commissioned by the World Bank, for example, reveals serious economic distortions in the way the government's standards, testing, and certification systems are designed (World Bank 2000a). In our judgment, reform of the standards system in Ukraine and other developing countries should be viewed as a development priority. Additional information on best-practice standards and new empirical data on the trade impact of standards would help serve both this objective and the need to meet WTO requirements.

Finally, it is important to note the work of the WTO in the Second Triennial Review of the TBT Agreement. These regular reviews of implementation and operation of WTO agreements can provide a platform for advancing rationalization.[9] This is particularly true in regard to developing countries, as the discussions in 2000 include a priority focus on developing member needs and challenges. However, the work in these regular reviews, which address non-tariff, technical barriers to trade, has taken place largely without benefit of an analytical framework based on empirical data. A stronger base of economic analysis is needed to inform trade policy as the WTO agenda extends deeper into areas of domestic regulation enforced through border measures.

3.2. Standards in Bilateral and Regional Trade Agreements: A Focus on Harmonization and Mutual Recognition.

The number of regional and bilateral trade agreements has risen rapidly over the past decade. All of these include some effort to address technical barriers to trade.[10] Examples include the Common Market for Eastern And Southern Africa (COMESA) in 1993, Mercosur in 1991 and the North American Free Trade Agreement (NAFTA) in 1994. A significant focal point in these negotiations centered on trade facilitation, advancing regulatory best practices, and removal of technical barriers to imports.

In particular, the use of mutual recognition of testing and certification procedures and related efforts to harmonize standards are among the most important policy tools advanced in regional trade talks.[11] An important factor underpinning the legitimacy of MRAs as a trade tool is that the multilateral TBT Agreement encourages WTO members to enter into these agreements. A total of 29 bilateral and regional MRAs and other

---

[9] Results of the first triennial review of the TBT Agreement are summarized at: http://www.wto.org/wto/goods/tbtindex.htm.

[10] There is an extensive literature on the impact of regional and bilateral trade agreements on the world trading system. See for example; World Bank (2000b), Baldwin and Venables (1997), Frankel (1997), and Winters (1999).

[11] The literature on MRAs from a trade policy perspective is limited. Among the most informative collection of papers on the subject can be found in OECD publications, including chapters by Roessler, Neven, and Nicoladis, among others in OECD (1996).

memoranda of understanding on mutual recognition have been notified to the WTO. These types of arrangements have proliferated with little empirical analysis on the costs and benefits of alternative policy options. Discussions launched in 1994 within APEC, and aggressive movement by the European Commission to conclude bilateral agreements with trade partners in the G-7 demonstrate anew the importance of standards and the need for empirical work to inform decisionmaking.

3.2.1. The APEC Agenda

Among the most important regional trading arrangements involving both developed and developing countries, APEC represents the largest regional grouping formed to date. Members represent about 24 percent of world trade. The APEC goal to achieve open trade in the Asia Pacific region by 2010 includes an emphasis on trade liberalization and facilitation. This part of the APEC work program has assumed greater importance over time, in part because consensus agreement on lowered tariff barriers and investment liberalization has proven difficult to achieve. The agenda on standards and technical barriers includes obligations under both Collective Action Plans (CAPs) and Individual Action Plans (IAPs). For example, APEC has launched programs to increase transparency in regulatory systems and exchange information on safety of toys. It has also funded projects such as training of customs officers in food safety inspection techniques.

APEC is driving broader policy discussions on standards and trade, in part through its relationships to sub-regional trade arrangements in the Asia Pacific. There have been 16 new sub regional arrangements in the APEC region since 1998, many of which have taken up the policy objectives APEC framed in standards in the early 1990s (Scollay and Gilbert 2000). An important objective in APEC is to move toward MRAs in regulated product sectors and related alignment (harmonization) of mandatory and voluntary standards with international ones. [12] This work is led by a Standards and Conformance Subcommittee in APEC. There is an MRA in place for exchange of information on toy safety, one on conformity assessment for food products, and an MRA under discussion covering electrical equipment.

Negotiating plurilateral MRAs such as these has consumed political energy in APEC and absorbed scarce government and private resources, with little evidence of concrete outcomes. Moreover, there are serious questions about the implementation of mutual recognition in APEC. The group acts on a consensus basis. Members can sign and implement MRAs among a subset of APEC nations and not extend privileges to others. Participation in these agreements by developing-country members is problematic,

[12] For an overview of the APEC agenda in standards see; www.apecsec.org. The "Report on Progress of Alignment with International Standards in APEC Priority Areas, APEC Subcommittee on Standards and Conformance, 1999 provides a status report on progress in alignment. Wilson (1995) includes a critique of the standards agenda, as based on member commitments in the Osaka Action agenda of 1995 which set the framework for current talks.

given their lack of technical parity in testing and certification infrastructure. Moreover, we know little about the net benefit of aligning national standards with international ones, especially for developing nations. Does harmonization benefit developing countries, even if they were not direct participants and lack the resources necessary to develop or absorb technology and information in standards? Significant pressure remains within APEC to harmonize standards in sectors such as electrical equipment, food labeling, and machinery.

3.2.2. The European Union: Exporting the MRA Model

The European Commission in the 1980s concluded several bilateral MRAs with other developed countries. The MRA model adopted is based largely on the framework developed in Europe to forge internal market harmonization. The EU has concluded MRAs with the United States, Canada, Australia, New Zealand, Switzerland, and Israel and is finalizing negotiations with Japan.[13] Product coverage varies with each agreement. The majority of these, however, cover regulations on products subject to electrical safety and electromagnetic compatibility requirements (radios, refrigerators, and the like), medical products, and telecommunications equipment, among others. The EU-Australia MRA includes motor vehicles and parts. Coverage of the MRA with the United States is estimated by the European Commission at approximately $41 billion in bilateral trade.[14] Over $1.7 billion in trade in autos and parts is covered under the MRA with Australia.

Although the European Commission has moderated its position of full support for MRAs, (Meyer 1999), it continues to negotiate them with countries seeking to join the EU and is considering extending them to other candidate nations. The EU represents about 22 percent of world trade (Bergsten 1999) and exercises significant influence in the developing world, especially in Africa, South America, and countries in the Middle East and North Africa (MENA) region. The continued advocacy by the EU of MRAs as part of its trade agenda provides powerful incentives for countries to embrace this model. Is the MRA framework suitable for development objectives and trade liberalization? Based on existing anecdotal evidence and lack of empirical data, one would certainly question the utility of such as tool. The next section expands on this theme to illustrate directions for empirical research on standards and trade.

3.3. Summary: What Does the Trade Policy Context Suggest Are Priority Areas for Research?

---

[13] Taking a broad definition of MRAs to include binding cooperative agreements between government standards and regulatory agencies to share data, information, and other expertise, the EU has entered into 12 of the 29 total agreements notified to the WTO and cited above.

[14] The Transatlantic Business Dialogue (TABD) has provided a CEO-level platform providing analysis and advice on U.S.-EU trade policy since 1995. Detailed industry sector information on MRAs is found at www.tabd.org.

We draw several conclusions from this review of standards viewed from a trade policy context and new areas of empirical research. As tariffs are eliminated, border requirements that may discriminate against foreign producers must be understood and addressed. Two issues are critical. First, information is needed in areas where government control is exercised through mandatory regulations (standards) on imports, thereby affecting the exporting firm's ability to produce to particular technical specifications or meet testing and certification requirements. Second, research can fruitfully focus on identifying the impact of barriers defined by WTO obligations as discriminatory. This avoids the problems of attempting to assess the trade impact of all standards that might affect competitive positions in the marketplace. Priority work should also be placed on assessing the impact of domestic regulations on trade in those areas where debate continues about the boundaries of WTO disciplines in the TBT and SPS Agreements. Among the latter issues are environmental standards tied to eco-labeling requirements and the issue of what constitutes an "international" standard, as specified in the TBT Agreement. The developing countries have great interests in both areas, as well.

For the most part, the disputes taken to the WTO since 1995 under provisions of the TBT and SPS Agreements meet the test of clearly defined regulatory control exercised by government. None of the cases involved voluntary standards reached through market competition without regulatory intervention. Research and data gathering focused on determining the costs of divergent government health and safety regulations seems highly appropriate, defined through definitions of discrimination within WTO rules. Determining whether regulatory harmonization and MRAs are viewed as important objectives by private firms, in contrast to other priorities should also shape the empirical research agenda. Examining the success or failure by developing country firms in entering major export markets where MRAs are complete or under negotiation would provide valuable data to inform policy.

Finally, a focus on understanding the impact of regulation on trade in both goods and agricultural products is important. There is a much more advanced analytical base in the literature on the trade effect of sanitary and phytosanitary standards to build upon, as outlined in Henson, Loader and Swinbank 1999 and Roberts 1999, among others. What is needed in this area is a richer base of empirical data on a global basis, especially to inform questions about the impact of standards in new regulatory areas, such as Genetically Modified Organisms. Firm-level data on costs of meeting differing sanitary requirements in the domestic market and those applied in major export markets is also needed, especially to inform debate over what constitutes "discrimination" in future trade talks in agriculture.

In regard to trade in goods, empirical research and data gathering should help inform on questions in which developing countries now have a direct stake. As global trade has expanded, the composition of trade has been altered. Developing countries produce and market more manufactures as a share of total exports. Given the nature of global manufacturing, they are also the location for production of components manufactured as inputs to final products -- parts for electric motors that are assembled in

a third country to manufacture lawn mowers, for example. As regulatory requirements conflict and dispersion of economic activity around the world continues, pressure on the WTO system in addressing technical barriers will increase. Data on the precise impact of regulations on trade will help in a significant way toward a more informed public policy dialogue and sound decisionmaking.

4. Analytical Overview of the Role of Standards in International Trade

A regulation is often defined as a mandatory requirement imposed by public authorities, whereas a standard is defined as a voluntary specification emanating from market forces (Sykes, 1995). Thus, competitors must comply with a regulation but may choose not to comply with a standard. While this distinction is useful for policy purposes, in the present section we use the term standards to refer to both mandatory requirements and voluntary specifications.

Standards may be categorized first by function. Product standards refer to characteristics that goods must possess, such as minimum nutrition content, maximum toxicity or noxious emissions, performance requirements, or interoperability with components systems or networks. Production process or methods standards refer to conditions under which products are made. Such standards may be directly related to the product itself, such as a prescribed chemical formulation or rules of production for wines within a geographical area. They may be more broadly aimed at production conditions that are not directly related to the final good, such as working conditions. A further type of standard is a labeling requirement, which mandates provision of information to consumers about product characteristics or conditions of production.

4.1. The Need for Standards

Standards arise for numerous reasons. In principle, they are designed to facilitate production and exchange, reduce transactions costs, guarantee quality, and achieve the provision of public goods. They may also operate, by design or by circumstance, to restrain competition.

In the first instance, standards are demanded because they contribute to the provision of public goods. Emissions standards and fuel-economy requirements can contribute to cleaner air, though whether they are the most efficient instruments for this purpose is another question. Health and sanitation requirements can raise average health status in an economy, with spillover benefits into higher productivity. Interoperability standards buttress gains from information networks.

It is possible to think of standards as public goods themselves in that a standard must appeal to a group facing a similar problem, generating joint consumption benefits (Casella, 1996; Kindleberger, 1983). In that context, standards may be non-rival in consumption. However, they are not necessarily non-excludable, for market and technical mechanisms may suffice to provide a sufficient return to standards

development. Thus, an important issue arises as to whether purely private provision of standards is sufficient and under what circumstances.

Because standards are tools for satisfying preferences, they do not remain constant over time, nor are they identical across countries. Demands for public goods vary with income levels, relative endowments of factors, information, technologies, and other variables. Accordingly, the derived demand for standards may be quite different in various countries.

Consider the potential market difficulties that standards might be used to overcome. First, standards can improve information flows between suppliers and consumers regarding the inherent characteristics and quality of products, thereby facilitating market transactions. For example, failing adequate information about products, consumers are vulnerable to the "lemons problem" (Akerlof, 1970). More generally, standardization may reduce the costs of uncertainty that consumers face in assessing product quality (Jones and Hudson, 1996). Costs include the time and effort consumers devote to search. Standards facilitate comparisons by consumers across products with common essential characteristics.

Standards can increase demand for complementary goods. Users may mix and match components within a system, thereby permitting them to choose based on broader characteristics. In consequence, demand for both systems and components may rise.

Standards can also raise the elasticity of substitution in demand between versions of similar products (Harrison, et al, 1996). Because essential characteristics are standardized and quality and performance are guaranteed, products become closer substitutes. An important implication is that trade liberalization generates a more elastic increase in demand for imported goods under standardization than under non-standardization.[15]

By permitting producers to settle on a limited range of product characteristics or processes, standards and regulations can promote economies of scale (Stephenson, 1997). Sectors that had been segmented by variable standards can be rationalized by greater output scale, albeit at the potential cost of reduced product variety. Standards may provide focal points around which firms can organize their production processes. For example, the ability of enterprises to interchange inputs can reduce inventory costs and raise flexibility. Moreover, because intermediates may be subject to quality or performance standards, characteristics of final goods attain greater certainty.

Technical standards serve as benchmarks for technological capability and guarantees of compatibility with other components or with networks (OECD, 1999; David and Greenstein, 1990). Thus, countries may choose to keep their telecommunications or information networks open to entry of new devices and technologies but would require such devices to operate effectively within the network.

[15] See Baldwin's chapter in this volume.

In sum, the essential point of standards is to support market development and facilitate transactions. They may also promote integration with global markets. The impacts may be both static and dynamic in nature. Adopting standards can improve resource allocation and help diffuse technical information embodied in products and processes. Indeed, standards themselves may embody considerable information about technical knowledge. Adherence to recognized standards provides incentives for firms to upgrade the quality and reliability of their products to required levels.

Perhaps the extreme form of this process arises in network industries, where standards are needed to promote the growth of attached users. An externality arises in that the value to any user of connection with the network depends positively on the number of other users, suggesting that networks may be under-provided in private markets. Technical standards for interoperability with the network can overcome this difficulty.

Standards and regulations are aimed also at overcoming market failures associated with public goods, such as environmental protection, sanitation, and plant, animal, and human health. It is unlikely that an individual firm would absorb the costs of investing in such standards. While the firm might try to signal its investment through some distinguishing marks or marketing programs, other firms could free ride on the development costs.

Thus, in a wide variety of circumstances it is likely that the social marginal values of standards exceed their private marginal values. Public intervention may be required to establish appropriate standards and requirements in cases where the objective is attainment of public goods.[16] In other cases, coordinated private solutions may be available through standards-setting bodies.

4.2. Standards and Trade Problems

To an important extent these observations about the benefits of standards apply across borders. Thus, a country's standards signal its product characteristics and regulatory preferences to foreign consumers and suppliers. Trade could be promoted as an extension of the market-building impacts of standards. By adhering to compatibility requirements, countries can improve their integration with global information and telecommunication networks.

However, standards and technical regulations also impose costs that could restrain competition. While this statement holds for both domestic and international markets, it is useful to illustrate these costs in the context of international trade.

The most straightforward problem is that costs of complying with standards may be higher for foreign firms than for domestic firms, implicitly erecting a trade barrier.

[16] Standards may not be the most efficient mechanism available for this purpose. For example, effluent fees or emission permits may be expected to achieve a target reduction in emissions at lower cost than mandated technical specifications (Perroni and Wigle, 1999).

Compliance involves one-time costs of product re-design and building an administrative system. It also involves recurrent costs of maintaining quality control and testing and certification. Moreover, there may be indirect costs, such as reformulating the ingredients of a food product because of a requirement to list its nutrition characteristics. Thus, a rich menu of cost-raising possibilities exists in which varying standards can raise entry barriers (higher up-front costs) or diminish the ability to compete (higher marginal costs). A variant of this problem is that firms must decide whether to establish a costly platform design that may be modified slightly to accommodate particular markets, or to design a product initially solely for the home market but with costly modifications required for export. The former strategy is more common among larger enterprises, while the latter characterizes smaller firms (OECD, 1999). Thus, compliance costs can provide an advantage to large firms in global competition.

Costs may be distinguished also between meeting the precise technical regulations and verifying that regulations are met. The latter task is called conformity assessment, and it presents the largest potential technical barrier to trade. Governments in importing countries may refuse to recognize tests performed by exporting firms or their public authorities and may not accept conformity declarations. They may insist on performing their own inspections of exporter premises and inspecting imported shipments. Thus, conformity assessment is vulnerable to bureaucratic non-transparency and susceptible to capture by domestic firms seeking protection. Time delays are particularly problematic for products subject to short technical life cycles. Moreover, the costs of uncertainty in complying with such procedures can reduce the willingness to compete.

Developing countries lag behind developed countries in their capacities for effective certification and accreditation of testing facilities (Stephenson, 1997). This situation has three important implications. First, developing countries find it difficult to develop adequate standards and reach mutual recognition agreements (MRAs) with other nations. Second, they also have not integrated themselves through accepting test results from abroad (Wilson, 1995). Third, because authorities in developed countries may not have much trust in inspection procedures in developing countries, the former group are liable to collaborate on standards and MRAs that exclude the latter group, as Baldwin discusses in his chapter. The potential for trade and investment diversion in this scenario seems extensive.

Variable international standards can serve to segment markets, raising market power and erecting entry barriers. For example, a simple requirement that product packaging or instructions be stated only in the importer's language makes it impossible for arbitragers to ship goods to higher-priced markets with different languages.[17] Markets would be better integrated under a rule permitting firms to use multiple languages.

It is evident that governments and firms could establish strategic standards that aim to achieve market closure, alter the terms of competition in favor of domestic firms,

[17] In their chapter, Ganslandt and Markusen simulate the costs of preventing arbitrage through the erection of standards.

or improve the terms of trade (Matutes and Regibeau, 1996; Fischer and Serra, 2000). In one example, if costs of converting to a new network are large, a subgroup of countries might find it advantageous to form an exclusionary standards union, to the detriment of excluded countries (Gandal and Shy, 1999). Standards not only could achieve static market exclusion but also could strengthen dynamic market power.

4.3. Recognizing Protectionist Standards

This complexity means that it would be difficult -- perhaps impossible -- to identify standards as protectionist trade restraints. Because standards are aimed at correcting market failures, there is no general presumption that relaxing or coordinating them would improve efficiency. Standards do not directly generate identifiable price wedges and rents, as do tariffs and quotas. Rather, their impacts are embedded in product prices, which depend on the market power created (or destroyed) by standards and regulations. Such rules could also protect monopoly rents. However, it would be difficult to unravel these kinds of effects from other influences on prices and market structure.

However, some principles may be used to consider the role of standards in restraining trade. First, if a standard or its enforcement is purely cost-raising (e.g., through delays in inspection or arbitrary fees) it is inefficient and should be removed. Second, if a standard is set at a level that is stronger than needed to achieve a particular policy goal, it may have protectionist intent by virtue of reducing foreign profits at the expense of domestic profits. One mechanism for defining such a protectionist standard is to ask whether it exceeds the regulation a government would choose if all producers were domestic (Fischer and Serra, 2000). Another mechanism is found in the WTO definitions on "least trade distorting" and "non-discrimination" in the TBT and SPS Agreements.

Third, if a standard (whether mandated or voluntary) is discriminatory in application or effect between domestic and imported firms, the margin of discrimination could be viewed as unnecessary protection and removed. Fourth, we could question whether a standard is chosen that is least disruptive to trade among available policies. And, finally, a standard might be considered protectionist if it mandates excessive caution in relation to scientific and reliable measures of risk. Note that the principles in this paragraph are incorporated into the TBT and SPS agreements.

4.4. Standards Coordination

Standards vary naturally across countries because of different levels of development, technological capabilities, endowments, and preferences. International harmonization of technical standards is virtually impossible. However, some forms of coordination could expand market access for developing countries. We discussed earlier some of the practical difficulties in achieving coordination in the WTO and among particular groups of countries. Here we make a few analytical points.

Developing countries may wish to achieve more effective representation at the deliberations of international standards-setting bodies. The standards advanced are typically voluntary but could have exclusionary effect when set by a small set of national or industry interests. Developing countries should also closely examine the adoption of technical standards developed in industrial countries, such as the United States or Canada. From an economic efficiency perspective, there is no reason why developing countries need to construct domestic capacities for standards development in all industrial sectors. By moving toward more harmonized regulatory approaches, developing countries would directly absorb the technological knowledge inherent in standards and also promote inward technology transfer. We know of no empirical study that examines this hypothesis.

Finally, exporters, in theory, may gain from mutual recognition agreements among themselves and with developed countries. However, the negotiation of such MRAs is dependent on building effective and competent domestic standards and procedures for conformity assessment and inspection. In this context, technical assistance would be beneficial. As noted above, caution should be exercised in aggressively seeking MRAs. While there may be some gains to regulatory competition among MRAs (OECD, 1999), it is not evident that such arrangements necessarily avoid races to the bottom. Moreover, an extensive web of bilateral and plurilateral MRAs raises risks of extensive discrimination.[18]

5. Review of the Empirical Literature

Four approaches exist in the literature for studying standards, regulations, and trade. These include surveys of firms' cost responses to regulations, macro-level econometric analysis of standards and trade, partial equilibrium models, and computable general equilibrium (CGE) models. Each approach provides useful insights and a basis for building further work.

5.1. Surveys

OECD (1999) conducted a survey of 55 firms in three sectors in the United States, Japan, the United Kingdom, and Germany. The sectors were terminal telecommunications equipment, dairy products, and automotive components. The purpose of the study was to examine the extent to which technical standards and conformity assessment procedures impede trade. Perhaps the most striking finding was that few firms considered standards to be of great concern. In telecommunications equipment firms reported wide differences in standards but most thought these differences amounted only to a minor problem. In dairy products there were problems in certification and approval delays for exporters of specialty products, but dealers in bulk dairy goods reported few difficulties. In auto parts there were significant costs imposed on a small range of products.

[18] Baldwin discusses this problem in his chapter.

Among those firms that estimated their additional costs of complying with foreign standards, the estimates ranged from no cost increase to ten percent, with most coming near the bottom of this range. A few firms reported that they chose not to enter a particular market because of expected regulatory costs. These firms tended to be the smaller ones in the sample, suggesting that standards do serve as relatively greater entry deterrents for small enterprises.

The interviews conducted by OECD supported a number of conclusions. First, harmonization can be helpful in lowering costs of product redesign and testing. Second, MRAs on conformity assessment procedures reduce trade costs. Some respondents claimed that competition among approval agencies has lowered costs of application and registration. Third, meeting the terms of voluntary standards was a larger issue than meeting mandatory ones. In effect, mandatory standards certify that a product may be imported but does not provide entry into local voluntary codes and requirements. Fourth, small companies relied heavily on external sources of information and could not spread these costs among much output volume. They were, therefore, considerably less likely to export than were large firms.

The United States International Trade Commission (1998) performed informal interviews of corporate executives, officers of trade associations and government officials for their views of the importance of standards as trade impediments in the information technology (IT) industry. Surveys were conducted in the United States, the European Union, and various countries in Asia and Latin America. The authors could provide only testimonial statements and did not attempt to categorize their results statistically.

Their principal finding was that many IT firms considered duplicative and discriminatory testing and certification requirements to be a substantial barrier to trade. Indeed, some representatives of the U.S. industry claimed that standards-related costs mounted the most significant trade restriction in the sector. One reason is that satisfying multiple conformity assessment procedures and varying labeling requirements in different countries is costly because inputs and products are sourced from numerous locations. This makes it difficult to apply varying inspection rules and labels to products, the ultimate destination of which is unknown at time of production. A further cost is that approval and testing procedures in importing nations are often lengthy in duration, a substantial problem in a sector with short average product life cycles. For example, meeting the EU's tests for telecommunications equipment was estimated to take six to eight weeks, reducing product value by five to ten percent (USITC, 1998, 4-2). Similarly, costs of registering products to recognized standards, such as ISO 9000, exceeded $245,000 per American telecommunications firm. These firms thought the registration was unnecessary and redundant in view of their own quality assurance systems. An estimate by an industry association claimed that duplication of mandatory U.S. and EU testing for computers, telecommunications equipment, and similar IT products raised costs for U.S. companies by more than $1.3 billion annually (USITC, 1998, 4-8). Finally, some importing nations require compliance with specific norms that duplicate international standards, raising an additional and unnecessary testing cost.

The study noted that some industry analysts thought the 1997 U.S.-EU MRA in IT products (and other goods) would reduce direct costs to IT firms by $1.3 billion and would achieve further gains through shrinking approval periods and raising competition among testing laboratories (USITC, 1998, 5-3). American trade officials thought that the 1998 APEC MRA on telecommunications equipment would increase intra-APEC trade in IT goods, which amounted to $45 billion that year. Finally, some analysts noted that potential efficiency gains could be realized if governments shifted toward unilateral recognition of foreign conformity assessment and supplier's declarations of conformity.

Henson, et al (2000) studied problems that developing countries have in meeting the SPS requirements of the developed countries and in adhering to the provisions of the SPS Agreement. They interviewed officials of multilateral organizations and performed a survey of developing-country members of the WTO or Codex Alimentarius. They claimed that developing countries are strongly constrained in their ability to export food products by SPS mandates in developed nations. Such requirements were ranked as the most significant constraint on exporting agricultural and food products to the EU, ranking ahead of transport costs, tariffs, and quotas. Among destination markets, the European Union afforded the most problems, followed by Australia, United States, Japan, and Canada.

Unfortunately, survey questions were qualitative in nature and could support no statistical analysis. The authors illustrated potentially costly impacts on developing-country exporters through a series of examples of SPS measures. These case studies provide an interesting compendium of circumstances under which exporters might find foreign market access restricted by a failure to maintain sanitary conditions in production or through hasty decisions by importing nations. The report also detailed difficulties that developing countries face in effectively participating in the SPS Agreement.

5.2 Econometric Studies

Two recent studies have related trade flows to measures of a country's stock of standards. Both Swann, et al (1996) and Moenius (1999) discussed the multiplicity of economic hypotheses about trade and standards, noting that virtually any prediction could be supported. Swann, et al (1996) regressed British net exports, exports, and imports over the period 1985-1991 on counts of voluntary national ("idiosyncratic") and international standards recognized by the United Kingdom and Germany. Standards counts were taken from the PERINORM database and concorded to the 3-digit Standard Industrial Classification (SIC). There are numerous problems with using counts of standards to measure the effective stock of technical specifications that could affect trade.[19] Standards vary in importance across sectors and products and different standards would not be expected to have similar effects.

The authors discovered that British national standards tended to raise both imports and exports. The coefficient in the imports equation was 0.34, while that in the exports equation was 0.48. This suggested that a 100-unit increase in British national standards

[19] The same situation applies to patents count data.

would raise manufacturing imports by 34% and manufacturing exports by 48%, which are highly elastic responses.[20] International standards to which Britain was a party had little impact on imports but a positively significant effect on exports, though at 24% this effect was smaller than that of the national standards. Idiosyncratic German standards tended to raise British imports significantly but had a negative effect on British exports.

The authors concluded that the imposition of British standards had a positive effect on both UK exports and imports. Thus, they served both to signal quality abroad and to raise import demand in the UK. They interpret the positive effect in imports to imply that idiosyncratic British standards raise costs disproportionately for domestic firms, bringing in lower-cost imports. It is impossible to make such a fine inference from their work, however, for the theory and regressions do not support such distinctions. They further concluded that German standards reduce British exports, perhaps suggesting a protective impact. Note that the two findings are inconsistent and the authors offered no explanation. Finally, they found that idiosyncratic standards raised trade more than international ones. They posited that the smaller effect of international standards reflected a tradeoff between more trade based on higher economies of scale and less trade associated with reduced product variety. This hypothesis went untested, however.

Moenius (1999) advanced this approach by incorporating standards counts data from PERINORM for 12 countries and 471 4-digit industries from the Standard International Trade Classification (SITC) into a gravity-based analysis of bilateral trade volumes over the period 1980-1995. He distinguished between country-specific standards, measured by the number of documents specifying a technical requirement solely within a country, and bilaterally shared standards, measured by the number of documents linked between two countries covering the same code. Objections raised about the information content of count data are particularly problematic with these linked standards. The sample used in the regression analysis included eight countries currently in the EU plus Switzerland, Australia, Poland, and Turkey, with U.S. and Japanese counts also made for comparison purposes. Note that this is the only study to incorporate data from a transition economy and a developing economy.

At the simplest level, it could be hypothesized that country-specific standards are implicit non-tariff barriers and restrict trade flows, while shared standards remove the underlying cost differences and raise trade. However, there are many channels through which both standards types could affect international trade. For discussion purposes it is useful to reproduce his summary table here as Table 2. For any geographical designation of standards, hypotheses exist that trade could either rise or fall. However, there seems a presumption that shared standards should increase both exports and imports on balance, importer-specific standards should reduce imports, and exporter-specific standards should have indeterminate effects on exports. Note that the sign pattern in each row is distinctive, so that econometric analysis bears some promise of distinguishing among these theories.

[20] Indeed, the response is so great that it defies belief, given that 100 additional standards would represent only a small rise in the British standards count. It seems likely that the authors misinterpreted the units inherent in their data or estimation.

Moenius (1999) regressed bilateral trade volumes in 4-digit SITC sectors on counts of shared standards and an array of dummy variables to account for other trade determinants in country pairs and years. He found that shared standards had a positive and highly significant effect on trade volumes, with a one percent rise in shared standards associated with perhaps an 0.32 percent increase in trade. This result held up when he added a lagged dependent variable to control for first-order serial correlation. By his calculations, taking an average elasticity across his specifications of 0.35, a one percent rise in shared standards between the United States and its trading partners would raise U.S. trade volumes by $6 billion, which seems economically significant. Finally, causality tests could not reject the hypothesis that increases in standards raise trade volumes and increases in trade generate higher numbers of standards in a feedback effect.

He also regressed bilateral import volumes on the same variables but added importer-specific and exporter-specific standards, along with dummy variables selecting 2-digit aggregate industry categories in an attempt to control for relative price variations across sectors. He found that shared standards raise imports significantly, with an elasticity of 0.16. Interestingly, the number of importer-specific standards also tended to increase imports slightly, rather than to reduce them as expected if standards are NTBs. Exporter-specific standards had a strongly positive impact on import volumes, with an elasticity of perhaps 0.27, supporting the idea that such standards provide a signal of quality and reliability to importers.

Moenius refined this result by repeating the analysis for industries grouped at the one-digit SITC level. He found that importer-specific standards significantly reduced imports for the non-manufacturing sectors but significantly raised them for manufacturing sectors. In contrast, exporter-specific standards were positively associated with most grouped trade flows.

This is his key finding and the author advanced an intriguing explanation for it. In particular, standards and codes have offsetting impacts on costs. By forcing adaptation, testing, and certification to meet needs in particular markets, importer-specific standards raise compliance costs and should reduce trade. However, both shared standards and country-specific standards should reduce the costs of acquiring information about market preferences and product quality, serving an important signaling function and raising trade.[21] The reduction in information costs should be particularly valuable for manufacturing products, which are subject to more variety in characteristics and technological specifications. The cost-raising aspects of standards may be more prevalent for more homogeneous non-manufactures.

[21] This distinction among standards is similar to conflicts in intellectual property protection between cost-raising market power and cost-reducing certainty benefits (Maskus, 2000b).

Table 2. Predictions of Theoretical Literature about Standards and Trade

Theory	Shared Standards	Country-specific Standards Importer	Country-specific Standards Exporter
Non-tariff barriers:			
Mainstream/strategic alliances	+	-	
Competitive disadvantage		+	-
Standardization trap	+	-	-
Competitive Advantage		-	+
Loss of Variety		+	+

Source: Moenius (1999).

5.3. Partial Equilibrium Studies

Partial equilibrium models provide a framework for analyzing tariff-rate equivalents of standards and technical regulations and associated welfare changes. Tariff-rate equivalents are estimated as a price premium that exporters must overcome in addition to the world price plus tariff. Welfare change is estimated by investigating impacts on domestic consumer and producer surplus caused by an increase in costs to comply with standards and possibly also the change in domestic utility reflecting improved product quality. Demand and supply elasticities are often calibrated from existing studies. At the sacrifice of generality, the partial equilibrium approach has the advantage of transparency and comprehensiveness in analyzing changes in various welfare components and in incorporating specific details of standards and regulations.

Specification of the manner in which standards affect markets varies across studies, depending on whether regulations are thought to benefit consumers, producers, or both, and on whether exporters are obliged to face a higher implicit tariff rate or higher compliance costs. Thilmany and Barret (1997) studied the implications of technical regulations for dairy exports from the United States to the other NAFTA member countries. In their approach, both demand and supply curves were assumed to shift up. The shift in the demand curve reflects the effect of standards to alleviate consumer uncertainty about product quality, and the shift in the supply curve is due to increased transaction costs of export including compliance costs. While they were unable to separate non-tariff and tariff effects in their empirical analysis, they compared domestic and international prices to estimate the producer subsidy equivalent and import tariff-rate equivalent of these trade barriers. They indicated that domestic producers are not necessarily subject to the standards, and that standards are often used to protect domestic producers as well as tariffs, thereby hurting domestic consumer welfare.

Paarlberg and Lee (1998) studied the case of U.S. tariff protection against beef imports from countries that may transmit Foot-to-Mouth Disease (FMD). In their approach, the domestic government is assumed to maximize the country's welfare by setting the optimal tariff rate, where expected loss of domestic beef production due to the FMD infection to U.S. livestock has been incorporated *ex-ante* into the tariff rate. They found that the magnitude of the optimal tariff, in the presence of an FMD risk, is very sensitive to the specification of the risk of importing FMD and to the size of output losses expected from an FMD outbreak. For example, holding expected output loss constant at 15.5%, the optimal tariff would rise from 8.1% to 929.4% when the import volume that is expected to cause one outbreak falls from 215,000 tons (low risk) to 24,000 tons (high risk). Put another way, an increase in the anticipated U.S. beef output loss from 1.4% to 15.5% would cause the tariff to rise by 86.8% and 929.4%, respectively, when one outbreak is expected for every 215 thousand tons of imports

Calvin and Krissoff (1998) studied Japanese imports of U.S. Red and Golden Delicious apples by calculating price and welfare effects of sanitary and phytosanitary standards. They compared Japan's welfare under two scenarios, with and without a loss of domestic production due to transmission of fire blight disease through importation.

The tariff-rate equivalent of the standards was estimated to be 27.2% in 1994-1997, which is high compared with actual tariff rate of 19.3%. When the production loss due to the disease outbreak was not considered, producer welfare loss directly related to trade from elimination of the standards was estimated to be $210 million per year, or 30% of original producer welfare. On net the welfare change in Japan was still positive, at $ 70.9 million, because there were larger gains in consumer welfare and tariff revenue. In the presence of production loss, the domestic supply curve was shifted up to reflect the additional production costs such as pruning. It was found that a 26% domestic output loss would be required to offset the net trade gain from eliminating the standards. The statistical probability of such a loss would be negligible. One drawback of the analysis is their rather strong assumption that the difference between the Japan's domestic and world prices plus tariff rate are solely ascribed to the price premium for the standards.

5.4. Computable General Equilibrium Studies

Computable general equilibrium (CGE) models provide considerable scope for understanding how changes in standards and technical regulations might affect trade and investment in various market settings. However, their measures of standards are necessarily heavily aggregated and cannot capture the complexities of codes as they exist at the detailed sectoral level. In that sense CGE studies incorporate crude specifications of standards into complex theoretical specifications, generating interesting predictions about how liberalization of technical barriers to trade could alter competitive prospects and rationalize industry. As policy guides, they are only suggestive.

Two studies are noteworthy in this context. Gasiorek, et al (1992) set out a CGE model of the EU economy with increasing returns to scale (IRTS) in several sectors. They modeled two scenarios, both of which assume that harmonization of standards in the EU would reduce trade costs by 2.5 percent. That is, technical regulations were assumed to be "sand in the wheels" and their harmonization would remove the associated inefficiencies. In the first case markets in various EU countries would remain segmented by other factors, permitting firms to mark up prices on the basis of local demand. In the second case markets would be fully integrated and firms would set uniform prices throughout the region based on EU-wide demand. They also distinguished between short-run effects, with fixed number of firms, and long-run effects, with endogenous firm exit.

This model generated large impacts on production and trade. In the IRTS sectors, EU production and exports would rise considerably due to the smaller costs. There would also be substantial trade diversion as imports from outside the EU were displaced by intra-regional production. Such impacts were even larger in the integrated-markets scenario. Welfare gains for the EU could be sizeable, at perhaps one percent of GDP in the short run and higher in the long run as inefficient firms leave production.

Harrison, et al (1996) extended this work in a number of ways. They questioned whether even full harmonization of standards would generate complete price integration

in light of American evidence suggesting otherwise.[22] They advanced a CGE model with monopolistic competition in which the EU would gain from additional competition and rationalization but firms would retain a reduced ability to price discriminate. They adopted the Gasiorek, et al convention of a 2.5 percent reduction in standards costs. However, they added a demand-side channel for gains from harmonization. In particular, harmonized standards should raise information about foreign products and raise consumer confidence in their characteristics, raising the elasticity of substitution between home and other EU products. They implemented this notion by permitting the intra-EU substitution elasticity to rise from a level where other EU products compete with products from outside the EU to a level where all EU products are considered home goods.

They found that the 2.5 percent fall in standardization costs would generate a welfare gain of up to 0.5 percent of GDP. Adding the possibility of higher substitution would more than double this gain, albeit at the cost of shifting demand away from extra-EU imports. Finally, they calculated that in the long run investment would increase due to a rise in the real return to capital. In the new steady state equilibrium, welfare benefits could reach 2.4 percent of GDP per year.

6. Problems of Measurement

The prior discussion suggests that it is difficult to develop adequate measures of the stringency and effects of TBTs. Indeed, they have been characterized as "...one of the most difficult nontariff barriers imaginable to quantify" (Deardorff and Stern, 1998, p. 119). There are several conceptual and practical reasons for this difficulty, which we now review, with the aim of informing future analysis.

6.1. Basic Notions

Consider the simplest case of measuring the effects of a pure cost-increasing industrial standard that is imposed on imports coming into a market in Figure 1. In the diagram, ED represents the domestic country's excess-demand (import) curve, while ES depicts the foreign country's excess-supply (export) curve. Suppose the standard erects an additional dollar cost per unit imported, due to conformity assessment or inspection requirements, shifting ES up to ES + c. The following questions could be posed about the effects of this standard.

Is the standard discriminatory? In the diagram, if ED does not incorporate an identical cost standard, the rule would discriminate against imports, causing them to fall as depicted and forcing exporters to absorb a lower net price, p_1^f as domestic price would rise to p_1^d. However, if the same standard were imposed on domestic production (here assumed to be perfectly substitutable for imports), the ED curve would rise by the same amount, with the effect being no change in quantity imported or exporter price but a domestic price that would be higher by c. In this context, a higher domestic price for the imported good is not necessarily indicative of a discriminatory standard and the usual

[22] The Gasiorek, et al approach predicts a fall in intra-EU trade volumes after price integration because production for domestic markets avoids transport costs.

tariff equivalent price measure of $(p^d-p^f)/p^f$ may be misleading unless compared to the cost increase imposed on domestic firms or to import quantity.

What are the appropriate measures of price and quantity change? In the simple case presented here, the compliance cost would generate an additive wedge between the foreign and domestic prices at any level of imports. However, the higher is the foreign price, the lower is this percentage tariff-equivalent, so that the standard price measure would depend on the final equilibrium point. This point is important when we recognize that the same absolute cost standard, if imposed by different importers with varying elasticities of excess demand, would generate different price measures of its restrictiveness. Put another way, quantity effects of the standard depend on market circumstances so it becomes difficult to assess them across countries without more information.[23] A purer measure, independent of the demand curve, would be to compare prices at the unchanged quantity level, by defining the tariff equivalent as $(p_0^d-p_0)/p_0$. However, it is unlikely that these prices are observable unless one has time-series information on prices and imports just before and after a standard is imposed.

There are many practical reasons why such price-based measures could be flawed. It is not possible to use a measure of c to calculate the implied domestic price in the absence of such cost data. However, technical regulations are not specified as some absolute monetary cost per unit imported. Rather, they are rules under which inspection or conformity assessment procedures will be adequate for market entry. Thus, the per-unit cost would vary by exporting partner, depending on underlying costs, the efficiency of assessment mechanisms, and the initial volume of imports if there are economies of scale in testing. These issues are taken up further below.

What is the impact on the shape of the export supply and import demand curves? Again, regulations are unlikely to entail this simple additive cost. If they raised costs as a constant proportion of price or import value, the new ES curve would pivot upward from the intercept and be steeper than the original one. While the tariff-equivalent measure of the cost would be independent of quantity, the impact on imports still would depend on demand elasticity.

If a regulation raised fixed costs of exporting but had no impact on marginal costs, the proportionate cut in imports from small-volume exporters would be larger than that for large-volume exporters. It is possible that such a change could eliminate imports from smaller trading partners in the long run. Thus, if p_1^d were the domestic price of the most efficient exporter with the regulation in place, other exporters would need to meet that price, which could be impossible on a small volume with increasing returns to testing. It is evident that regulations can be discriminatory in effect if not in intention. In this regard, it is important for researchers to attempt to distinguish between impacts of technical regulations on fixed costs and variable costs.

The regulation could also affect the ED curve. If it were a requirement for customs inspection, for example, costs and delays could make it operate in a similar

[23] Deardorff and Stern (1998) develop this point.

fashion as an import quota, with the demand curve becoming highly inelastic after some manageable level of imports. In this case, the tariff-equivalent price measure would depend on the proximity of import volumes to the inelastic range.

How does the regulation affect preferences? The position of the ED curve reflects a degree of consumer confidence in the imported good in the absence of a technical standard. The standard could signal consumers in the importing market that a product is safe, thereby reducing consumer uncertainty associated with inadequate information. The ED curve would shift to the right in Figure 1, reversing the decline in imports associated with the cost impact. It is possible over time to observe a higher domestic and foreign price and also a higher import volume. In this context, the original price wedge would become a misleading indicator of the impacts of the standard and it would be important to track market responses over time.

A further mechanism by which demand would be affected is that the regulation could increase the elasticity of substitution between the imported good and domestic products and products imported from other nations. How this would affect the ED curve would depend on the nature of substitution, as demonstrated in the Ganslandt-Markusen paper in this volume. Ordinarily, however, it would be expected to increase the price elasticity of import demand, rather than reduce it as is often be the case with more conventional NTBs.

6.2. Complications

These basic observations point to the inherent difficulty in sorting out the various impacts of a technical regulation on trade, prices, and ultimately economic welfare. However, additional complications arise that should be considered in an accounting of economic impacts. Many of these are discussed at length in other papers in the volume and we only highlight them here.

An obvious difficulty is that the impacts of regulations could vary considerably over time, depending on shifts in market demand and supply. Thus, for example, the tariff-equivalent price impact would depend on exporter price, itself a function of such variables as changes in technology, weather, and trade policies in third markets. Such variability can impose an additional cost on society.

One reason for regulating imports through sanitary and technical standards is to manage associated risks, such as an outbreak of a plant or animal disease. However, a regulation may not fully eliminate risk from imports; indeed, we would not anticipate an optimal regulation (one that balances costs and benefits at the margin) to do so. Rather, the regulation may reduce the probability of an outbreak and alter the variance of its distribution. Therefore, the import demand curve could shift in complex ways after the introduction of a standard. Imagine, for example, that in the absence of a regulation the probability of disease rises with the quantity of imports and is highly uncertain.[24] Further, suppose that the increase in marginal costs imposed on domestic producers in the

[24] See James and Anderson (1998).

presence of an outbreak depends on the quantity of imports but is uncertain. If consumers and producers are both risk-averse, a mean-reducing risk-management regulation would expand both consumption demand and domestic supply, with ambiguous effects on the ED curve in the neighborhood of free trade. However, if the regulation did not reduce the probability of an outbreak but tightened its variance, we would observe a rise in excess demand. Thus, the nature of the underlying risks and how they are affected by policy is of interest. It is evident that this factor would further complicate welfare calculations.

While technical barriers can manage risks, they may be subject to considerable uncertainty themselves. To the extent that they are applied in an arbitrary or variable manner, they would impose uncertainty costs on exporters. These costs could have potentially significant negative impacts on exports in the presence of fixed costs or an inability to divert products among destinations, and could limit investment in export facilities. This possibility seems particularly relevant in the area of technical regulations and standards, which may not be transparent due to their complexity.

In another vein, products are likely differentiated rather than perfect substitutes. In a differentiated products model with varying marginal costs among suppliers, a common standard can have distinctive impacts across competitors. Thus, for example, Egyptian and Moroccan exporters might react differently to a regulation imposed in the United Kingdom. Alternatively, the reaction of an Egyptian exporter to a regulation in the United Kingdom might differ from its reaction to a similar regulation in Germany. Moreover, when products are differentiated a country could be both an importer and exporter of products affected by the same standard. In this case, a regulation that reduced the risk of importing a disease could promote exports by raising consumer confidence abroad. Tracing through such complicated effects would be a difficult empirical task.

Three other issues emerge in this area that could be important. First, markets may be imperfectly competitive, unlike that in Figure 1. It is evident that firm reactions to technical regulations could be markedly different in the case of oligopoly under varying degrees of increasing returns and entry conditions. Second, the effects of standards could depend on the existence of other standards, taxes, and market distortions. There may be interaction effects across sectors through inter-industry linkages or allocative decisions arising from standards, the extent of which would depend on alternative market barriers. These types of questions could be analyzed most readily in a CGE framework.

Finally, as some of the papers in this volume attest, standards could be endogenously set in some political economy process. Presumably such an outcome would be reflected in standards or procedures that discriminate against foreign suppliers, suggesting that a finding of extensive discrimination in itself could be evidence of endogeneity. It is possible that the trade-restrictive impacts of regulations could be underestimated if this causation is not accounted for. However, such an accounting lies beyond the scope of the current project.

6.3 Practical Difficulties

These conceptual problems are compounded by certain practical complications that make direct measurement of technical regulations especially difficult. First, they are complex in design and operation. Standards are not simple taxes, nor are they quantitative limits on trade or percentage procurement preferences. Rather, they are complicated specifications of such characteristics as minimum quality, maximum toxicity, ambient characteristics in the production environment, and technical compatibility, along with rules for demonstrating conformity. If products meet such rules they are permitted access without further limitation, at least in principle. Direct quantification of such rules typically is infeasible, except in cases where they are written as numerical limits and are comparable across countries or products. Rather, they need detailed description and micro-level analysis in which responses of individual firms are investigated.

A related issue is that the effects of standards may depend on their method of administration. It is evident that unreasonable delays in inspection and certification can erect a barrier to business certainty and trade. Sampling techniques and requirements could vary by trading partner, affecting export decisions. If administrative procedures are sufficiently unclear and variable, they could have a significant deterrent effect on investments in export facilities that would restrain trade more than the regulations themselves might suggest.[25]

A final practical difficulty relates to aggregation. Researchers may wish to characterize the regulations of particular countries, or facing particular products, in an index that captures some aspect of their operation, such as severity of trade impacts or degree of information revelation. In doing so, analysts would face the usual problems of deciding appropriate weights to choose in the aggregation. Import or export weights can be misleading if regulations limit or expand trade considerably. Production weights by importer or exporter would presumably, but not necessarily, be less biased. The best choice would be world production weights but such data may be difficult to find for detailed product categories.

The more difficult problem is that the complex nature of regulations in itself may make aggregation questionable. As noted below, simple counts of the number of regulations mixes those with significant effect and those with little impact, biasing the overall index. They also bunch together regulations of different types (quantity-based, quality-based, process requirements, inspection and certification rules), which may not be comparable. To make them comparable, analysts need to normalize them in terms of some economic impact, such as a relative cost or price effect. These economic impacts could then be weighted to establish the aggregated index. Even then analysts should state clearly what the information content of the index really is.

The list of conceptual and practical problems we have discussed pose daunting problems for empirical analysis. However, we contend that many of these issues may be addressed satisfactorily through firm-level survey analysis that permits careful and

[25] Deardorff and Stern (1998) discuss this problem in the context of import quotas.

detailed investigation of how enterprises react to technical regulations. For example, the problems with the price-based measures noted above stem from the desire indirectly to infer the effects of regulations through associated price data. Such data may not be capable of identifying the supply-side effects of interest to exporters. Thus, surveys focused on cost impacts and actual trade decisions should be informative. In the following sections we present central aspects of the proposed research program.

7. Data Collection

Our ultimate objective is to develop useful evidence on the scope and consequences of TBTs for firms in developing countries. This requires specification of an empirical framework for the analysis. The initial task is to gather data that would improve our knowledge base. Among the many issues that could be investigated, the primary ones are as follows. First, within selected sectors and countries, how pervasive are regulations that could affect trade? Do exporting firms face more (or more costly) regulations imposed by domestic governments or by governments in importing countries? Does this mix of regulations vary by level of economic development? Second, what are the costs of complying with such regulations? These costs come in three categories: production or design costs, conformity assessment costs, and costs of meeting variable standards in different markets. Third, do mutual recognition agreements bear potential for reducing such costs?

These complex questions cannot be answered with currently available information and may defy precise quantification. Nonetheless, a comprehensive effort to gather and analyze data would create an important information base and improve our understanding of the relevant processes.

7.1. Policy and Industrial Surveys in Developing Countries

The World Bank research team will design and administer surveys of manufacturing firms in key developing nations. These instruments will elicit information on cost structures, production and exports, impediments to domestic sales and exports, and operations to conform with regulations. They should be administered to as many firms as possible, depending on budgetary costs. Public agencies and standards-setting bodies would also be surveyed to elicit information on the important standards and TBTs in each country and how these are established.

Country Selection. The countries included should cover a range of economic development and export experience yet have sufficiently deep agricultural and industrial structures to permit sectoral comparisons. The research team has chosen the following list of nations for study.

Sub-Saharan Africa: South Africa, Senegal, Mauritius.
Latin America and Caribbean: Argentina, Chile, Panama, Honduras.
South Asia: India.
East Asia: Thailand, Malaysia, Vietnam.
MENA: Egypt, Morocco.

Europe: Poland, Czech Republic, Bulgaria.

Sector Selection. The sectors chosen should be those of actual or potential comparative advantage for developing countries and for which regulations are important. The research team has chosen the following list of sectors, which cover several areas of regulatory scope.

Fresh produce: food safety, human health, SPS.
Processed foods: food safety, human health, SPS.
Electrical and electronic equipment: electrical safety.
Industrial or agricultural chemicals: environmental protection.
Textiles and apparel: environmental protection.
Telecommunications terminal equipment: electromagnetic interference.
Automotive parts: safety.

TBTs Selection. In the main, the standards about which the surveys will generate information are dependent on respondents' answers. Specific firms may pay more attention to standards of particular concern to their product lines than to broader sectoral or national regulations. Yet for comparative purposes it is useful to develop information about the operation of identifiable regulations in both domestic markets and export markets. For example, it is interesting to discover whether the responses of South African and Egyptian exporters to a British regulation are different and whether those responses are further differentiated between the British and the American regulation. Conformity assessment procedures may be particularly important in this context. Thus, for each sector incorporated into the analysis it is desirable to characterize the major TBTs in important export markets. This will further help interviewers guide respondents' attention to international cost comparisons. Selected export markets will include the United States, Japan, Canada, Australia, the European Union (to the extent there are common regulations), or specific EU countries, such as Germany, the U.K., and France.

Time Selection. It will be important to repeat the surveys in at least two respondent countries annually over a three-to-five year period. With a sufficiently large number of firms in the surveys the panel results could be used to assess changes over time in responses to standards, including export behavior.

Question Categories. The survey instruments should elicit the following types of information from each firm.

1. Production costs, including fixed costs. Fixed costs are charges related to headquarters and plant operation that are unaffected by output scale. Examples include R&D expenditures, marketing costs, debt service, property taxes, and certain capital taxes. Variable costs are charges for inventory, materials, labor, new investment, and taxes related to profits, outputs and variable inputs. Estimates of installed capital values are useful for identifying short-run fixed factors.

2. Output measures, including domestic sales, exports, and exports to particular markets in which TBTs are to be studied. The dates at which firms entered production

and export markets are important, as is information on why firms choose particular export markets or choose not to export.

3. Measures relevant for assessing market structure, including numbers of firms by sector, including importing firms; firm sizes by employment, capital stock, and sales volumes; and number and age of product lines.

4. Major impediments to firms seeking to expand output, exports, or enter new markets. These impediments may be unrelated to policies. Examples include distance to markets, scarcity of skilled labor, translation costs, and fixed exporting costs. They also may stem from policies, including restraints on hiring and firing, inadequate access to capital due to financial market regulation, protected and inefficient transport systems, export disincentives, and trade restraints in import markets.

5. Assessments by firm managers of the costs of compliance with TBTs. Questions could be posed in a multidimensional framework, as shown in Table 3. First, for each regulatory area (regulations in home country, importer regulations, conformity assessment, and MRAs) the standards or regulations at issue must be precisely identified. In most cases the respondent would identify the procedures of most concern to him. However, in the case of importer regulations, conformity assessment, and MRAs, it would be important for the interviewer to ascertain whether the firm must deal with those procedures that were identified for key export markets in the standards selection stage. Second, there are issues of consistency and whether the rule induces higher quality. Finally, to the extent possible it would be valuable for the survey to ask about how firms respond on the cost side, including whether production processes vary by intended market, impacts on input use, and effects on fixed costs.

7.2. Supplemental Information

To facilitate the empirical analysis the survey results must be supplemented by other sources of information. First, detailed information on standards and technical regulations is available from international sources. A prominent case is PERINORM. However, the country coverage of this databases is limited and it does not incorporate SPS measures. Thus, for the target countries and sectors it will be necessary to develop further compilations of TBTs, SPS procedures, and standards.

Next, to undertake analysis of TBTs and trade at the detailed sectoral level we need bilateral trade data for the countries in the standards and regulation databases. Trade data are easily available but, since they are classified on the Harmonized System, must be concorded to the sectoral classification of standards. The trade data would also be useful for constructing weighted averages of the standards counts data in an effort to assess the relative importance of standards by type.

Finally, it is of considerable interest to supplement the survey data on outputs and costs with information from the statistical authorities of target nations on detailed sectoral production and costs by country. This would provide another layer of information for

investigating how regulations affect productivity, product quality, and costs and also would permit comparison of the survey data for consistency with other sources. These data need to be assembled on a time-series basis for as many countries and sectors as possible for the analysis. Thus, one desirable criterion for country selection is that the country undertake periodic or annual detailed industrial surveys. Such information might also be collected from international organizations, such as UNIDO.

8. Empirical Approaches

With the information described it will be possible to engage in substantive empirical inquiry. An initial overview of the data would be informative about such questions as how firms respond to standards and regulations, correlations between regulations and costs, and the incidence of regulations between home markets and export markets. However, our interest lies in deeper econometric and structural approaches.

Among the questions to be analyzed are the following. First, what are the effects of particular standards on productivity, costs, and export opportunities? Second, can these cost measures be used to develop meaningful indicators of trade restrictiveness? Third, are there significant diversionary effects from bilateral or regional MRAs and standardization blocs? Under what circumstances would this be a danger?

8.1. Gravity Models of Trade and Standards

One approach is to extend the study by Moenius (1999), which was a simple gravity model of trade. In the standard gravity approach, bilateral trade between countries, either at the aggregate level or at the industry level, is regressed on the GNP levels of both countries, their populations, and geographical distance between them. Moenius did not incorporate these variables into his estimation, attempting to capture them, and other trade determinants, with a series of dummy variables. In that context his results are difficult to interpret for they may not adequately control for scale effects and resistance factors. A particularly noteworthy omission was the absence of indicators of joint membership in regional trade agreements. Thus, one important extension would be to include these, and other, basic trade determinants into the specification. Further, Moenius included only counts of product standards in his estimation, making it impossible to distinguish between standards and technical regulations. To the extent we can gather information on such regulations, including them in the trade equations should provide valuable information about differences between the trade effects of voluntary standards and TBTs. Finally, our aim is to incorporate trade and regulation activity in a number of developing countries.

Thus, a useful form of the gravity equation is:

$$(1)\ \ln(M_{ij}^{k}) = b_0 + b_1\ln(GNP_i) + b_2\ln(POP_i) + b_3\ln(GNP_j) + b_4\ln(POP_j) + b_5\ln(DIST_{ij}) + b_6RTA_{ij} + b_7\ln(ST_i^{k}) + b_8\ln(ST_j^{k}) + b_9\ln(ST_{ij}^{k}) + b_{10}\ln(TB_i^{k}) + b_{11}\ln(TB_j^{k}).$$

Table 3. Basic Design of Survey Questions Regarding TBTs

Home Regulations	Importer Regulations	Importer Conformity Assessment	MRAs or Harmonization
Identification	Identification of countries and regulations	Describe requirements and operation	Identification of agreements
National or regional and consistency	Consistency across markets	Consistency across markets	Consistency across MRAs
Impact on quality	Impact on quality	Investments in quality control	Preferences for MRAs or harmonization agreements
Costs of re-design	Costs of re-design	Costs of compliance	Impacts on costs
Home sales vs. exports	Differences by export market	Differences by export market	Differences by MRA
Input use	Input use	Internal vs. external resources	Compliance costs
Investment and R&D	Investment and R&D		
			Exclusionary impacts

Here, subscripts i and j refer to exporting country and importing country, respectively, while superscript k indicates sector of activity. RTA denotes a dummy for bilateral membership in a regional trade agreement and is taken here as a prototype variable for trade-expansion factors. The variable ST refers to standards, which, as in Moenius (1999) may be exporter-specific, importer-specific, or shared between the nations. The variable TB refers to technical regulations on trade in manufactures and sanitary standards in foods. The conception here is that these standards and regulations may be identified at the sectoral level, though national measures might be used as well. Note that sector-specific impacts of standards on trade may be captured by individual sectoral regressions or by sectoral fixed effects in a pooled regression. The gravity equations would be estimated in a cross-section of countries and industries for a particular year.

The signs and significance of the coefficients should provide information on how standards and regulations affect trade volumes and how these impacts vary by sector. Of particular interest is whether standards and regulations differ. It is possible, for example, that standards could expand trade in certain circumstances, while regulations could limit trade. At a more quantitative level, the coefficients may be used to compute implied elasticities of trade volumes with respect to standards and regulations and whether such elasticities depend on the existence of preferential trade arrangements.

The primary measures of standards and regulations must be how many there are ("counts") by sector or country. It is generally infeasible to assess the relative importance of different standards simply by reading them. It may be possible to supplement the counts data by developing qualitative measures of the extent and severity of standards from firm surveys. That is, firms could be asked to provide a numerical ranking by importing country and sector of how many standards must be accommodated and their intrusiveness. However, such indexes constructed from survey respondents should be treated with caution. For example, it is unlikely that firms would have sufficient information about restraints in countries to which they do not export to form meaningful opinions. Moreover, the subjectivity of such answers would depend importantly on other business conditions faced by firms.

8.2. Cost-Function or Production-Function Estimation

The essential question posed by this research is how technical regulations affect production and export costs. If the data collection is successful it will provide cost information for individual firms that may be used to estimate cost functions across firms within a sector or pooled across sectors. Assuming a time dimension exists for the data, a general specification of cost is:

$$C_{it} = G(Y_{it}, \mathbf{w}_t, \mathbf{Z}_{it}, t) + \pi_i \quad (2)$$

Here, C_{it} is total cost of production for firm i in period t, defined as the sum of primary input costs and intermediate purchases incurred to produce output and undertake necessary inspection procedures. Y_{it} is output, $\mathbf{w}_t$ is a vector of purchased input prices

(including input taxes), and t is a time trend to capture technical change. The term π_i is a firm-specific productivity effect, estimable only in a pooled data set. It is reasonable to assume that common input prices face each firm. The vector $\mathbf{Z}_{it}$ captures additional impacts on costs, including such variables as public inputs (shared by all firms) and specification of fixed factors (for a short-run cost function).

A dual specification that encompasses the same technological information as the cost function is the production function with general representation:

$$Y_{it} = F(\mathbf{x}_{it}, \mathbf{Z}_{it}, t) + \theta_{it} \tag{3}$$

Here, $\mathbf{x}_{it}$ is a vector of inputs and θ_{it} is a different measure of firm-specific efficiency.

As noted earlier, technical regulations could affect either fixed costs or marginal costs. If such distinctions may be drawn from the survey results, their separate impacts may be estimated via introduction of firm-level responses into a short-run cost function. Thus, two types of responses may be envisioned First, for a given level of output, firms may alter their demands for labor, capital, and materials in their marginal production costs, a result from, say, a regulation requiring inspection of all products and new packaging. Such impacts could be estimated by appropriate adjustment of the implicit factor-demand equations in the underlying cost and production functions. That is, factors devoted to compliance would be included as separate inputs.

Second, for a given production technique, firms may devote more expenditures to fixed costs, such as R&D to reorient production processes, factory inspection and maintenance, legal fees, and meeting reporting requirements. These effects could, in principle, be estimated by altering the demands for fixed factors. Alternatively, to the extent that average costs are raised (average productivity is lowered), it should be feasible in the pooled approach to explain statistically the cross-firm or cross-sectoral productivity coefficients as a function of these cost shifts. Thus, π and θ could be specified as linear in the logarithms of standards costs, with a residual inherent productivity effect.

The cost or production functions selected for estimation would depend partially on the information provided by surveys and supplemental data sources. Given the multiplicity of cost factors, the most appropriate approach would be a flexible functional form, such as the translog or generalized Leontief (Kohli, 1991). However, because these functions are quite demanding in their informational requirements, it may be necessary to employ a more restricted approach, such as functions with constant elasticity of substitution.

Implementing the cost or production approach will be a challenge in the event that data are limited or essentially qualitative. For example, suppose we considered the firm-specific productivity effects to have components reflecting a standards impact and a TBT impact, where these impacts could vary by export market and between exporters and non-exporters. This specification would require the data to support estimation of large numbers of parameters that must satisfy certain regularity conditions. Moreover, it may

be that survey respondents are capable only of providing standards counts or qualitative information, such as a ranking of cost impacts as "low", "medium" or "high". In that event, the estimation must shift to a more qualitative basis, with a selection of discrete independent variables.

8.3. Simulation Analysis

Data collection and cost estimation should provide valuable evidence on the extent of regulations and their perceived or actual cost impacts. However, econometric cost estimation techniques place considerable demands on data that may be imprecise and noisy. Moreover, they cannot readily account for the potential impacts under conditions of imperfect competition or other market distortions. Neither do they permit consideration of demand responses in market countries where products are differentiated and consumers may interpret adherence to standards as a legitimate signal of quality. In this regard, both partial-equilibrium sectoral models in each country, and a multi-country computable general equilibrium model, could be specified and simulated to provide additional information on the competitive aspects of standards. Indeed, the survey results and econometric parameters would serve as key inputs into this set of empirical exercises.

Partial-equilibrium models consider impacts of standards and regulations within a particular sector, accounting for market structure elements, such as numbers of firms and the size distribution of firms.[26] Standards and regulations may be modeled as either cost-increasing, demand-shifting, or both. Specification of demand impacts is important, for there could be both price-related shifts in demand for given substitution parameters (say, between exports and home goods) and a change in substitution possibilities. On the cost side, regulations could alter either marginal costs or fixed costs, while the impact on profits would depend on the ease of entry and exit and the nature of competitive conjectures. An additional parameter relates to market segmentation.

For example, one extreme specification would permit perfect competition with free entry, constant returns to scale without consideration of fixed costs, and perfect homogeneity of goods. In this framework, straightforward analysis of an increase in marginal costs would capture, quantity, price and incidence impacts of a regulation, subject to assumed elasticities. It would also be straightforward to compute impacts on trade diversion from regional standards.

The competitive model is inconsistent with observed product heterogeneity in international trade, while firms may demonstrate increasing returns to scale associated with fixed costs. These costs are likely to be raised by certain types of technical regulations. Thus, another canonical model would permit firms to produce imperfectly substitutable goods, subject to free entry and increasing returns. In such a model long-run profits would be invariant to standards but the number of firms and the scale of operations would be affected. Alternatively, the model would be calibrated to existing numbers of firms with varying degrees of entry possibilities. These models could be

[26] See Richardson (1993), Maskus (2000a), and the papers in Krugman and Smith (1994) for examples and Helpman and Krugman (1989) for a theoretical basis.

implemented either with a fixed degree of product substitution on the demand side or with substitution elasticities that would vary with the nature of standards and regulations.

To illustrate, consider the following simple model of Cournot competition where imports and domestic goods are heterogeneous but an endogenous number of symmetric firms produce a homogeneous "national" variety. Within a market called "home" and denoted by H, both varieties H and F are sold (a similar specification holds in the rest of the world). The inverse demand functions are:

$$p = a - bqn + dq^*n^* \tag{4}$$

$$p^* = a^* - bq^*n^* + dqn \tag{5}$$

where a (a*) indicates the intercept for the home (imported) variety, b indicates the common slope coefficient on own demands, d is the common parameter detailing cross-substitution in demand, q (q*) is output (imports) per firm, and n (n*) is the number of home (importing) firms. Cost functions per firm may be specified as:

$$C = F + G + (\mathbf{wx} + c)q \tag{6}$$

$$C^* = F^* + G^* + (\mathbf{w^*x^*} + c^* + t)q^* \tag{7}$$

Here, F (F*) is home (foreign) fixed cost per firm, while G (G*) is the addition to fixed cost associated with a technical regulation in the importing country. The variables **w** and **x** (**w*** and **x***) are input prices and per-unit input choices. The variable c (c*) indicates the addition to marginal cost of the home firm (importing firm) from a regulation in the importer. Finally, t indicates the marginal cost of importing, associated with transport costs and tariffs.[27] Firms would maximize profits subject to the demand and cost constraints, generating predictions for equilibrium levels of output, imports, prices, and firm numbers.

The associated first-order conditions could be calibrated to actual data on initial firm numbers, imports, domestic sales, and costs, along with demand parameters. The calibrated model could then be used to simulate the impacts of varying G and c (G* and c*) to determine impacts of standards and regulations on competition and trade. Note further that the intercepts a and a* and the cross-substitution parameter d could be varied to capture the demand-side effects of standards.[28]

This basic model could be altered in a variety of ways to study the impacts of regulations in alternative market settings. For example, the case just discussed presumes that the importer imposes its standard on the exporting firm but that this has differential cost impacts on the firms, or that the standards themselves are different. Standards could be modeled to have the same cost impacts (a natural definition of harmonization). Alternatively, a mutual recognition agreement could be modeled by having country-

[27] This model could be used also to investigate the determinants of FDI in the presence of regulations if we added plant-specific fixed costs.

[28] While pre- and post-standard consumer surplus measures could be computed, they would not be particularly meaningful unless there were a fuller specification of utility in a general-equilibrium model.

specific inspection costs subject to a minimum quality constraint (that is, a maximum value for d). A separate specification could examine cases where two countries form a standards union (such as an MRA) and exclude a third country.

Finally, turning to a CGE framework, its main advantage lies in the ability to assess the cross-sectoral impacts of regulations on outputs, prices, employment, and trade, along with meaningful computations of economic welfare. CGE models may also be developed to handle alternative market structures, demand specifications, and policy interventions in a flexible manner, both for single countries and multiple countries. For example, an integrated multi-country model could examine the implications of an MRA between the United States and Europe on the exports of particular developing countries. Moreover, conformity assessment costs could be modeled as additional production activities in the intersectoral and international context.

Its disadvantage lies in the need to conduct the analysis at aggregated levels, making it difficult to translate specific regulations, which typically exist at the product level, into meaningful policy experiments. The papers in this volume by Ganslandt and Markusen and by Anderson and Nielsen demonstrate this problem. However, the data gathered through this project's surveys should support a considerable analytical improvement in that the reported costs for particular regulations could be combined into weighted-average cost wedges per sector.

Thus, assume that the data analysis generates information on domestic and foreign regulations and their direct costs in key nations, and that these may be aggregated into sectoral cost impacts. Assigning these wedges to countries and regions in the GTAP model could support computation of their general-equilibrium international effects. It would further be possible to compute impacts of preferential agreements on standards and regulations. Note that care must be taken in considering the welfare gains and losses from such exercises, for a simple treatment of standards as costs means they would reduce economic well-being. Thus, the analysis would require some modification of utility functions to account for the demand for standards.

9. Concluding Remarks

The application of product regulations and standards is becoming increasingly contentious as an implicit non-tariff barrier to trade. Many developing countries express rising frustration with regulations that vary across their export markets, require duplicative conformity procedures, and seem to change capriciously in order to exclude imports. Some developed countries are adopting MRAs that may lower costs for their trading firms but could result in greater discrimination against countries that do not belong to them. Substantial anecdotal evidence suggests that compliance costs with regulations can be high in relation to the value of products, which could deter entry into export markets altogether.

In this context, it is important to obtain as much information as possible about the quantitative implications of standards and regulations for costs and trade prospects of

firms in developing nations. The World Bank is undertaking such a study, which will survey enterprises in numerous developing and transition economies over a three-year period. Extensive data will be gathered on firm structures, output and export patterns, and fixed and marginal costs in addition to costs of complying with home and foreign regulations. These data should form the basis for econometric work on costs and trade dynamics, the results of which should be informative for analysts and policymakers interested in the international impacts of standards.

The main purpose of this conference is to suggest approaches for practical analyses of standards and trade that could benefit understanding of these processes on the part of developing countries. These suggestions would inform the World Bank's research program on standards and technical barriers to trade. Our reading of the literature points to three avenues for research.

First, there remains considerable room for further applied theoretical work aimed at improving our understanding of how particular aspects of standards formation and operation affect behavior. The available literature tends to focus more on strategic aspects of international competition subject to cost-increasing standards issued by one country or a bloc of countries and less on the actual competitive impacts of particular standards. It would be fruitful, for example, to contrast the potential costs and benefits for lagging nations of harmonization versus mutual recognition agreements. Such policies might be complementary or offsetting in their effects on trade. They might also serve to exclude poor countries from the gains from standardization among richer nations, but we should know more about the circumstances under which that would be true and prospective policy responses.

Second, evidence on how firms in developing and transition economies actually respond to domestic and international standards is completely unavailable. Aggregate data on variables such as standard counts are useful for looking at broad trends but it is vital to undertake detailed microeconomic, firm-level studies of compliance costs, problems in compliance, quality responses, and export and import impacts. This would require extensive surveys of firm behavior in a cross-section of industries, with parallel studies in a sample of countries. The selection of countries and firms would be constrained by available research funds. However, a useful approach would incorporate countries at different levels of development and global integration, which presumably would correlate with the number and extent of domestic standards and the use of international standards. It would include also a sample of narrowly defined industries of export interest to the countries selected, such as certain agricultural products, apparel, and electronic implements.

Thus, the initial task will be to design and implement the recommended survey instruments. Besides country and industry selection, it will be critical to develop a questionnaire/interview format that bears promise of extracting important quantitative information that could be combined with other economic data in ensuing analysis. Regarding standards, questions to be posed should be aimed at determining the mix of domestic and international standards firms employ, their compliance procedures and

costs, related investments in quality and marketing, investments in re-design of products or production methods, and the like. Further information requests would focus on broader aspects of costs, investment, and trade. Funding permitting, it would be beneficial to undertake surveys over multiple years in at least one country for purposes of looking at standards and export and import dynamics.

Finally, if these surveys yield usable and comparable information on costs, investments, trade, and growth they could form the basis for valuable econometric and CGE studies. Such studies could be aimed at a variety of questions. Are standards a determinant of trade expansion or contraction and under what circumstances? Is this process more or less in evidence for countries at varying levels of development? Which standards are critical in the determination of trade, structural change, and growth? Can the standards and measures of costs be combined in meaningful ways to develop some form of restrictiveness measures? A basic but valuable approach would be to calculate "tariff or subsidy equivalents" of particular standards in selected importing countries or regions and see if they vary by economic circumstances of trading partners. If such calculations could be made they would be informative in many contexts, including the potential effects of standardization blocs.

References

Akerlof, George, "The Market for Lemons: Qualitative Uncertainty and the Market Mechanism," *Quarterly Journal of Economics* 84 (1970): 488-500.

Baldwin, Richard E. "Regulatory Protectionism, Developing Nations, and a Two-Tier World Trade System." Manuscript (2000).

Calvin, Linda and Barry Krissoff. "Technical Barriers to Trade: A Case Study of Phytosanitary Barriers and U.S.-Japanese Apple Trade," *Journal of Agricultural and Resource Economics* 23, no. 2 (1998): 351-366.

Casella, Alessandra, "Free Trade and Evolving Standards," in J. N. Bhagwati and R. E. Hudec, eds., *Fair Trade and Harmonization: Prerequisites for Free Trade?* Cambridge, MA: MIT Press (1996).

Chang, Seung Wha. "GATTing a Green Trade Barrier -- Eco-Labelling and the WTO Agreement on Technical Barriers to Trade." *Journal of World Trade* 31, no. 1 (1997): 137.

David, Paul A. and Shane Greenstein. "The Economics of Compatibility Standards: An Introduction to Recent Research." *Economics of Innovation and new Technologies* 1 (1990) 3-41.

Deardorff, Alan V. and Robert M. Stern. *Measurement of Nontariff Barriers*. Ann Arbor: University of Michigan Press (1998).

Finger, Michael, and Philip Schuler. "Implementation of Uruguay Round Commitments: The Development Challenge." Washington D.C.: World Bank (1999).

Fischer, Ronald and Pablo Serra. "Standards and Protection," *Journal of International Economics* (2000), forthcoming.

Gandal, Neil and Oz Shy. "Standardization Policy and International Trade," manuscript (1999).

Gasiorek, Michael, Alasdair Smith, and Anthony J. Venables. "1992: Trade and Welfare -- A General Equilibrium Model." In L. A. Winters, ed., *Trade Flows and Trade Policy after 1992*, Cambridge: Cambridge University Press (1992).

Harrison, Glenn W., Thomas F. Rutherford, and David G. Tarr. "Increased Competition and Completion of the Market in the European Union: Static and Steady State Effects." *Journal of Economic Integration* 11, no. 3 (1996), 332-365.

Helpman, Elhanan and Paul R. Krugman. *Trade Policy and Market Structure*. Cambridge, MA: MIT Press (1989).

Henson, Spencer, Rupert Loader, Alan Swinbank, Maury Bredahl, and Nicole Lux.

Impact of Sanitary and Phytosanitary Measures on Developing Countries, Center for Food Economics Research, University of Reading, Reading, UK (2000).

Henson, Spencer, Rupter Loader, and Alan Swinbank. "The Impact of Sanitary and Phytosanitary Measures on Developing Country Exports of Agricultural and Food Products, paper prepared for Agriculture and the New Trade Agenda from a Development Perspective: Interests and Options in the WTO 2000 Negotiations, World Bank, Geneva, November 1999.

Hertel, Thomas W., Kym Anderson, Joseph Francois , and Will Martin. "Agriculture and Non-Agricultural Liberalization in the Millennium Round." *WTO 2000 Negotiations,* WTO (2000).

Hertel, Thomas W., Bernard M. Hoekman, and Will Martin. "Developing Countries and a New Round of WTO Negotiations." Washington D.C.: World Bank (2000).

Hertel, Thomas W., and Will Martin. "Developing Country Interests in Liberalizing Manufactures Trade." Background research for *Seattle Ministerial Meeting,* Seattle, Washington (2000).

James, Sallie and Kym Anderson. "On the Need for More Economic Assessment of Quarantine Policies." *The Australian Journal of Agricultural and Resource Economics* 42, no. 4 (1998), 425-444.

Jha, V., A. Markandya, and R. Vossenaar. *Reconciling Trade and the Environment. Lessons from Case Studies in developing Countries.* Edward Elgar Publishing C., 1999.

Jones, Philip and John Hudson. "Standardization and the Costs of Assessing Quality." *European Journal of Political Economy* 12 (1996), 355-361.

Kindleberger, Charles, "Standards as Public, Collective and Private Goods," *Kyklos* 36 (1983), 377-396.

Kohli, Ulrich. *Technology, Duality, and Foreign Trade*, Ann Arbor: University of Michigan Press (1991).

Krugman, Paul and Alasdair Smith, eds., *Empirical Studies of Strategic Trade Policy.* Chicago: University of Chicago Press (1994).

Maskus, Keith E., "Intellectual Property Rights in Lebanon," in B. Hoekman and J. Zarrouk, eds., *Sizing Up the Competition.* Ann Arbor: University of Michigan Press (2000a).

Maskus, Keith E., *Intellectual Property Rights in the Global Economy*, Washington D.C.: Institute for International Economics (2000b), forthcoming.

Matutes, Carmen and Pierre Regibeau. "A Selective Review of the Economics of Standardization: Entry Deterrence, Technological Progress and International Competition." *European Journal of Political Economy* 12 (1996), 183-209.

Moenius, Jonannes. "Information versus Product Adaptation: the Role of Standards in Trade," manuscript (1999).

National Research Council. *Standards, Conformity Assessment, and Trade: Into the 21st Century*. Washington, D.C.: National Academy Press (1995).

Organization for Economic Development and Cooperation. *Regionalism and Its Place in the Multilateral Trading System*. Paris: OECD (1996).

Organization for Economic Development and Cooperation. *An Assessment of the Costs for International Trade in Meeting Regulatory Requirements*. TD/TC/WP(99)8/FINAL, Paris: OECD (1999).

Paarlberg, Philip L. and John G. Lee. "Import Restrictions in the Presence of a Health Risk: an Illustration using FMD." *American Journal of Agricultural Economics* 80, no. 1 (1998): 175-183.

Pardo Quintillan, Sara. "Free Trade, Public Health Protection and Consumer Information in the European and WTO Context -- Hormone-Treated Beef and Genetically Modified Organisms." *Journal of World Trade* 33, no. 6 (1999): 147.

Perroni, Carlo and Randall Wigle. "International Process Standards and North-South Trade." *Review of Development Economics* 3, no. 1 (1999): 11-26.

Richardson, J. David. *Sizing Up U.S. Export Disincentives*. Washington DC: Institute for International Economics (1993).

Roberts, Donna. "Analyzing Technical Trade Barriers in Agricultural Markets: Challenges and Priorities." *Agribusiness* 15 , no. 3 (1999): 335-54.

Scollay, Robert and John Gilbert, *New Sub-Regional Trading Arrangements in the Asia Pacific*, Institute for International Economics (forthcoming 2000).

Stephenson, Sherry M. *Standards and Conformity Assessment as Nontariff Barriers to Trade*. Policy Research Working Paper no. 1826, World Bank (1997).

Swann, Peter, Paul Temple, and Mark Shurmer. "Standards and Trade Performance: The UK Experience," *Economic Journal* 106 (1996): 1297-1313.

Sykes, Alan O. *Product Standards for Internationally Integrated Goods Markets*. Washington D.C.: Brookings Institution (1995).

Thilmany, Dawn D. and Christopher B. Barrett. "Regulatory Barriers in an Integrating World Food Market." *Review of Agricultural Economics* 19, no. 1 (1997): 91-107.

United States International Trade Commission. *Global Assessment of Standards Barriers to Trade in the Information Technology Industry.* Publication 3141, Washington, DC: USITC (November 1998).

Wilson, John S. *Standards and APEC: An Action Agenda.* Washington D.C.: Institute for International Economics (1995).

Wilson, John S. "The Post-Seattle Agenda of the WTO in Standards and Technical Barriers to Trade: Issues for the Developing Countries." Washington D.C.: World Bank (1999).

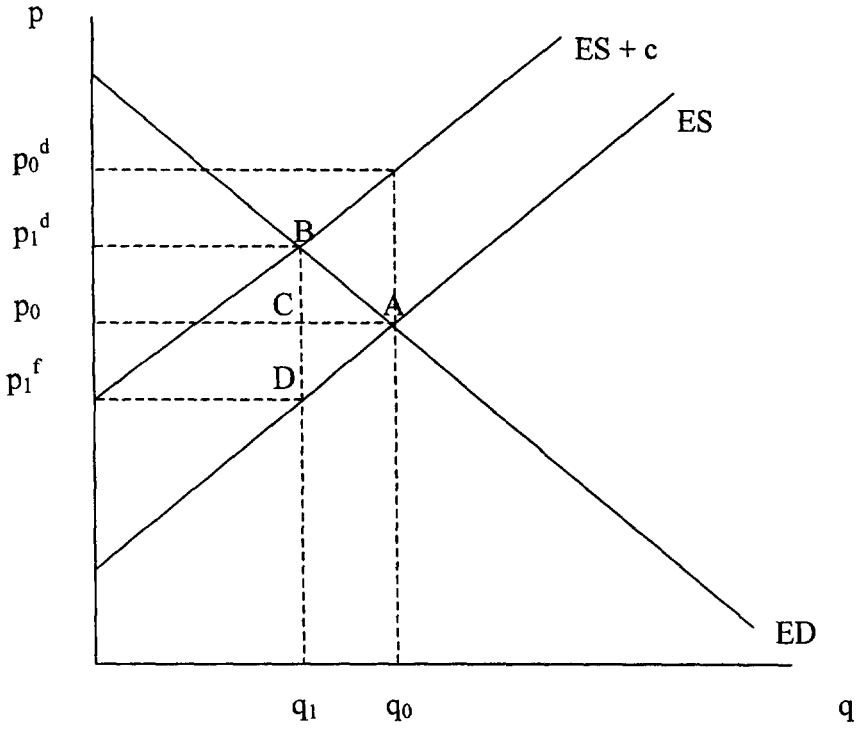
Wilson, John S. "Technical Barriers to Trade and Standards, Challenges and Opportunities for Developing Countries Presented by the World Bank." Submitted to *the Technical Barriers to Trade Committee Meeting World Trade Organization* (2000).

Wilson, John S. *Standards and APEC: An Action Agenda.* Washington, D.C. Institute for International Economics (1995).

World Bank. "Draft Report on Standardization and Conformity Assessment in the Ukraine." Washington D.C.: World Bank (2000a).

World Bank. *Trade Blocs.* Washington D.C.: World Bank, forthcoming (2000b).

Figure 1. Price and Quantity Effects of a Technical Standard



Policy Research Working Paper Series

	Title	Author	Date	Contact for paper
WPS2493	Annuity Markets in Comparative Perspective: Do Consumers Get Their Money's Worth?	Estelle James Dimitri Vittas	November 2000	A. Yaptenco 31823
WPS2494	The Relevance of Index Funds for Pension Investment in Equities	Ajay Shah Kshama Fernandes	November 2000	A. Yaptenco 31823
WPS2495	The Australian Annuity Market	David M. Knox	November 2000	A. Yaptenco 31823
WPS2496	Perspectives on the Sources of Heterogeneity in Indian Industry	Somik V. Lall G. Chris Rodrigo	November 2000	R. Yazigi 37176
WPS2497	State Policies and Women's Autonomy in China, India, and the Republic of Korea, 1950–2000: Lessons from Contrasting Experiences	Monica Das Gupta Sunhwa Lee Patricia Uberoi Danning Wang Lihong Wang Xiaodan Zhang	November 2000	M. Das Gupta 31983
WPS2498	Sustaining Economic Welfare: Estimating Changes in Per Capita Wealth	Kirk Hamilton	November 2000	L. Rivera 82819
WPS2499	The Treatment of Non-Essential Inputs in a Cobb-Douglas Technology: An Application to Mexican Rural Household-Level Data	Isidro Soloaga	December 2000	L. Tabada 36896
WPS2500	Investigating Corruption	Canice Prendergast	December 2000	H. Sladovich 37698
WPS2501	Anti-Corruption Policies and Programs: A Framework for Evaluation	Jeff Huther Anwar Shah	December 2000	A. Santos 31675
WPS2502	Implications of the Currency Crisis for Exchange Rate Arrangements in Emerging East Asia	Masahiro Kawai Shigeru Akiyama	December 2000	A. Azarcon 36049
WPS2503	Proposed Strategy for a Regional Exchange Rate Arrangement in Post-Crisis East Asia	Masahiro Kawai Shinji Takagi	December 2000	A. Azarcon 36049
WPS2504	Social Capital and the Quality of Government: Evidence from the United States	Stephen Knack	December 2000	P. Sintim-Aboagye 38526

Policy Research Working Paper Series

	Title	Author	Date	Contact for paper
WPS2505	Family Altruism and Incentives	Roberta Gatti	December 2000	R. Bonfield 31248
WPS2506	Ethnicity and Wage Determination in Ghana	Abigail Barr Abena Oduro	December 2000	R. Bonfield 31248
WPS2507	Public Expenditures and Environmental Protection: When Is the Cost of Funds Irrelevant?	Gunnar S. Eskeland	December 2000	H. Sladovich 37698
WPS2508	Sources of Financial Assistance for Households Suffering an Adult Death in Kagera, Tanzania	Mattias Lundberg Mead Over Phare Mujinja	December 2000	V. Soukhanov 35271
WPS2509	How Tax Policy and Incentives Affect Foreign Direct Investment: A Review	Jacques Morisset Neda Pirnia	December 2000	N. Busjeet 33997
WPS2510	Environmental Protection and Optimal Taxation	Gunnar S. Eskeland	December 2000	H. Sladovich 37698
WPS2511	Monetary Policy under Flexible Exchange Rates: An Introduction to Inflation Targeting	Pierre-Richard Agénor	December 2000	M. Gosiengfiao 33363

1/16