B THE ECONOMICS OF STANDARDS AND TRADE

We live in a world profoundly reliant on product standards. Faxes can be sent around the world because fax machines obey a common protocol. Computer files can be shared because computers employ various standardized hardware and software formats. The need for product standards is not a new phenomenon. In biblical times, the lack of a common (standardized) language wreaked havoc at the Tower of Babel (Shapiro, 2000). In more recent times, during the great Baltimore fire of 1904, fire fighters called in from neighbouring cities were unable to fight the blaze effectively because their hoses would not fit the hydrants in Baltimore.

The specific functions that standards fulfil are very diverse. Two of the most important are providing compatibility and information. It is through sharing a common standard that anonymous partners in a market can communicate, can have common expectations on the performance of each other's product, and can trust the compatibility of their joint production. Thus, standards are necessary for the smooth functioning of anonymous exchanges – and therefore, for the efficient functioning of the market. Although standardization is necessary, it does not follow that all variety is undesirable. Standards reflect the needs of the groups that express them, and as long as groups differ, their optimal standards will reflect their differences (Casella, 2001).

This Section is about the economics of standards and trade. It provides an explanation of the basic economic concepts related to standards and explains what economic role these standards play. It will explore the implications of adopting standards on international trade. The terminology used in the economic analysis of standards does not always correspond to that used in the legal literature on the same subject, and these differences are explored.

Subsection 1 introduces the most important economic concepts relevant for any discussion on standards. Subsection 2 discusses in detail the different situations in which standards can improve efficiency and what this means for international trade flows and welfare. In particular, it discusses standards in markets characterized by direct or indirect network externalities, standards in markets characterized by information asymmetries, and standards in markets with negative consumer or producer externalities. A well-designed standard can increase efficiency and trade. Standards can, however, also create new inefficiencies through their effect on the range of varieties supplied in a market and through the possible resulting effects on competition in the relevant market. For each of the different types of standards discussed, the likely effect on international trade flows will be considered and welfare implications will be discussed. Given the diversity of roles of standards, it is likely that they can have different, possibly even opposing, impacts on international trade and welfare. The discussion will show that the actual impact of standards will to a large extent depend on their design. It will also depend on whether and to what extent standards are set by public or by private actors.

In many instances, the existence of product standards is necessary to allow international exchange between anonymous economic agents, since parties to the transaction must be assured of the nature and quality of products. But differences in preferences, tastes and assessment of risks among countries can lead to the adoption of differing product standards. Imports may only be allowed if products have been tested to conform to the standards adopted in the destination country. This can increase the costs incurred by exporters and thereby lower the volume of international trade. Subsection 3 examines to what extent mutual recognition and harmonization can reduce any trade-distorting effects of standards in these cases. It also discusses the welfare implications of both policy options. Finally, Subsection 4 examines the empirical evidence bearing on the effects of standards on international trade.

1. DIFFERENT TYPES OF STANDARDS AND SOME DEFINITIONAL ISSUES

An on-line search for the word "standard" in the Compact Oxford English Dictionary returns two definitions of relevance for this Report: "a (required or agreed) level of quality or attainment" and "something used as a measure, norm, or model in comparative evaluations". The requirement that chocolate does not contain more than 5 per cent vegetable fat (instead of cacao butter) in order to warrant the name chocolate, could probably fall under both definitions of a standard. The requirement for a traffic light to use the three colours

red, yellow and green would fall under the second definition, but not necessarily under the first one. The difference between the two examples is that in the first case the "norm" refers to something that can be measured (lower or higher percentage of vegetable fat), whereas the second does not. For an economic analysis of standards, the difference between norms referring to characteristics that can be measured on an objective scale and norms referring to other characteristics that cannot be measured is quite important.

(a) Vertical versus horizontal differentiation

Product standards specify the characteristics of a product. By nature product standards therefore play a role in markets of differentiated products, i.e. products that appear in different varieties. Economists distinguish between two types of product differentiation: "vertical" product differentiation and "horizontal" product differentiation. In the case of vertical differentiation, different varieties can be ordered according to a certain scale. One variety is better than another, larger than another, safer than another, etc. Examples of such varieties are chocolates with higher or lower contents of cacao butter, or cars that use more or less petrol per kilometre. The differentiation is based on content of cacao butter in the first case and petrol use in the second case. This differentiation always appears in varying degrees among the different product varieties. One feature of vertical differentiation is that it often leads to price differences among varieties. Consumers will, for instance, agree that a computer with a memory of 512 MB is better than one with a memory of 256 MB and they will be willing to pay a higher price for the first one. This does not imply, however, that all consumers will buy the computer with the higher memory, as this decision depends, among others, on consumers' disposable income.

In the case of horizontally differentiated products, the characteristic that is responsible for the differentiation cannot be ranked. Colour is an example of such a characteristic, or flavour. A red t-shirt is different from a blue t-shirt, but the two varieties cannot really be ranked according to an objective scale. The same for strawberry ice-cream and vanilla ice-cream. Horizontal differentiation is not necessarily associated with price differences among varieties. In the real world many products are differentiated along both lines. Cars for instance appear in different colours and differ in their use of petrol.

The concept of a "minimum standard" only makes sense in the context of vertically differentiated goods. It implies that only products reaching a certain level of "quality or attainment" or higher are considered to meet the relevant standard. The introduction of a minimum standard therefore does not necessarily reduce the number of product varieties in the market to just one (the minimum standard), as products exceeding the standard are also allowed to circulate in the market.

The difference between horizontal and vertical product differentiation is relevant for the structure of the rest of this Section. Each of the following Subsections discusses a different type of market failure, in the presence of which the introduction of a standard may be welfare improving. Problems of imperfect information (e.g. safety standards) and negative production or consumption externalities (e.g. environmental standards) are typically analysed in models of vertical product differentiation, while for the analysis of network externalities (compatibility standards) both types of differentiation play a role.

(b) Private versus public standards

Another distinction of importance for this Section is between private standards and public standards. Unfortunately, the line separating these two concepts is not entirely clear and probably depends on the perspective from which the issue is examined. From the point of view of international trade law, "public standards" imply the existence of a domestic or internal law which refers to the standard. Yet, when looking at the institutional environment in which standard-setting takes place (discussed in Section IIC) it appears that many standards which are public by law are based on technical specifications and initiatives by private standard-setting organizations. The question thus arises as to whether such standards should indeed be considered "public".

This Section looks at standards from the point of view of economic theory. The distinction between public and private standards will depend not so much on whether standards are public law, but rather on whose interests are taken into account when a standard is set and enforced. In the case of public standards, it is

assumed that the interests of all actors in an economy are taken into account when the standard is set. This implies that the effect on the profits of all companies and the wellbeing of all consumers have been considered. Externalities like those related to the environment or to public health are also factored into the decision-making of the government. Private standards, on the other hand, are assumed to take account only of the profits of firms. Depending on the situation, individual firms will decide if they are willing to cooperate in standard-setting activities. Private standards may implicitly take consumer interests into account, but only if these interests correspond to their own interests. Standards are also sometimes set by non-governmental organizations (NGOs).[1] From the point of view of international trade law such standards would probably be considered "private standards". For the purpose of this Section, NGO standards would probably represent a separate category as NGO activities tend not to be profit-oriented and do not necessarily pursue the same objectives as governments. This Section does not deal with NGO standard-setting activity in any systematic manner and the term "private standard" only refers here to standards set by firms.

(c) Mandatory standards, voluntary standards and the role of labels

While private standards are by definition voluntary, public standards can either be mandatory or voluntary. In the case of mandatory standards, only standardized products are allowed to circulate in the market, whereas in the case of voluntary standards even those products not meeting the standards can be supplied. Note that in this particular aspect the terminology used in this Report differs from the one used in WTO law. While the distinction between voluntary and mandatory standards is common among economists and practitioners, only the former are considered to be standards in WTO terminology. The term "mandatory standard" does not exist in WTO terminology. Mandatory standards would, according to TBT terminology, fall under the term "technical regulation". Depending on its function, a mandatory standard could also fall under the term "sanitary or phytosanitary measure" as defined in Annex A of the SPS Agreement. This would, for instance, be the case of certain mandatory food safety standards. Section IID will discuss in more detail the differences and similarities between economic and legal thinking.

The term "minimum standard" does not exist in the legal terminology of the TBT Agreement and the SPS Agreement. As explained previously, minimum standards refer to standards used in the context of vertically differentiated goods, i.e. goods that have characteristics that can be ranked according to an objective scale. Food safety standards (imperfect information) and environmental standards (environmental externalities) often take the form of minimum standards.[2] Voluntary minimum standards would in the TBT Agreement fall under the term standards, whereas mandatory minimum standards would be covered by the term technical regulation.

In the case of voluntary standards, different varieties of goods are allowed to circulate in the market – those conforming with a standard and those not conforming with it. In many cases, it is not easy for consumers to distinguish between the two types of products. Labels are then necessary to support this policy.[3] Two types of situations can arise. The government may choose to oblige producers not meeting the standard to label their products. A voluntary standard may, for instance, pin down the characteristics of clothing that can be considered to limit flammability and the government may decide that clothing not corresponding to these characteristics has to carry a label "flammable". This type of "negative" labelling is typically mandatory, but would in this particular case support a voluntary standard.[4] Alternatively, the government may decide not to combine the voluntary standard with a mandatory labelling policy. In such cases, producers of the standardized

1 Although strictly speaking many standard-setting organizations (discussed in Section II.C) can be considered to be non-governmental organizations, they are not embraced by the term NGOs in this Report. See Section II.C for a definition of NGOs and further discussions.

2 Such standards can also be expressed in terms of upper limits instead of lower limits, e.g. the maximum amount of pesticides used. These concepts would also be covered by the idea of "minimum standards" as they refer to characteristics that can be ranked (more or less pesticides).

3 The relevant market is thus partitioned into two segments: products carrying the label and those not carrying the label. It could be argued that a continuous variable (e.g. more or less petrol use, more or less cacao butter) is transformed into a binary variable (e.g. environment friendly or not, chocolate or not).

4 Labelling policies are not always linked to standards, but may exist for purely informative reasons. Textiles may for instance be required by law to carry a label indicating the composition of the fabrics used. Such a label would also be mandatory, but would not partition the relevant market into one of goods meeting a standard and one of goods not meeting a standard. The discussion of this type of label falls out of the scope of the current Report.

products will often voluntarily label their products in order to signal to consumers that their products meet the "(required or agreed) level of quality or attainment". The possible combinations of voluntary and mandatory standards and labels are summarized in Table 1.

Table 1
Standards and labels: economic versus legal terminology

Economic terminology used in this Report			WTO legal terminology
Mandatory (minimum) standard	1. No label necessary		Technical regulation under TBT or sanitary or phytosanitary measure under SPS
Voluntary (minimum) standard	Label necessary in order for consumers to distinguish between products meeting the standard and those not meeting the standard	2. (a) Government obliges those not meeting the standard to use a label ("negative labelling"): mandatory labelling	Technical regulation under TBT or sanitary or phytosanitary measure under SPS
		2. (b) Government does not oblige those not meeting the standard to use a label. Producers of products meeting the standard may end up labelling voluntarily ("positive labelling")	Standard under TBT

When introducing a public standard a government thus has the choice of the three approaches depicted in Table 1. The following Subsections discuss in detail the effects of these policy options in different market set-ups. In general, the government needs to take into account a number of trade-offs. Mandatory standards tend to lead to the supply of fewer varieties in the market than voluntary standards. This outcome can be desirable if fewer varieties increase efficiency, for instance in the case of network externalities, or if the government has strong reasons to ban certain varieties from the market, for instance in order to protect the health of consumers. When a voluntary standard is introduced, the choice between "negative or positive" labelling will determine who carries the cost of the labelling policy. In the first case the producers (and thus ultimately the consumers) of products not meeting the standard end up paying the labelling costs, whereas in the second case the price of products meeting the standard will incorporate the labelling costs. It has also been argued that consumers react differently to negative labelling than to positive labelling, in the sense that the labelling policy determines whether they purchase the product meeting the standard or the one not meeting it.

(d) Process standards

This Section deals with both product and process standards.[5] Process standards specify the characteristics of a production process. Processes are typically not traded. But the goods they produce may be traded and process standards are therefore relevant to the multilateral trading system. This "indirect" relevance – that is, through the traded products – explains to a large extent why multilateral trade law finds it difficult to deal with process standards.

Process standards are introduced for different reasons:

- because they affect the goods that are produced (e.g. hygiene standards);
- because they affect the efficiency of the production process (e.g. in the case of network externalities);
- because they affect the environment (e.g. pollution standards).

It is only in the first case that process standards may be reflected in the final good and thus have a direct impact on trade. WTO terminology would refer to such standards as "incorporated processes and production methods (PPMs)" and their relevance for trade policy is relatively straightforward. The relevance

[5] Process standards are also referred to as production standards.

of unincorporated PPMs for trade policy is less straightforward as they do not directly affect anything that is traded. Yet at the same time, consumers or governments in an importing country may care about the way in which an imported good is produced – for instance, because they care about the environmental impact of the production process. This Section discusses the role of both incorporated and non-incorporated PPMs in the presence of environmental externalities and their relevance for trade flows and trade policy.[6] While the discussion will focus on economic aspects of the issue, the relevance of process standards for multilateral trade law will be discussed in Section IID.

2. WHY STANDARDS ARE SET AND THEIR EFFECTS ON TRADE

Consumers differ and they appreciate the characteristics of products in different ways. The availability of different varieties of products in the market should, therefore, be welcomed. As a starting point, it is often presumed that markets provide those varieties demanded by consumers and that they provide them in the appropriate quantities. However, this is not always the case. Sometimes consumers may be better off if governments or private institutions enforce the supply of only one product variety in the market. In other instances, there is an undersupply of varieties in the market, or certain varieties are not supplied in optimal quantities. In all these situations, the introduction of a standard can improve welfare, even though it may create new problems, in particular through its effect on the competitive forces at work. The following Subsections will discuss in detail in which type of market set-up the introduction of a standard can be considered desirable.

(a) Network externalities and compatibility standards

Many products have little or no value when consumed in isolation, but generate value when consumed together with other products. For example, computers are of no use without a monitor or without software. Similarly, camera bodies are not useful without lenses or a film, just like a CD player is useless without speakers or headphones and CDs. In the economic literature, these are all examples of products that are strongly complementary. Complementary products need to be compatible. Computer software must be specified in a way that makes it workable on a certain operating system. Likewise, lenses must be designed in a way that they can fit on a camera.

Other products generate a value to users only if they are consumed together with other users. In a communication network, for example, such as a network of electronic-mail users or a network of mobile phone users, each person finds subscribing to a certain electronic-mail system or buying a mobile phone valuable only if she can communicate with other people. This requires that people buy compatible mobile phones. Likewise, if people want to exchange emails they need to subscribe to compatible networks. Compatibility can be achieved in two ways: standardization, whereby products are designed according to certain specifications; or adapters, which provide an interface between products with different specifications. The principal cost of an adapter is the adapter itself. The primary cost of standardization is a loss in terms of product variety.[7] In all these cases, consumers do not shop for individual products, but for systems. The peculiarity of system markets is that the utility that a consumer derives from the consumption of the product does not depend only on the quantity and quality of the product itself, like in the case of bread, but also on the availability and variety of complementary goods and/or the number of people using the same product or compatible ones.[8]

System markets are characterized by potential problems of coordination, whereby market forces may lead to inefficient outcomes. The source of this market failure is network externalities. Positive network externalities arise when a good is more valuable to a user the more users adopt the same good or compatible ones. The

6 Labour standards share many characteristics with process standards. However, labour standards are not discussed in this Report.

7 Other costs include switching to a different system if the one selected turns out to be inferior, and the risk of anticompetitive behaviour in the market, as discussed below.

8 See Shy (2000) for a comprehensive study on network industries.

externality can be direct or indirect. A telephone network is an example of a direct externality because its value for the consumer increases as the total number of network users increases (actual network). A computer is an example of an indirect externality because its value increases as the variety or quality of compatible complementary goods (i.e. compatible software) increases (virtual network). Indirect network effects arise in this case from improvements in the supply of complementary goods. It may happen that the increase in the sale of a given product results in lower prices, better quality and/or greater variety of its complementary goods. Consider the situation when a consumer needs to buy a durable good such as a computer – say IBM or Apple. In making such a choice, a consumer needs to form expectations about the availability of software in the future for each of the computers. If the production of software exhibits economies of scale, this in turn will depend on how many people installed the hardware product in previous purchases. This positive feedback effect of the network constitutes an indirect externality. This "virtual" network creates welfare effects similar to that of the physical network, such as the telephone network, where users are physically linked to one another.

The market, in these cases, may fail to deliver an efficient outcome because the marginal benefit of one more consumer joining the network differs from the social benefit. The private marginal benefit determines whether a consumer joins the network or not. The social benefit of one more user joining the communication network includes the private benefit of the new user and the increase in benefits of the old users. Since social marginal benefits exceed private marginal benefits, the equilibrium network size is smaller than the socially optimal network size, and the perfectly competitive equilibrium is not efficient (Katz and Shapiro, 1985a and 1994). In the case of indirect network externalities, a consumer decision to choose a certain product does not affect the utility of other consumers at present but impacts on future variety and prices of compatible components. Again, it is in the interest of consumers to purchase the most popular product to benefit from an improvement in the supply of complementary goods. However, lack of information, different preferences and firms' marketing actions (such as promotional pricing and advertisements) may generate a non-optimal outcome (David and Greenstein, 1990).

In all these cases, setting a single standard solves the problem of coordination among consumers. Compatibility standards are standards that promote network effects. They can increase welfare because they increase the network of users adopting the same good or compatible ones. Moreover, compatibility standards allow each consumer to "mix and match" components from different manufacturers. Therefore, consumers may enjoy a greater variety of available systems (Matutes and Regibeau, 1988). A classic real world example is that of home HiFi stereos, where all components are compatible and the consumers are free to combine components from different brands to assemble the stereo most preferred. To the extent that compatibility standards reduce the costs to consumers of switching between different interfaces and thereby promote competition.

Welfare effects of compatibility standards may, however, depend on the particular variety chosen as the standard, and this may in turn depend on who sets the standard. In the case of network industries, three types of standards have been observed (Gandal, 2001): i) de facto standards (often proprietary), e.g. Microsoft, and VHS/Betamax; ii) voluntary industry agreements (typically non proprietary), e.g. in the case of Sony and Philips CD-players; and iii) government-imposed standards, e.g. national standards imposed by the US Federal Communication Commission (FCC) for compatibility in the telephony network.

Virtual networks exhibit a natural tendency towards de facto standardization or voluntary open standards (Katz and Shapiro, 1994). This is because, as a consequence of the strong feedback effects, network industries often show a propensity to "tipping" – that is, the tendency for a single technology to dominate the whole market once it has reached a certain critical mass. For example, no one would choose Betamax videocassette recorders over VHS, even if they preferred the former technology, because there is little or no pre-recorded material in Beta format. Therefore, firms owning different technologies will either engage in fierce competition with each other to persuade a sufficiently large number of consumers to choose their technology, or they will cooperate, agree on a single standard, and compete "within" that standard. In the former case, the dominant firm is likely to win the whole market and the risk of anticompetitive behaviour emerges (e.g. Microsoft).

Network externalities may also lead to dynamic inefficiencies when users have to decide whether to switch to a new technology and which competing technology to choose. In particular, network externalities may lead to excess inertia (users delay adopting a new technology or choosing among several technologies) or excess momentum (consumers rush to an inferior technology) for fear of becoming stranded (Katz and Shapiro, 1985b). Also, supply-side mechanisms can lead to excess inertia, since in industries characterized by network externalities the dominant firm usually sets the standard. Competing firms may then wait to adopt a new technology because they fear being displaced by a subsequent innovation of a dominant firm. Standards are necessary for the diffusion of a new technology in network industries. Setting a standard has, for instance, proven to be essential for successful innovation in the wireless networking industry (so-called Wi-Fi). Initially, vendors of wireless equipment developed their own standards. In this way, users of the Wi-Fi technology were locked into a particular vendor's products. It was not until 1999, when the six major companies of wireless technology – Intersil, 3Com, Nokia, Aironet, Symbol and Lucent – agreed on a common standard, that the Wi-Fi market took off.

An important issue is whether compatibility standards should be determined by the market or whether there is a role for the government to play. Coordination problems, excess inertia and excess momentum are all cases of market failure. Firms may fail to agree on a standard or a dominant firm may impose its own standard and develop anti-competitive behaviour. Government intervention may then be needed to improve market performance, either by setting a standard or ensuring competition.

Costs are, however, associated with standardization on a single technology, and the government does not seem to be in a better position than the market to minimize these costs. Standardization can result in large costs, for example, if the technology selected turns out to be an inferior technology. Learning to use a certain system takes time. Switching to a different system has costs in terms of retraining. Switching costs may lock consumers into using an inferior technology. A well known case is that of the commonly used QWERTY keyboard configuration.[9] There is no reason to think that the government is better informed and less prone to mistakes than the private sector. Analysis of standard setting in mobile telecommunications in Europe and the US (see Box 1) provides a useful case to compare alternative approaches to standardization. The European and US experience in the wireless telecommunication industry shows that a government-mandated standard can partially solve the coordination problem among consumers, as the critical mass of the network is reached very quickly and consumers benefit from the network externalities associated with a larger market. When the AMPS was deployed as the American standard for the first generation mobile phones, it quickly became a de facto world standard. The adoption of the GSM as the pan-European standard for second generation mobile phones (1989) also fostered the diffusion of GSM outside Europe. As a result, GSM is the de facto global standard today. At the end of 2003, GSM was used by more than 72 per cent of mobile phone subscribers. However, government-mandated standards do not avoid the risk of being locked into obsolete technologies, or the risk of inertia. Switching costs for consumers (such as the cost of replacing a cellular phone or breaking an existing contract) and carriers (such as the costs of replacing base stations, retraining employees and redesigning contracts) may lock in obsolete technologies. For example, the use of AMPS technology (government-mandated first generation technology in the United States) continues to be widespread in the United States despite the availability of superior second and third generation technology. On the other hand, the case of third generation (3G) mobile phones shows that the support for a specific standard by a regional entity, such as ETSI, was not sufficient to trigger its adoption in the global market. Commercialization of 3G mobile phones has been retarded not by the non-availability of the 3G technology, but rather by the fact that for over five years no agreement was reached on what the standard would be adopted by the International Telecommunications Union.

[9] This configuration was initially introduced by the Remington Arms Company, a leading manufacturer of manual typewriters, deliberately to slow down typists and avoid jams. At this time, available keyboard technology had no engineering solution to the problem of frequent jams. In 1911, the QWERTY keyboard became a de facto standard when it was applied to the first typewriter that allowed characters to be visible to the typist immediately after they had been typed. Typists started being trained on these new machines, and other keyboard arrangements were abandoned. In the 1930s, Dvorak developed a more efficient keyboard that allowed a typist to type up to 20 per cent faster. The American National Standards Institute published a standard for keyboards based on the Dvorak configuration. However, this configuration was not taken up by the market as the costs for producers and consumers of switching to the new configuration were considered too high (David, 1985).

Box 1: The mobile phone industry in Europe and the United States

Mobile communication networks have experienced dramatic growth over the past decade. In 2002, the number of cellular mobile subscribers around the world exceeded 1 billion, up from just 11 million in 1990. In 1990, mobile phone subscribers represented only 2 per cent of fixed telephone line subscribers, while by the end of 2002 there were more mobile cellular subscribers than subscribers to fixed telephone lines.

The creation of standards in the wireless telecommunication industry followed a different pattern in Europe and the United States. In the early 1980s, Ameritech installed the first analog mobile phones system in the United States. The Federal Communication Commission (FCC) mandated the adoption of a single standard for the United States – the AMPS system (Advanced Mobile Phone Service). To avoid the emergence of a monopoly service provider, the FCC also imposed an antitrust regulation. The adoption of a unified, government-backed standard fuelled the growth of the network, and by 1993 more than half of the worldwide wireless cellular systems used this technology.

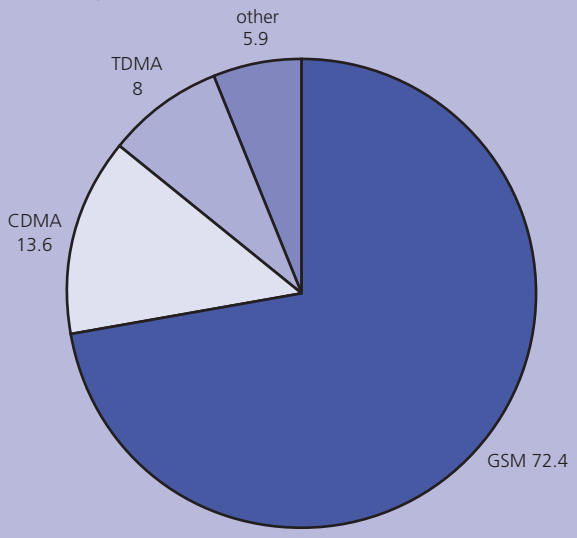
By contrast, in Europe standards for first generation mobile phones differed across countries and were not compatible with each other. Two standards for first generation cellular phones competed in the European market: the Nordic Mobile Telephone (NMT) and the Total Access Communication System (TACS). The former was developed by Nokia and Ericsson. It was first implemented in Sweden, then spread to other Scandinavian countries. The latter standard was established in Italy and the United Kingdom. In this situation, not only was mobile communication equipment limited to operation within national boundaries, but there was also limited scope for exploiting economies of scale and forgone savings. The rate of diffusion of mobile phone communication (growth of the percentage of people using mobile phones) remained higher in the United States than in the EU during the whole of the 1980s.

In 1991, the second generation digital mobile phone was commercialized. The United States and the EU again chose different approaches to standardization. The FCC adopted a market-based approach. Several standards for digital mobile phones emerged in the United States market and they were left to compete for the dominant position in the market. In contrast, in 1989 the European Telecommunication Standards Institute (ETSI) adopted a unified Global System for Mobile Communications, or GSM. This continent-wide standard for the digital network allows one cell phone to work across all European countries. The adoption of a single standard in Europe favoured the rapid diffusion of GSM technology in Europe, where analog technologies (such as AMPS, TACS, NMT) were nearly completely displaced. The digital network grew very rapidly in Europe. The number of users of the digital network for cellular communication rose in Europe from 4 per cent in 1992 to over 90 per cent in 1998. In North America, where the choice of the second generation technology was left to the market, there were a variety of technologies used, including AMPS, a first-generation technology. The growth of digital mobile phones suffered as a result. In the United States, they began to be used only in 1995, and in 1998 the percentage of mobile phone subscribers using digital cellular phones was still below 30 per cent.

Harmonization of standards in the network industry in Europe allowed the rapid diffusion of the GSM technology across users, including outside European boundaries (see Chart below for an indication of the diffusion of the GSM technology as of 2003). By 1993, there were 36 GSM networks in 22 countries and over 1 million subscribers worldwide. At the end of 2003, over 400 GSM networks were operational in over 110 countries around the world and there were nearly 1 billion GSM subscribers, more than 70 per cent of the digital network. Standardization and diffusion of the GSM technology in the United States followed, but with a delay. In 2003, 20 per cent of North American mobile telecommunication used a GSM technology. The advantage is that now a European mobile user who travels to the United States can use her mobile phone to make a phone call in the United States (so called international roaming).

In 2000, in an effort to consolidate existing incompatible mobile environments into a global network, the International Telecommunication Union (ITU) adopted a standard for third generation (3G) mobile phones: the International Mobile Telecommunication 2000 (IMT-2000). Two technologies were competing in the market to become the 3G global standard: Universal Mobile Telecommunication System (UMTS) and Code Division Multiplexing Access (CDMA-2000). UMTS was supported by European and Japanese telecommunication firms. ETSI recommended that the ITU adopt this technology and a European decision in 1998 had mandated that 3G UMTS service cover 80 per cent of the population in Europe by 2005. The wireless communication company Qualcomm had endorsed CDMA-2000 as a 3G standard and protected this technology entering into a patent dispute. Discord on a global standard retarded the commercialization of 3G mobile phones, which only just started at the end of 2004. The transition to the new technology will ensure compatibility with mobile phones from previous generations. In this way, switching costs will be minimised. Producers and consumers will benefit from economies of scale and network externalities.

World mobile telecommunication by type of technology, 2003
(Percentage)



Source: GSM Association.

Source: Ritchie et al. (1999); ITU (1999); ITU (2004); www.gsmworld.com as at November 2004. John Scourias "Overview of the Global System for Mobile Communications" at http://ccnga.uwaterloo.ca/~jscouria/GSM/bib#bib.

The effect of compatibility standards on international trade

To the extent that compatibility standards allow network externalities to be captured, or allow producers to coordinate their activities more efficiently or embody information about consumer preferences in foreign markets, they are likely to enhance international trade. Several network industries are global in scope: the telecommunications, personal computers, and car industries are examples where global competition prevails. In some of these cases, firms compete in markets with different government-imposed standards. In other cases, perhaps more frequently, product standards are set by industry groups whose membership is increasingly international in scope.

The theoretical literature on compatibility standards shows that when network externalities are large, countries (and industrial groups operating in different countries) have an incentive to harmonize standards or make them compatible, and that in these situations there is more international trade (Gandal and Shy, 2001).[10] For products or services which are characterized by global network externalities, the adoption of an agreed standard facilitates the expansion of the market, which can extend beyond national borders, for the product or service. For example, the adoption of the GSM standard in cellular phones enabled rapid penetration of cellular phones in Western Europe, and then it quickly extended to Asia and Africa (see Box 1). Not only did this result in massive growth in domestic calls using cell phones, it has also led to the growth of

[10] Gandal (2001) used the example of Japanese television set exports to the United States and Europe to study the effect of differing standards on international trade. Both Japan and the United States had adopted the same National Television Standards Committee (NTSC) system, while European countries had adopted either the Phase Alternate Lines (PAL) or Sequential Couleur Avec Memoire (SECAM) standards. The three standards are incompatible. Despite the strong competitive advantage of Japanese TV manufacturers, their market share differed significantly in the United States and Europe. By the early 1980s, Japanese sets accounted for 43.5 per cent of the US market while their market share in Europe was only 15.2 per cent. He attributes the failure to develop an integrated global market in TV receivers to the adoption of different standards in the major markets.

roaming (which represents trade in telecommunications service), in which a caller with a domestic cell phone subscription can make a call while overseas, utilizing the network of a foreign telecommunications provider. As the number of GSM users increased from 258 million to 456 million between 1999 and 2000, the number of international roaming calls surged to 540 million in 2000, doubling relative to the year before.

Compatibility standards also facilitate trade in the case of virtual network industries built on complementarities in production or consumption, since an incentive exists here to ensure that compatibility is extended across countries. Modern manufacturing involves a large number of firms in different locations, often also in different countries, who produce parts and components which are assembled before being distributed to the final consumer. Effective assembly of products from a host of suppliers require that the inputs are compatible with each other such that they can be fitted together with as little adjustment as possible. The role of standards is particularly important in the information technology sector, but all sectors depend on common standards in order to exchange goods, services and information. Some standards such as measurement units are internationally accepted and others are global, national or regional. However, in order to ensure compatibility of purchased inputs firms or coalitions of firms typically develop standards that are specific to their technology. Often the ability to conform to a firm's standards is a prequalification criterion for a potential supplier to be allowed to bid for contracts. This creates a supplier base of qualified firms, and the larger this supplier base the more competitive the market and the lower the cost of inputs to the downstream firm producing final goods.[11]

In industries where the final product is assembled from parts and modules, the compatibility of parts and components (i.e. to what extent they are standardized) is decisive for whether or not the firms in the industry are vertically integrated. With standardized inputs, it is easy for suppliers of parts and components to find a customer and vice versa. If, on the other hand, a downstream firm has set product standards that are specific to the firm, it might have difficulty in persuading suppliers to conform to the standard. The supplier cannot be sure that the customer will actually pay for its effort, since *ex-post* nobody else will be interested in buying the product in question.[12] When lack of trust or lack of opportunities for setting up a mutually beneficial enforceable contract makes this a serious problem, the assembler will have to produce its firm-specific components in-house. When the majority of companies in an industry use their own standards and produce their components themselves, the market for independent suppliers of components is thin and underdeveloped. McLaren (2000) shows that trade liberalization is a possible way of thickening the market for suppliers of components and thus inducing more firms to diversify the sources of their input purchases. Clearly, replacing firm-specific standards with shared standards will have the same effects within and across international boundaries.

Standards therefore represent an important way to ensure the compatibility of inputs, parts and components. They are also essential in ensuring adequate quality and coordinating the pace of adoption of innovation across suppliers of parts and components (see Box 2 for the role of standards in fostering technology diffusion). Internationally accepted product standards can facilitate international trade in intermediate products through reducing search costs and production costs. Production costs are reduced because imported inputs can enter the production process directly without any intermediate processing and also because an international market can support a larger supplier base and thus a more competitive market for intermediate inputs.

[11] This relationship between the degree of specialization (as given by the number of differentiated suppliers) and the extent of the market is referred to as pecuniary externalities in the literature. This is because the entry of a new supplier lowers the cost of the downstream firm by extending the number of inputs and reducing everybody's margin. Since the impact is reflected in prices, it is not a pure externality.

[12] This is the so-called hold-up problem discussed in the industrial organization literature.

Box 2: Technology diffusion and the technology content of standards

The information contained in standards can also play a role in the diffusion of technology. The information contained in non-proprietary standards is in principle accessible to everybody. In particular, standards may embody considerable technological knowledge. Firms can access and acquire this knowledge and standards can therefore serve as a vehicle for technology diffusion within or across countries. Even where knowledge is patent-protected, information registered under patents may permit useful knowledge adaptations that can be incorporated into standards.

In industries that assemble parts and components from various providers, both uniform quality and uniformity in the pace of technological advancement are essential. Standards are crucial in coordinating the pace and the adoption of innovation across suppliers of parts and components, thus fostering technology diffusion across sectors.

A recent study has found that standards play an important role in the diffusion of new technology and ultimately contribute to growth. On the basis of a survey conducted of 700 companies, the study finds that in the period 1960-96, one per cent of Germany's gross domestic product and one-third of its economic growth were attributable to standards. Standards are at least as important as patents for growth. They act as catalysts for the spread of innovations into the market. The study found a positive correlation between patent applications and new technical regulations, especially in innovative fields (Blind et al., 1999).

To the extent that standards incorporate information about a particular technology, they create a means of diffusing know-how internationally. While a technology that has now become an industry standard may not be on the technological frontier, one can imagine a situation where technological know-how differs among firms in developed and developing countries. So a mature technology which is adopted as an industry standard in developed countries may still represent an advance for firms in developing countries. The existence of such standards that can be adopted by firms in poor countries can represent an important mechanism for diffusing technology.

However, while these conditions make it more likely that compatibility standards increase trade, there are no guarantees. Where network externality effects are strong, compatibility standards can also be a source of market power. In the information technology sector, for example, firms can garner an important, if not decisive advantage when their standard (usually in the form of copyrighted software) is adopted as the de facto industry standard. When a de facto standard conveys market power, it will limit competition and act as a deterrent to trade.

Moreover, while network externalities provide incentives for international compatibility, it may be difficult to achieve such an outcome. The coordination problem consumers face – trying to avoid either excess inertia or excess momentum – is likely to be more acute in an international setting since there are more consumers to coordinate and they are spread across different jurisdictions. To the extent that promoters of competing standards come from different countries and the winner can claim rents from the adoption of their standard, strategic trade policy considerations can come into play. A government can try to tip the balance in favour of its national champion by mandating the use of the firm's standard at home. This would be in the hope that an installed base of users would create a strong enough bandwagon effect to convince foreign suppliers to switch to the national firm's standard in other markets.

Recent developments in the computer industry have shown that multinational companies may also have incentives to avoid international competition. For example, the new iMac G5s sold in the United States are designed to work only with the electric power systems in the United States and Japan, but not in Europe. Similarly, some of the latest printers from Hewlett-Packard Co. are configured to use only printer cartridges

purchased in the same region as the printer. Adoption of incompatible standards across countries works as a market segmentation device and reduces competition and trade. Faced by strong competitive pressure, for example the pressure resulting from the recent depreciation of the dollar for those producing in Europe, multinationals may be induced to price discriminate across countries. Setting incompatible standards between the EU and United States allows multinationals to set different prices for the two markets, as arbitrage from imports is rendered impossible.

(b) Imperfect information: the case of safety standards

Many situations in which consumers, producers and governments have to make decisions are characterized by Imperfect information. Decision-makers do not have all the information at hand when they make purchases, investments or decide on policies. Sometimes, both parties to a transaction do not have all the necessary information. But in many instances, one party to a transaction (typically the seller) may have better information about a product than the other party (typically the buyer). This is the case of information asymmetry. While the former case is also important, the focus in this Report would be on problems created by asymmetry of information and the role that standards can play in these situations.

Information asymmetries occur when producers have information about the characteristics of goods they produce which users do not have when purchasing these goods. Users may in this case be consumers of final goods or companies buying intermediate goods as an input for their production process. In both cases, the information asymmetry may significantly hamper the efficient functioning of markets. Standards can solve the information problem and thus enhance efficiency.

Because consumers differ they appreciate characteristics of products in different ways. The availability of different varieties of products in the market should, therefore, in principle be welcomed. In the presence of information asymmetries, markets that are left alone may end up undersupplying certain varieties of goods. The market outcome in the case of information asymmetries thus stands in stark contrast to the case of network externalities discussed in the previous Subsection. While in the case of network externalities markets may end up supplying too many varieties, the opposite is likely to be the case in the presence of information asymmetries.

If, for instance, consumers have only imperfect information about the characteristics of a product upon purchase, there may be an undersupply of higher-quality varieties, where the term "quality" can refer to any characteristic that can be ranked by consumers according to an objective scale (e.g. size, durability, safety). The safety of meat may, for instance, depend on the way cattle have been raised. "Safer" meat may be more costly to produce and therefore demand a higher price in the market. Yet if consumers are not able to distinguish the quality of the meat upon purchase, they will tend to buy the cheapest meat on offer. Production may become unprofitable for producers of high quality meat and they may disappear from the market or switch to cheaper production methods that increase health risks for consumers. Thus, the market alone may end up undersupplying "safe meat".

Perhaps the most typical example of standards that work against the undersupply of "quality" output relates to product safety. Indeed, a wide range of consumer goods – food, drugs, vehicles, electrical appliances, safety equipment – face many types of requirements, from design (e.g. toys), to ingredients (e.g. chemicals), to the process of manufacture or production (e.g. pasteurization of milk), and to performance (e.g. helmets). Mandatory standards act in these situations like minimum standards, as they rule out the supply of products not meeting the quality (e.g. safety) level determined by the standard. Voluntary standards in combination with a label, e.g. child-safe toys, have the effect of guaranteeing the supply of higher quality products next to the supply of lower quality products. Voluntary standards thus do not rule out the supply of lower quality products, but ensure that higher qualities are not pushed out of the market. The fact that lower quality products are not banned from the market can be considered more "market-friendly", but also more "risky". Voluntary standards will therefore be preferable to mandatory standards if the risks involved are considered to be acceptable to society.

The economic cost from accidental injuries and deaths can be large. In the United States, for example, there were more than 12 million accidents in 2003 from the use of consumer products that required treatment in hospitals.[13] The US Consumer Product Safety Commission estimates the economic costs of these accidental deaths and injuries at $700 billion annually. Unfortunately, risk and its cost are not always easy to measure, in particular because consumers tend to value risk in different ways. It is therefore not straightforward to design optimal policy instruments in these cases.[14]

Public versus private initiatives to protect consumers

The rationale for government intervention rests on the existence of information asymmetry between the producer of the possibly defective product and the consumer. A manufacturer knows more about the reliability or safety of his product than the consumer. Of course, it may be possible that the threat of a consumer backlash against firms discovered selling unsafe products will deter producers from willingly selling substandard products in the marketplace. Firms also have an incentive to improve the reliability of their products in order to differentiate their output and create a price premium for them (Shapiro, 1983). The extent to which consumers can "punish" producers providing unsafe products or reward those supplying safe products will, however, depend on whether consumers identify the exact characteristics of a product they buy and on how frequently they return to the market to buy that product.

Economists have classified goods into three categories that signal the degree of information available to consumers when purchasing a good. These are search goods, experience goods and credence goods. In the case of search goods – for example, clothing – quality can be ascertained by consumers before purchase. In other cases, the quality may be learned after the good is bought and consumed. This is the case for instance with the quality of food or washing machines. The literature refers to these goods as experience goods.[15] For still other goods, aspects of quality (e.g. the amount of fluoride in toothpaste or the amount of calories in a snack) are rarely learned, even after consumption. This last type of product is referred to as credence goods in the economic literature.[16] Note that credence goods have above all been analysed in the context of services: the timeliness of a doctor's intervention, the quality of a lawyer's advice and the reliability of car repairs are typical examples of credence good characteristics. Box 3 discusses the case of standards in services.

Box 3: Services as credence "goods"

Credence goods refer to goods and services whose quality cannot be determined before, during, or sometimes even after their use. The usual examples are services – medical, legal, financial and auto-repair services – where the consumer is largely dependent on the expertise and counsel given by the provider of the service. The information asymmetry between provider and consumer arises because of the specialized knowledge of the provider and the high cost involved for the consumer to verify the advice he is given. So in the case of medical services, a patient will just be told what ails him and what medical tests and procedures to undergo. A patient must take much of the medical advice he is given on faith (hence the term credence). In many cases, the consumer will not be able to determine the quality of the service provided even after its consumption. A patient would not be able to appraise how well he was treated by his physician since the medical outcome (good or bad) will only partly depend on the physician's skills.

13 NEISS is a national probability sample of hospitals in the United States and its territories. Patient information is collected from each NEISS hospital for every emergency visit involving an injury associated with consumer products.

14 See also Section 4 on balancing.

15 Nelson (1970).

16 The term was first used by Darby and Karni (1973).

This asymmetry of information gives providers ample opportunity to exploit consumers. The provider may recommend expensive procedures, even though less expensive alternatives are available. Or the provider may recommend treatments that are not even necessary. Emons (1997) gives some examples of the possible effects of this information asymmetry:

- In the Swiss canton of Ticino, ordinary patients (i.e., the population average) had 33 per cent more of the seven most important operations than medical doctors and their families;
- In Germany, the most expensive garages charge up to double the amount that the cheapest garages charge for bodywork without necessarily being any better;
- In the United States, unnecessary repairs were recommended to car owners by employees of Sears Automotive Centres in 90 per cent of the test cases.

Given that the consumer will not be in a position to appraise the quality of the services which are provided, markets often require some public or private regulatory structure to remove the inefficiency. In the case of service providers, these often take the form of minimum qualification or educational standards. In many countries, in order to practice medicine, a medical licence is required. Licensing, in turn, requires the would-be physician to complete an approved medical training programme and pass a standardized test. Since the licence must be renewed, a physician's performance is monitored by the licensing board. Lawyers also face similar standards. In the United States, one must have graduated from law school and passed the state bar exam in order to practice law in a particular state.

Foreign service suppliers usually face more severe requirements. Seldon et al. (1998), for example, point out that the residency requirements for foreign-trained physicians exceed the requirements for graduates of US medical schools.

In the case of credence goods, consumers rely to a large extent on government intervention to ensure the quality of products provided in the market, reflecting both the difficulty for consumers to evaluate a product's safety or to take recourse against producers if the product turns out not to meet expectations. If the government has serious reasons to believe there is a demand for (what is perceived by consumers as) higher quality goods, it may want to introduce voluntary standards in order to increase the range of qualities provided in the market. But where deceptive practices by producers have such serious effects as to endanger the health of consumers, the government may wish to take preventive action in order to rule out such cases. In these circumstances, the government will choose mandatory standards.

In the case of experience goods, producers have an incentive not to sell unsafe or unreliable products in order to avoid a consumer backlash against the firm, as described above. Government intervention could be minimal in such cases and, for instance, take the form of product liability legislation, which allows a consumer who has been injured by a defective product to claim damages from the producer through the courts.[17] In some ways, this is a less intrusive form of public action than specifying what types of technical specifications a product must have before it can be sold in the market. But there are cases in which product liability legislation would not result in satisfactory outcomes. The impact of a product defect may, for instance, be catastrophic – with victims suffering from severe injuries or deaths – so that survivors can never be entirely compensated for their sufferings. Finally, manufacturers who face a large number of lawsuits and claims may go into bankruptcy first before payments to claimants are ever made.[18]

[17] Another source of market imperfection continues to exist in such cases; in an imperfect information setting, there is a positive externality from knowledge acquired by the subset of consumers who have consumed a product. This information about the product's reliability is essentially a public good that government should then make available to the uninformed.

[18] See Tirole (1993) for a further discussion of these issues.

Without some form of public intervention, the market will produce a welfare-inferior outcome in such cases. But if the need for public intervention can be justified in this case, should it take the form of product standards? And if so, how should these standards be designed? Designing standards often implies the specification of a large number of technical details. Ideally, consumer preferences should be taken into account when designing standards but a government's knowledge of consumer preferences is typically imperfect. Small changes in the specification of a standard may also have an important impact on producers and on the competitive setting in a market. Designing optimal standards is therefore not a straightforward exercise.

There are a number of advantages to mandatory product standards which lead to their wide application by governments. An extensive set of safety-related standards exist for many consumer products. (See, for example, Box 4 on federally-mandated motor vehicle standards in the United States). The use of technical standards can build on accumulated experience and scientific knowledge about the likely effect of a product standard on consumer safety. Second, conformity with technical standards provides an objective and easily monitored benchmark for the regulator. Third, the imposition of product standards is more likely to convey to consumers that public attention is being paid to important safety issues and that action is being taken by responsible authorities.

Box 4: US Federal Motor Vehicle Safety Standards and Regulations

In the late 1960s, public concern over motor vehicle safety in the United States was a major factor in the establishment of the National Highway Traffic Safety Administration (NHTSA). The public uproar was sparked by the publication of Ralph Nader's book *Unsafe at Any Speed: The Designed-in Dangers of the American Automobile,* which accused General Motors of corporate negligence in its design and manufacture of the popular Corvair. This was followed up by a congressional investigation. The NHTSA has the mandate to issue federal motor vehicle safety standards and regulations to which manufacturers of motor vehicles and items of motor vehicle equipment must conform. The first standard to become effective, on 1 March 1967, was for seat belt assemblies.

The federal standards cover motor vehicle components (e.g. tires, brake hoses), systems (e.g. hydraulic and brake systems) and protection devices (e.g. seat belt assemblies). They also include requirements on fuel economy, anthropomorphic test devices (size, shape, weight, etc. of the test dummies to test performance of safety systems in motor vehicles). Safety-related defects must be reported to the NHTSA and made public.

Notwithstanding these efforts, fatalities from motor vehicle crashes continue to number in the tens of thousands. In 2000, the NHTSA reported 41,821 casualties from motor vehicle crashes. The total economic cost of motor vehicle crashes was estimated at $230.6 billion, which included the present value of lifetime costs for the fatalities, 5.3 million non-fatal injuries, and 28 million damaged vehicles.

However, this benign view of regulatory action does not go unchallenged. An important argument against the use of mandatory product standards is that they can create moral hazard, creating an impression in the public mind that government-mandated standards have succeeded in eliminating all the risks from a given product. Given what is essentially a public guarantee about the safety of the product, consumers may then become less cautious in their use of it. So if this induced change in consumer behaviour is taken into account, there may be no significant difference in accident and mortality rates arising from the mandatory adoption of product standards. In the meantime, the requirement for manufacturers to configure their products according to government specifications increases the costs of production.

The empirical evidence on whether mandatory standards improve safety is mixed. A study by Peltzman (1975) on auto safety belt regulations found no significant differences in total fatalities from automobile accidents. Similarly, another study by Peltzman,[19] on mandatory prescription drugs, found no effect of standards on the incidence of accidental poisonings or adverse reactions to drugs. Viscusi (1984, 1985) also found no evidence that product specific standards set by the US Consumer Product Safety Commission reduced accident rates. However, Magat and Moore (1995) examined the bicycle industry in the United States and United Kingdom and found a statistically significant decline in accident rates as the stock of bicycles in compliance with mandatory standards increased.

The impact of safety standards on trade

The area of government-mandated product (and process) standards is where the greatest concern exists about possible adverse effects on trade. There are two reasons for this. First, such standards are a requirement supported by the coercive power of the state. Second, it is likely that in the course of developing standards, governments will be most responsive to domestic concerns, in particular the interests of domestic industry whose product competes with imports. As a result, standards may be designed in such a way that gives domestic producers a competitive advantage. Although this is, in principle, not in the interest of domestic consumers, governments may – deliberately or not – impose safety standards that act as protectionist devices.

Safety standards designed with the aim of maximizing national welfare, i.e. not as a protectionist device, may increase trade, decrease it, or leave it unaltered (see Box 5 for an example). The outcome will to a large extent depend on a standard's effect on the relative costs of domestic and foreign producers. But it also depends on many other factors, like the level of competition in exporting and importing countries and the willingness of consumers in different countries to pay higher prices for safer products. It is therefore difficult to predict the effect of a safety standard on trade flows. The following discussion should therefore be considered as indicative of what could happen rather than as assertions on what will happen.[20]

Box 5: Standards, trade and welfare

To investigate the ambiguity of the effect of a product standard on trade and welfare, consider a two-country situation in which there are many consumers and many firms in each, i.e., there is perfect competition, except that the assumption of perfect information is not met for consumers. The product is assumed to have a credence characteristic. The possibility that it might be optimal for the government in each country to exploit its international market power is ignored. Prior to imposition of the product standard by the importing country, the equilibrium world price (p_{ns}) is found in the middle panel where the export supply function (ES_{ns}) and the import demand (ED_{ns}) function intersect (see Chart below). These functions are derived from the domestic demand and supply functions for the exporting country (left-hand panel) and the importing country (right-hand), respectively. The volume of the product traded is q_{ns} and the welfare gains from trade for both countries jointly, measured from no trade, is given in the middle panel by the area of the triangle bounded by the price axis, and the ED_{ns} and ES_{ns} functions. The area below the price line (p_{ns}) and above the ES_{ns} line is the gain to the exporting country; and the area above the price line and below the ED_{ns} line is the gain to the importing country.

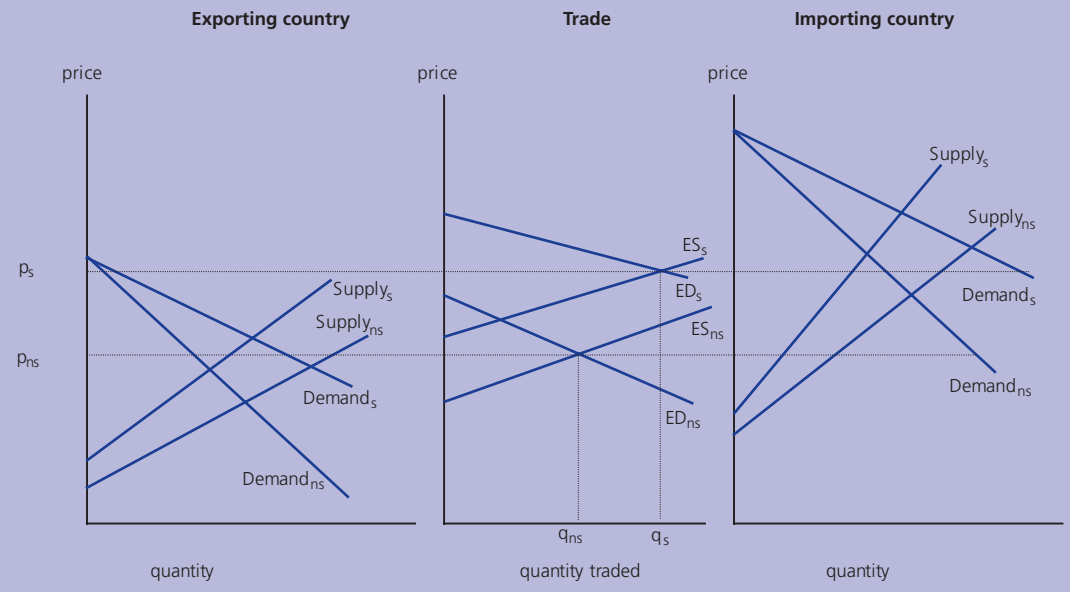
To overcome the market failure caused by lack of information about the quality of this product, suppose that the government in the importing country imposes a standard which has to be complied with by both domestic and export suppliers. There are two consequences in the importing country: production costs are likely to rise and consumers will gain greater utility from consuming the good. These effects are illustrated in the right-hand panel by the upward shift in the supply function and the rotation of the demand function,

19 Peltzman (1987).

20 As Ganslandt and Markusen (2001) put it: "...one could imagine a whole portfolio of models to deal with these issues."

respectively. Together, these changes alter the position of the import demand function from ED_{ns} to ED_S. In the exporting country, production costs will also rise, at least in producing the product for export. Consumers in the exporting country may or may not hold the same preferences as those in the importing country and, therefore, there may or may not be a rotation in the domestic demand function. In the diagram it is assumed that costs rise for all production and that consumers prefer the higher standard.

The effect of the standard on trade and welfare are shown in the middle panel. Given the assumptions made about cost increases and consumers' utility, there is an increase in the volume of trade, an increase in welfare for each country and for this two-country world. However, it is straightforward to show that this is not the only possible outcome. By altering the assumptions and reflecting these in the relative shifts of the trade functions, it is possible to show that the exporting country can lose welfare from the imposition of the standard by the importing country and that world welfare could still rise. But it is also possible to show that there is no monotonic relationship between the direction of change in the volume of trade and that of welfare for the exporting country or for world welfare: the volume of trade could increase and yet world welfare could fall. It can be assumed that the welfare of the importing country will not fall because a rational government would not impose a welfare-reducing standard in order to correct a market failure.



If the country introducing the standard is an exporting country, trade is unlikely to increase. To the extent production costs are higher for safer goods, domestic exporters will become less competitive in world markets where their competitors do not need to meet the same safety standards.[21] If the country imposing the standard imports the relevant good, the effect on trade is ambiguous. Foreign exporters will, in this case, incur higher costs as they must adapt their products to conform to the new regulations. Typically, the change in costs can be modelled either as an increase in fixed cost with marginal cost remaining unchanged (as in the case of a once-and-for-all redesign change) or a percentage increase in cost (Ganslandt and Markusen, 2001). But domestic producers also have to adapt their production and incur higher costs. If the standard affects marginal costs, trade will tend to decrease if the cost increase for foreign producers exceeds that experienced by domestic producers. Trade will tend to increase in the opposite case.

Welfare effects are even more difficult to predict than trade flow effects, but the following scenario cannot be excluded. When trade flows decrease as a result of the standard, the reduction in imports represents a welfare

[21] It may be possible for exporters to produce different goods for foreign markets than for the domestic market in order not to deteriorate their competitive position abroad. But maintaining two production lines may involve additional costs and thus not increase trade.

loss for the country setting the standard. On the other hand, the standard increases product safety, i.e. it corrects an existing market failure. This has a positive effect on domestic welfare. The optimal standard from the point of view of the country setting the standard is the one that leads to the best trade-off between a negative trade effect and a positive welfare effect due to increased product safety. In other words, safety standards may increase national welfare even if they decrease imports. Besides, a decrease in the exporting countries' welfare cannot be excluded, implying ambiguous global welfare effects. In theory, at least, standards may thus create conflicts of interest even if they are not set with the intention of protecting domestic producers.

The risk of disagreements among countries about the appropriateness of certain measures is likely to be higher the more different countries are. In particular, the level of development of countries is likely to play an important role, as it affects the level of available production technologies and consumer preferences. Producing higher quality goods may be relatively more expensive in developing countries than in developed countries.[22] More importantly, the demand for quality, for instance in terms of product safety, is likely to increase with income. Theoretical considerations would therefore suggest that optimal safety standards may differ significantly between developing and developed countries and that the potential for conflicts of interest is relatively high. In practice, however, significant conflicts of interest also appear to exist among developed countries. All six GATT/WTO disputes involving product safety have been disputes among developed countries. However, only one of them – *EC–Asbestos* – has been ruled in favour of the standard-setting country. This might indicate that protectionist interests were deemed to have influenced the design of the standards causing disagreement, or at any rate that avoidable protection effects resulted from the design or application of a measure.[23]

(c) Negative production and consumption externalities: the example of environmental standards

An important area where governments around the world have increased regulatory activity in recent decades is in the environmental sector. Environmental externalities are a form of market failure that arises because the use of environmental resources, whether in the form of air, water, land, etc. is not properly priced. Therefore, producers make use of these resources at a rate that is not socially optimal. Production may occur to the point where the air pollution, for example, results in respiratory problems whose costs are considered to outweigh the benefits obtained from more goods. To achieve the efficient outcome, economic theory recommends the use of environmental taxes or charges (the so-called Pigouvian tax) to manage environmental externalities.[24] But many governments prefer to pursue their environmental objectives through performance standards or mandated technologies, licenses, permits, zoning regulations, registration, and other regulations.

Why are environmental regulations preferred to taxes?

In theory, regulations are less efficient than taxes because they do not reduce environmental damage at the lowest cost possible to society. By contrast, an environmental tax will do so, if the tax is set equal to the marginal social cost or damage of the environmental externality. An intuitive explanation for this result is that in the case of a production externality, the firm whose production causes the externality will continue to produce so long as the revenue (price) to be earned from the sale of the product exceeds the (private) cost of producing an extra unit of the good. In its calculations the firm does not take into account the damage caused to the environment through its activities. In other words, the firm does not take into account the environmental cost to society. This "under-evaluation" of production costs leads to a higher level of production than is desirable from an environmental point of view. A tax could remedy this situation as it increases the firm's production costs. Ideally, the tax should be set at the level that guarantees an equilibrium situation in which the social value of the good (price) equals the social cost of producing an additional unit of the good. This (Pigouvian)

22 The issue of available production technologies for instance played a role in *US-Shrimps* (see Section IID).

23 The relevant cases are discussed in Section 4. Section 4 also argues that it is not entirely clear whether WTO Agreements intend to ensure global welfare maximization or only intend to ensure that standards are not abused as protectionist devices.

24 More precisely, in the absence of transaction costs, private bargaining will achieve the efficient outcome (Coase, 1960). In the presence of transaction costs, the Pigouvian tax is efficient.

tax would guarantee an optimal production level for society as both the pure economic benefits of producing and consuming a good and the environmental effects of producing that good are taken into account.[25]

Although Pigouvian taxes, in theory, represent an optimal policy instrument, their application raises a number of concerns. These include distributional issues, uncertainty about the costs and benefits of abatement, and the costs of monitoring and enforcement (Bovenberg and Goulder, 2001). Governments may be reluctant to saddle households and firms with the distributional consequences of an environmental tax. While an increasingly wider set of methods are being applied by social scientists to measure the monetary value of environmental costs (including hedonic pricing, contingent valuation, etc.), there continues to be a great deal of uncertainty about the exact magnitudes of the benefits and costs from pollution abatement. Finally, there is the cost of monitoring and enforcement. As a result, calculating the Pigouvian tax rate is not a straightforward exercise. It requires knowledge of the cost of the pollution (monetary value of the increase in mortality or morbidity) at the optimal level of production. For these and other reasons, policy makers tend to give a preference to the use of environmental standards.[26] It may, for instance, be much easier to monitor and enforce compliance by manufacturers through environmental standards than though the more market-based approach of fiscal interventions.

Preferences for different environmental policy instruments are likely to differ across countries. Some governments are more able than others to absorb the costs of environmental policies. Producers and consumers with lower average incomes are also less able and willing to incur such costs. Members of lower-income societies often face greater uncertainty about the future and therefore are more reluctant to invest in it, which after all is what much environmental policy is about. These are all reasons why industrialized countries tend to have more stringent environmental standards than developing countries.

Environment-related product and process standards

While there are a number of ways in which environmental standards can be categorized, the distinction between product and process standards has become important in the context of the multilateral trading system. Process standards are typically used in situations where environmental externalities arise during the production process, while product standards tend to be used when the externality arises through the consumption of a product. Carbon dioxide (CO_2) emissions by a plant, for instance, would be considered to lead to production externalities, while CO_2 emissions by cars are to a large extent related to consumption externalities. This distinction is important for the multilateral trading system, as many consumer goods can be traded, whereas production processes are typically not traded. Besides, a distinction has to be made between global/transboundary and local externalities. Carbon dioxide emissions are of a global nature, while the use of pesticides in farming tends to have a more local impact. Taking into account that standards can be either mandatory or voluntary, eight different categories of environmental standards can be distinguished, as illustrated in Table 2.

Table 2
A taxonomy of environmental standards

Producer	Local	I. Mandatory process standard (maximum amount of pesticides used per acre).
		II. Voluntary process standard (organic label).
	Global	III. Mandatory process standard (maximum CO_2 emission level per plant).
		IV. Voluntary process standard (timber from renewable forests).
Consumer	Local	V. Mandatory standard (maximum level of non-recyclable waste per household).
		VI. Voluntary standard (private: recyclable package materials).
	Global	VII. Mandatory standard (mandatory CO_2 emission standard on cars).
		VIII. Voluntary standard (private: HFCs-free sprays).

[25] Effluent fees and marketable emission permits are considered to produce efficient outcomes like those associated with Pigouvian taxes (see, for instance, Cropper and Oates, 1992).

[26] Also referred to as "command-and-control" regulations, to use a more general term (Cropper and Oates, 1992). Oates et al. (1989) show that a relatively sophisticated command-and-control approach can produce results that compare reasonably well to the prospective outcome under a fully cost-effective system of economic incentives.

Two things are worth noting in Table 2. Firstly, "voluntary product standards" related to consumption externalities tend not to be regulated by the government. This is probably the case because the role of public labelling schemes is taken over by private labelling or branding schemes.[27] Secondly, voluntary process standards typically have to be combined with product labelling schemes in order to allow consumers to distinguish between the outputs of more or less environmentally friendly production processes. Through such a label, process characteristics are therefore to a certain extent transformed into product characteristics ("labelled" or "non-labelled").

The label is needed because in most cases consumers cannot recognize which production process has been applied from a simple glance at the product. Timber from renewable forests cannot be easily distinguished from other timber. The same is the case for vegetables produced according to organic production methods and others. Labels allow consumers to make such distinctions. The more difficult it is for consumers to check the veracity of labels, the more likely it is that government intervention in the definition and enforcement of the labelling policy is required, as private labelling schemes would tend to collapse due to the incentives to cheat.[28]

Environmental standards and trade

How do environmental standards affect trade flows? This depends on the type of environmental standard at issue (any of the eight cases distinguished in Table 2). In the case of standards relating to production externalities, it also depends on whether standards are applied to both foreign and domestic producers or only to domestic producers.

In the case of local production externalities, it makes sense to apply a mandatory standard only to domestic producers. An example of such a standard would be a requirement for domestic firms to install waste water treatment facilities in order to treat their water discharge. In this case, the standard raises only the costs of domestic producers. As a consequence imports may increase, and if some of these domestic firms also export to the world market, the environmental regulation may also affect their ability to compete there. But against this conclusion, Porter and van der Linde (1995) have argued that compliance by domestic firms with environmental regulations can trigger innovations which lead to an increase in the competitiveness of these firms. This implies that there may even be a gain in future competitiveness as a result of the imposition of environmental regulations. But this link between environmental standards and international competitiveness can affect the pace of standard-setting activity by governments. It has often been argued that one effect of trade liberalization is a regulatory chill or a race to the bottom in environmental standards. Governments become reluctant to tighten environmental regulations for fear that their economies will lose jobs and investment because firms might leave or potential investors might be discouraged. A more extreme reaction is also possible if governments compete to lower environmental standards so as to keep or attract jobs and investments.

Mandatory process standards applied to global production externalities would have similar trade effects to the ones described before. The main difference between this case and the one of local production externalities is that individual countries are unlikely to develop optimal policy instruments in the case of global externalities. This is because they will not take into account the impact the deterioration of the environment caused by domestic production has on individuals abroad. International collaboration is therefore desirable in the case of global production externalities. The same holds for global consumption externalities (cases VII and VIII in Table 2). In the absence of such collaboration, countries may choose also to apply mandatory process standards on foreign producers.[29] This raises two major concerns. First, the domestic process standards imposed on foreign producers may not be efficient from a global point of view, as the costs of production techniques

[27] Any type of voluntary scheme is unlikely to internalize externalities completely because consumers of the environmentally friendly good only take into account the value the environment has to themselves and will ignore the environment's value to other consumers, some of whom may not even buy the product at issue.

[28] See Brown (1999) for a discussion of similar problems when it comes to using labels to signal "child-free-labour" production methods in the carpet industry.

[29] As was the case in *US–Shrimps*, where the US limited imports of shrimp or shrimp products to those harvested with a fishing technology that avoided killing sea turtles.

differ across countries.[30] Second, the question arises as to who controls and enforces the standards applied in the production of imported goods, given that production takes place abroad. This question is particularly important if production processes do not leave traces in the traded products, as this will make it impossible to detect upon inspection at the border whether a certain environmental process standard has been applied or not.[31] If the exporter claims that the standard has been applied, the importing country may either trust the exporter or insist upon inspecting the production site abroad. The latter option raises concerns about countries' sovereignty.[32]

Voluntary process standards tend to be accompanied by a labelling policy, as consumers need to be able to distinguish between goods produced in an environmentally friendly way and other goods. Foreign producers can thus choose which production process to apply. But independent of their decision, they may be affected in any case if the labelling policy has an effect on the prices of both labelled and unlabelled products. If foreign producers decide to target the environmentally friendly market, problems of control and enforcement of process standards arise, as discussed above.

Control and enforcement issues do not arise in the case of product standards related to consumption externalities. An example of a mandatory standard relating to a global consumption externality would be a mandatory emission standard on all motor vehicles sold in the country (case VII in Table 2). In this case, the standard affects both domestic production and imports. It could be argued that *a priori* there is no reason to expect that the regulation will favour domestic firms relative to foreigners. However, to the extent that the appreciation for the environment differs across countries and results in differing standards, foreign firms could be penalized more. Products intended for export have to be re-engineered to conform to more stringent regulations in the export market than those found at home. The likelihood of trade disagreements may be higher in this second instance. Adverse trade impacts can be minimized by adequate consultation with foreign exporters during the process of developing the standards so that their interests could be taken into account.

3. HARMONIZATION VERSUS MUTUAL RECOGNITION

It was illustrated in the previous Subsection that the use of standards and technical regulations can help markets to operate effectively in a variety of ways. First, they help to overcome the problem of asymmetric information about product quality, both between suppliers and consumers, and among producers serving the same market. Second, they enhance compatibility between complementary goods in consumption and production. Third, standards may help to mitigate other instances of externalities or market imperfections where the market, left to itself, would fail to provide the optimal level of a good or service. For example, emission standards can help to deal with pollution externalities.

Since countries differ in terms of levels of development, technology, environmental requirements and preferences, it is natural that optimal national standards (that is, the specification of the type of standard that solves a market failure) differ across countries. Standards may therefore have a negative impact on trade even if they have been designed to help certain markets to operate more efficiently. National standards may impose disproportionate costs on foreign producers. Costs may also fall disproportionately on foreign producers if standards result in a lower scale of operation, for instance because the producer has to meet a different standard at home than for export markets. Governments and industries may even define national

30 In the US law relevant to *US–Shrimps*, exporters were expected to apply measures "comparable in effectiveness to United States measures". The Appellate Body and the Panel found that the "comparable in effectiveness" standard allows for "sufficient flexibility" so as to avoid a finding of "arbitrary or unjustifiable discrimination" under the Article XX *chapeau*. (See also the discussion in Section IID.) It has been argued in the literature (Howse and Neven, 2003) that the concept of policies "comparable in effectiveness" could lead to rather inefficient outcomes if it is interpreted as policies "yielding comparable results" rather than being interpreted as policies leading to comparable marginal results for any level of investment made in the reduction of negative environmental effects.

31 See also the discussion of unincorporated PPMs in Sections IIB.1 and IID.2.

32 See also the discussion in Abdel Motaal (1999).

standards with the strategic aim of creating a disadvantage for foreign competitors. To the extent that standards increase costs for foreign companies relatively more than for domestic firms, they reduce the ability of a producer to enter a foreign market.

(a) Policy options when standards differ across countries

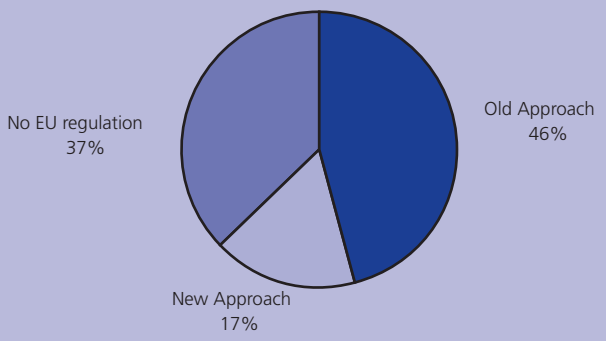
When countries open up to trade, previous standards may become suboptimal. Consider, for example, the case of two similar countries sharing a common policy objective of ensuring a certain degree of safety for car drivers. Due to country-specific differences, however, the two countries chose different technical provisions before trade. One country required the presence in the vehicle of a frontal and a side air bag, the other country required seat belts and only a frontal air bag. If both countries stick to their standards, car manufacturers who want to export will have to face the costs of adapting their product to the requirements of the destination country or alternatively, produce cars that meet both standards (e.g. by introducing both seat belts and a two-air bag system). Since the market failure is addressed equivalently by the two policy measures, both countries would be better off if they chose a common standard or (mutually) recognize each others' standard.

In the case of full harmonization both the policy objective and the detailed technical provisions required to achieve the objective are commonly defined. A country can, however, simply recognize as "equivalent" the exporting country's product standard (that is, for example, the product of the exporting country provide the same level of health protection as what is achieved by the importing country's requirements). Recognition can be unilateral or mutual. Mutual recognition implies that countries simply accept each others' standards. This policy option carries the risk of a race to the bottom if countries pursue significantly different policy objectives. In practice, mutual recognition will therefore only be observed among countries with "equivalent" policy objectives. This policy option also presupposes a fair amount of trust among trading partners. If countries, instead, prefer to control the risk of variation in policy objectives among partners, they may opt for a third approach – harmonization of essential requirements. This approach implies that countries accept (mutually recognize) each others' design/ specific technical details, given a commonly agreed policy objective (See Box 6).

Box 6: Standards within the European Union: the "new approach"

The EU's approach toward removing technical barriers to trade combines all three ways of dealing with technical barriers to trade. For the products covered by the so called "old approach" (1969) harmonization is achieved by means of detailed directives, the content of which is determined by negotiations among EU countries. Once adopted, such directives replace national standards. The "new approach" accomplishes harmonization by indications of essential safety and health requirements. The process of specification of these essential requirements in technical standards (that are then voluntary)[1] is left to European standardization bodies (CEN, CENELEC and ETSI).[2] Where technical standards are not harmonized, the principle of mutual recognition of standards applies – that is, if products are produced and tested in accordance to one countries' regulation, they are granted access into any other member country. The Chart shows the percentages of intra-regional EU merchandise trade covered by the different approaches. It appears that the "old approach" applies to

Intra-EU trade by type of policy initiatives to remove technical barriers to trade, 1998
(Percentage)



Note: calculations are based on intra-EU trade at 4 digit ISIC classification.
Source: WTO calculations on COMTRADE and Atkins (1998) and http://www.newapproach.org/Directives/DirectiveList.asp visited in December 2004.

products that represent about 46 per cent of intra-EU trade. Nearly 20 per cent of intra-EU merchandise trade is in products covered by the "new approach", the remaining 37 per cent of trade is in products where no EU directive applies (see also Box 8 in Section IIC).

1 These common voluntary standards serve the useful purpose of lowering information costs and uncertainty for manufacturers by clarifying what specifications are presumed to be in compliance with an often quite general health and safety objective.

2 CEN is the European Committee for Standardization, CENELEC is the European Committee for Electro-technical Standardization and ETSI is the European Telecommunication Standards Institute.

There are costs and benefits associated with each of these approaches. In the next Subsections the welfare and trade effects of harmonization and mutual recognition will be discussed. It is worth noting that the fact that one approach is more trade-enhancing than another does not necessarily imply that it is better either in terms of national welfare or global welfare.

(b) The welfare impact of different policy options

At a certain level of detail, it will be extremely rare that countries have identical policy objectives. Heterogeneity in terms of the level of development, culture, risk preference and other tastes will generate different policy objectives. However, these policy objectives can change when countries open to trade. With integrated markets, governments need to think not only of efficiency gains from addressing a market failure (environmental externality, for example), but also of possible efficiency losses due to forgone gains from trade, if different standards represent a barrier to trade. This national welfare consideration may lead governments to harmonize standards with their trading partner, to opt for mutual recognition or simply not to accept the other country's standard. The latter would be an optimal strategy if the gains from trade did not offset the welfare loss from not fully solving the market failure.

There is no *a priori* answer to the question whether regulatory harmonization is more desirable than regulatory competition (a corollary of mutual recognition) from a national or global welfare point of view. Some economists would favour mutual recognition on the basis that: (i) it allows each country to pick the standard that maximizes its welfare; (ii) the optimal policy is unknown, and mutual recognition would allow the market (rather than civil servants or ministers) to reveal consumers preferences; and (iii) mutual recognition exercises a disciplinary effect on national regulators, thus constraining the propensity to over-regulate for vested interests.

However, there are risks associated with mutual recognition. National welfare considerations should include the risk that mutual recognition may undermine national policy objectives. When countries with different optimal standards trade, there might be an incentive for governments (or firms) to lower a standard to provide a cost advantage to domestic firms engaged in international competition, thus compromising quality or safety and triggering a "race to the bottom".[33] Alternatively, willingness to access the market of a country with a higher standard may also push standards up in a country where this is not necessary, with negative consequences on the level of domestic product variety ("trading-up"[34]) (Vogel, 1997). Moreover, the process of reaching harmonization may be costly.[35]

Only two cases suggest themselves where economists are likely to have an *a priori* preference for the international harmonization of standards: in the presence of global (environmental) externalities and in the presence of network externalities. In the first case, cross-border externalities generate a tendency to under-regulate. For example, there would be little incentive for a country to control pollutant emissions if the

33 This obviously requires that standards are not equivalent in terms of the two countries' policy objectives. Therefore, in practice, this situation will not emerge insofar as countries will agree on mutual recognition only when they trust that the other country's standard meets their own policy objectives.

34 This presupposes an effort of countries to make their standards equivalent, so as to be mutually recognized.

35 The costly process of reaching a consensus on specific standards has led the EU to pass from the "old" to the "new approach" to standardization.

resulting emission caused acid rain to fall in another country. Yet this behaviour would be inefficient and would likely reduce global welfare (in the simplest form the sum of the welfare of each country). Cooperation is therefore necessary in order to solve the problem, whereby countries may agree on a common standard or on a core standard that increases global welfare. It is not necessarily the case, however, that a welfare maximizing solution involves a single international standard. To the extent that production technologies differ across countries, cooperation may instead lead to the use of different standards in different countries. It may be noted that mutual recognition would not solve the market externality problem in this case (Sykes, 2000 and Pelkmans, 2003).

A similar argument can be made in favour of harmonization for the case of network externalities. However, it needs to be highlighted that in this case market forces are likely to generate the desirable outcome, without need of a government intervention (see discussion above).

As Sykes (2000) argues, it is likely that a certain degree of cooperation is "almost always valuable", at least to the extent of prohibiting regulators from engaging in rent-seeking behaviour. Focusing on the EU, Pelkmans (2003 p.5) argues that the advantage of the new approach is that in "emphasizing the objective(s), rather than the detailed specifications,...national regulations... are forced to concentrate on overcoming the market failure".

(c) The trade effects of different policy options

Harmonization and mutual recognition are commonly believed to be steps towards freer trade. However, the impact of harmonization and mutual recognition of standards on trade among the countries participating in an agreement is quite complex.

On the one hand, both harmonization and mutual recognition of product standards will foster trade because they create scale economies and allow a more efficient allocation of resources. In particular, harmonization may facilitate trade more than mutual recognition, because it requires that countries adopt an identical standard. This implies that products manufactured in different countries are more similar, more homogeneous and, therefore, better substitutes from the point of view of the consumer and the producer than when products can enter the market under mutual recognition. Moreover, adoption of identical standards will improve consumer confidence in the importing country about the quality of the good produced abroad. In sum, a common standard will act as a quality signal and lower information costs for the consumer. Also, identical standards will enhance the compatibility of imported and domestically produced goods. In this sense, harmonization would make it easier for producers to match imported components with those available domestically, would reduce costs and increase trade. In the case of network industries, harmonization would allow network externalities to more readily spill over internationally, thus fostering trade. Finally, harmonization can foster trade by enhancing competition. To the extent that different standards serve as market-segmentation devices, harmonization will facilitate arbitrage and parallel trade, thus enhancing competition.

On the other hand, there are potential negative effects of harmonization on trade that could be avoided through mutual recognition of product standards. For example, harmonization imposes a cost in terms of reduced variety. Although this cost is likely to be small or nonexistent in the presence of network externalities, these costs may be significant in any of the other cases discussed above. To the extent that demand for foreign goods is driven by love of variety, a reduced degree of differentiation of production would then reduce trade. In addition, harmonization to a specific standard may imply a higher cost of compliance for some countries. If countries lack expertise that would allow them to take full part in the setting of international standards or if they lack bargaining power, harmonization can generate asymmetric compliance costs for different countries. Gains from harmonization will not be distributed equally among participating countries. In general, the impact of harmonization on the firm of a specific country "depends on how the costs of meeting the new harmonized standard compare with the benefits from economies of scale in integrated economies" (Chen and Mattoo, 2004, p.5). The problem exists both when harmonization takes place at the regional level and at the international level.

In contrast, mutual recognition allows a country to choose one standard and sell products meeting that standard to its trading partner(s). Unless consumer preferences are biased towards its partners' technical specifications, a firm can freely access its partners' markets without the added burden of harmonizing its standard with those of its partners. Gains from removing technical barriers are in this case distributed equally among countries participating in the agreement.

It is important to highlight that when the removal of technical barriers to trade takes place at the regional level, harmonization and mutual recognition might have different implications for trade with countries excluded from an agreement. To the extent that harmonization of product standards reduces the fixed costs of learning about the regulation of each member of the agreement and avoids the associated additional compliance costs, regional harmonization also benefits firms from the rest of the world. For example, an Asian manufacturer of toys might not find it profitable to export to Europe if it had to adapt its product to different safety legislation for each European country, but might find it worthwhile to export to Europe if there is an EU-wide norm. However, harmonization could also be achieved by adopting a common regional standard that systematically increases costs of compliance for firms outside the region relative to firms in the region. This situation may arise, for example, because of region-specific technological advantages or design advantages enjoyed by firms within the region.

Mutual recognition of standards within a region could also boost exports by firms located in a country outside the block, but only if the agreement is not restricted by stringent rules of origin. The advantage of mutual recognition relative to harmonization for producers outside the region is that they can pick the standard adopted by any one country in the region that better suits their production needs and advantages. In practice, though, mutual recognition agreements can be designed in such a way that third countries cannot benefit from them – by requiring, for example, that products originate in the region.

Baldwin (2000) points to the possible emergence of a two-tiered world when the removal of technical barriers to trade takes the form of mutual recognition of product standards within a region.[36] Under mutual recognition, standards are assumed to be equivalent in achieving a certain policy objective and mutual recognition requires a certain degree of trust among countries regarding their respective ability adequately to safeguard health and safety. This is more likely to occur in regional agreements among developed countries than at the multilateral level, thus excluding developing countries.

The problem of a two-tiered world is not solved, however, by removing technical barriers to trade through harmonization of product standards. Although a certain degree of coordination of standards is desirable, there are natural limits to the extent of international harmonization due to countries' different levels of development, technological advancement, endowments and preferences. Therefore, harmonization is more easily and efficiently reached among similar countries, rather than at the multilateral level.

Even if harmonization had to occur at the multilateral level, the problem exists as to whether developing countries can effectively participate in deliberations of international standard-setting bodies, as they might lack the technical expertise to influence the creation of some technical standards (see Section IIC).

(d) The role of the private sector in the international domain

Both mandatory and voluntary standards can differ across countries, thus effectively raising a barrier to trade. Such barriers can be removed through harmonization or mutual recognition. While it is evident that harmonization of mandatory standards is a government-to-government activity, international harmonization of voluntary standards could either take place through inter-governmental treaties or be left to the market.

Casella (2001) argues that harmonizing standards should not be a primary concern of governments. She claims that when economies open up to international competition, coalitions of firms will reorganize internationally and exploit economies of scale at a more disaggregated level of economic activity. There will

[36] The argument can also be extended to regional agreements of conformity assessment procedures (see below).

be more harmonization "from the bottom" (that is initiated by private industry groups), in order to avoid wasteful replication of national standards and a larger number of specialized international standard groups. The model does not rule out the possibility that the number of standards created by the market are non-optimal. Therefore, there is still space for policy intervention. Yet the role of the government that the model envisages is not that of establishing harmonization through inter-governmental treaties, but rather setting up the appropriate regulatory framework to prevent anti-competitive outcomes.

Some empirical evidence supports Casella's conclusions. First, two main non-governmental international standardization bodies exist: the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC). ISO Members are national standards institutes, while IEC Members are national committees representing all electrotechnical interests in that country. Both organizations issue non-mandatory recommendations. Since they are supported by industries, they represent standards-sharing coalitions of the kind found optimal in Casella's model. Second, industry involvement in international standard setting is increasing as integration progresses. In Germany, for example, the share of resources spent by firms on standard-setting that was directed towards work within international standard-setting organizations rose from 35 per cent to 65 per cent between 1984 and 1991 (Casella, 2001). Third, in accordance with the fragmentation of coalitions predicted by the model, the number of standards institutions devoted to specific areas has been increasing over time. An example is the case of European standards organizations in telecommunications. As market integration has deepened in Europe, standards organizations have evolved from national public monopolies to an increasing number of specialized international coalitions of firms.

(e) Conformity assessment

Conformity assessment is the process whereby a product, process or service is evaluated against specified requirements. It is the technical proof that a product complies with the laws of the country where it is sold. Conformity assessment procedures differ, depending on the product. For low-risk products, the manufacturer may assume total responsibility for conformity assessment and use internal testing for the assessment. For other products, the manufacturer may be required to test his product in a designated laboratory and obtain an official certification mark.

Exporters are often faced with having to test or certify their products in each of the countries to which they are exporting. Even if countries rely on internationally harmonized standards or accept as equivalent another country's standard, they may not rely on an exporting country's conformity assessment results. This can substantially increase costs of exports in a number of ways. First of all, exporters incur the costs of redundant testing and certification for each of the destination markets. Second, they face the risk of higher transportation costs if the goods are rejected by the importing country after shipment. Third, there is a cost in terms of time required for complying with administrative requirements and inspections by the importing country's authorities. For some time-sensitive products, such as textile and clothing, the time delays associated with product testing and certification in the importing country can severely impact on profitability and the ability to penetrate the market.

In order to reduce such costs, a number of conformity assessment recognition agreements have been negotiated between and among countries bilaterally. Obviously, these agreements do not have an influence on the standards and technical regulations themselves. The impact of such agreements on the trade of participating countries is clearly positive due to a reduction in costs generated by the avoidance of duplicative tests, as well as lower transport and administrative costs, as handling time and uncertainty of delivery are reduced. Mutual recognition requires confidence in the competence of one another's conformity assessment bodies and in the methods employed to assess conformity. For this reason, agreements are often limited to accepting conformity assessment results from bodies that are recognised by the parties concerned, and do not extend to self-certification arrangements such as suppliers' declarations of conformity.

Agreements involving mutual recognition of conformity assessment procedures are likely to have trade-diverting effects on countries outside the agreement. As an example, Baldwin (2000) refers to the EU-Swiss Bilateral Trade Agreement. According to this Agreement, only goods made in Switzerland (satisfying specific

rules of origin) can circulate freely in the EU after being tested and certified in Switzerland. This privilege does not extend to products originating in third countries. Therefore, a foreign firm that wants to access both the EU and Swiss markets will have to pay twice for conformity assessment. Thus, mutual recognition of conformity assessment procedures between the EU and Switzerland raise costs for producers located in a third country relative to costs faced by European or Swiss producers, thus diverting trade. A recent empirical study (Chen and Mattoo, 2004) confirms that mutual recognition arrangements with rules of origin have a strong positive effect on intra-regional trade, but reduce imports from excluded countries by over one-third.

The issue of conformity assessment has received relatively little attention in the theoretical economic literature. This is perhaps because conformity assessment can be modelled in a relatively straightforward way as an additional transaction cost of exports. In practice, though, the issue of conformity assessment requirements and their impact on trade have given rise to the development of a complex institutional infrastructure. This will be discussed in more detail in Section IIC.

4. THE IMPACT OF STANDARDS ON INTERNATIONAL TRADE FLOWS: EMPIRICAL EVIDENCE

This Subsection contains a survey of the empirical literature on the effect of standards on international trade. From the theoretical discussion above it is clear that standards are able to deal with a number of economic problems – network externalities, information asymmetry and environmental externalities. The impact of standards on trade will likely depend on what they are used for. Ideally, therefore, this survey of the empirical literature on standards and trade should seek to confirm whether it is indeed the case that certain types of standards are trade-creating while other types are not. For example, in industries where network externalities are present, are standards inevitably trade-enhancing? Or do standards in these industries tend to bolster the market power of the standard setters and therefore limit trade? Unfortunately, a large part of the empirical literature on standards and trade does not distinguish the nature of the standards being studied. Rather, the literature has tended to rely on an index of standardization activities – usually the number of standards or the number of technical measures maintained by a country. The focus has then been on the relationship between this broad measure of standards and trade flows, or on the cost-raising impact of standards. To the extent possible, this survey of the empirical literature on standards and trade will be structured to correspond to the functions of standards identified in the previous Subsection. This can certainly be done for environmental standards, where an established literature has examined links between regulation and trade and investment flows. A similar body of work has been undertaken on animal and plant health standards (SPS measures). But where no distinction is made in regard to the nature of the standards, the survey will follow the direction in which the available empirical literature leads it.

Although the survey focuses on the links between these various standards and trade, many standards mitigate market failures and therefore involve social benefits that will not be fully captured by trade flows. In some cases, trade may even be hampered, even though it could be argued that society benefits overall from the adoption of the standard. Fortunately, some of the empirical work on SPS measures has involved a welfare analysis of these measures.

The Subsection begins by examining some recent trends in standardization activity and draws some inferences regarding the types of standards where growth has been particularly pronounced. Then the effect of standards on two key economic variables are examined. First, how much do standards raise the costs or prices of tradable goods? Second, what does the empirical literature say about the effect of standards on trade? Are standards trade-creating or trade-hampering? The economic theory examined above suggests that both forces are likely to be present. Then a closer look is taken at the question of whether harmonization and mutual recognition, either at the multilateral or regional level, can significantly reduce any trade-hindering effects of standards. Finally, the empirical evidence regarding two specific types of standards – those that manage environmental problems and those that are intended to protect human, plant and animal life and health – are examined. Each of these issues are now considered in greater detail.

(a) Measuring standardization activity

The empirical literature has tended to rely upon a rather short list of databases to measure standardization activity, such as Trade Analysis and Information System (UNCTAD TRAINS), notifications to the WTO, ISO, IEC and Perinorm. But the data are not usually classified in a way that reflects the various economic functions of standards. Information on whether these are voluntary or mandatory, national or international, can be found in some databases but not in others. While it may be possible to identify the sector to which a standard applies, it will not be clear whether all products in that sector are covered or only a subset of them. Most of the available databases also depend on the willingness of countries to provide accurate and prompt responses to questionnaires or surveys. As a result, frequently the most that one can extract from these databases is the count of standards or measures that have been adopted. However, the likely effect of standards on welfare and trade hinges far more on their functions, design and application than on their sheer number. It is important to keep these limitations in mind when examining how standards are measured in the literature.

The simple approach of counting the number of standards has been employed, for example, in studies by Swann et al. (1996), Moenius (1999) and the German standards body *Deutsches Institut für Normung* (2000) or DIN using the Perinorm dataset. An alternative approach is to count the number of tariff lines and the value of imports covered by product standards. The major drawback to both approaches is that they do not distinguish the restrictiveness of various standards. So a sector may have a large number of applicable standards, but they may have only limited effects on trade. On the other hand, another sector may have only a single regulation in place, but that measure imposes significant costs on producers or exporters. Given these caveats, these approaches nevertheless provide important information about the scale of standard-setting activity and the types of standards that are being developed.

Table 3 uses information from UNCTAD TRAINS to compile counts of tariff lines affected by technical measures in a number of markets. TRAINS categorizes technical measures into product characteristics requirements, marking requirements, labelling requirements, packaging requirements, testing, inspection and quarantine requirements, information requirements, requirements relative to transit, and requirements to pass through specified customs and technical regulations not elsewhere specified. The definition of technical measures used by UNCTAD TRAINS covers a lot of standards that tackle information asymmetry problems, although it also includes regulations involving transit and other customs formalities. Some limitations of this dataset should be noted. It is confined to government-imposed requirements and does not capture a host of product standards that have been developed and adopted by industry coalitions or firms. The coverage is incomplete and some of the data are not very recent. For example, TRAINS reports no technical measures for major trading countries like the Republic of Korea and Switzerland, while the information for Hong Kong, China is over a decade old.

Table 3
Tariff lines covered by technical measures in selected markets

Country	Number of subheadings	Share of imports covered (%)
Australia	1092	27.0
Brazil (2001)	2204	46.2
Canada (2000)	142	9.7
China	841	34.9
European Communities (1999)	116	0.6
Hong Kong, China (1994)	223	2.3
Japan (2001)	77	1.9
Republic of Korea	n.a.	-
South Africa (1999)	101	2.7
Switzerland	n.a.	-
United States (1999)	1084	31.9

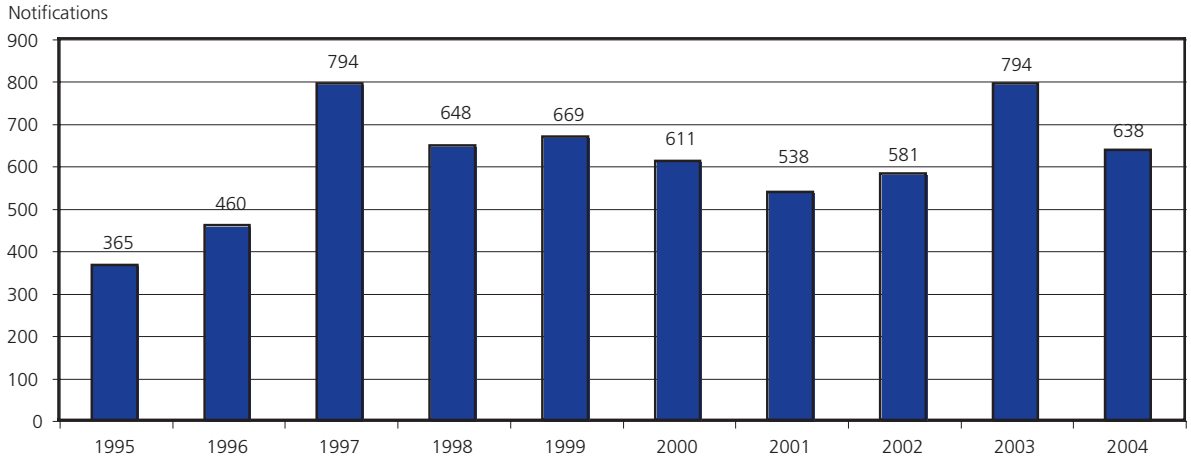
Note: TRAINS reports data at different tariff heading levels (sometimes at HS 6, 8 or 9 digit levels). The information provided in the Table has been standardized at the HS 6-digit level ("subheading") even though the tariff lines covered by a technical measure may not extend to all the tariff lines in that subheading. But since the number of these subheadings is the same for all countries who adhere to the WCO's HS 1996 convention, the numbers in the second column are comparable. The trade-off is that the share of imports covered by technical measures reported in column 3 is likely to be an overestimate.

Source: UNCTAD TRAINS and UN Comtrade.

While keeping these qualifications in mind, the Table suggests that technical measures (whatever the underlying policy objectives) can have a significant impact on trade given that they affect a large number of tariff subheadings and a large share of imports. Based on a count of tariff subheadings, Brazil, the United States and Australia have the largest number of products covered by technical measures. The share of imports covered by technical measures ranges, at the high end, from about half of total imports in the case of Brazil to about a third in the case of the United States and China. By contrast, only 2 per cent of Japan's imports and less than 1 per cent of the EU's imports are covered by technical measures. The figures for the United States, China and Brazil are several multiples of the number of products or the share of imports covered by technical measures in other large economies such as the EU, Japan and Canada.

The number of annual notifications made to the WTO Secretariat under the TBT Agreement and the SPS Agreement provides another source of useful information, since they report new measures that have been introduced by Members. Henson, et al (1999) used the number of notifications of technical measures to GATT/WTO between 1981 to 1998 as an indication of the global proliferation of technical measures. Using more recent data, Chart 1 below shows the number of notifications received by the Secretariat since 1995 on technical barriers to trade. Over the past ten years, notifications have averaged about 610 per year with peaks in 1997 and 2003. These notifications also include information about the policy objectives of the regulations. About 40 per cent of the notifications in 2004 are measures to protect human health or safety. Other reasons frequently given for new measures were prevention of deceptive practices and consumer information and labelling. This suggests that many of the technical regulations that have come into being in the past ten years are concerned with solving information asymmetry problems.

Chart 1
Total number of TBT notifications since 1995



Source: WTO (2005a) Tenth Annual Review of the Implementation and Operation of the TBT Agreement G/TBT/15.

Beyond aggregate counts, the distribution of standards by sector may provide a clue about which sectors are characterized by a higher rate of standard-setting activity. This information can assist more focused research on problem sectors and closer examination of factors behind the growing use of product standards.[37]

A third source of information comes from the Perinorm database. Perinorm is a consortium of standard-setting institutes with an extensive database on standards (see Box 7). A sectoral analysis of the total number of published technical standards up to October 2004 shows that the most active sectors in releasing standard documents are telecommunications, audio and video engineering, followed by construction material and

[37] On the basis of a cross-country analysis, Blind (2004) finds that sectors with a higher propensity for standardization (in his study the number of standards includes drafts, pre-standards and revised standards) tend to be more patent-intensive and export-intensive. He argues that sectors characterized by a higher rate of innovation are more prolific in standards because innovations make existing standards obsolete and call for the publication of a revised document. The correlation between export intensity and the quantity of standards produced is explained as follows: exports depend on the standard specifications in the destination countries. Therefore, export companies have a higher propensity to participate in the standardization process at the European and international level to exercise influence in the specification of standards, which presupposes an engagement at the national level.

building and electrical engineering (see Chart 2). For each of these sectors, the total number of standards published exceeded 30,000. On the other hand, low-technology industries, such as clothing, mining, paper and glass and ceramic industries usually report a far smaller number of standards – generally below 6,000. The smallest number of standards is found in the military engineering industry (only 649).

Box 7: The Perinorm database

The Perinorm database tracks the development of standards across a large group of primarily developed countries. Perinorm is a database developed by the British Standard Institute (BSI), Association Française de Normalisation (AFNOR) and Deutsches Institut für Normung (DIN). It contains information on about 650,000 standards, including documents of all national standardization institutes in each country covered.

The database has a system of keywords enabling a count of standards at the 3-digit industry level per country of origin. Fields in the database include country of origin, industry classification code (recorded according to the International Classification for Standards (ICS) category), dates on which the standards were introduced (and in certain cases, withdrawn), information about related documents, and international relationships among different standards. Information on the relationship among standards includes whether they are identical, equivalent or not-equivalent. These relationships are determined on the basis of ISO/IEC Guide 21 (Adoption of International Standards as Regional or National Standards). In addition, there are other regional or national codes which clarify the relationship among the product standards, such as whether they are related, modified, or necessary. Perinorm International includes data from European countries (13 EU members) and other countries like Russia, Switzerland, Norway and Turkey as well as the United States, Japan, Australia and South Africa. The database also contains information on the European and International standards that have been adopted in the domestic market.

The Perinorm database has been used in various empirical estimations to count the number of shared standards between a pair of countries. Notwithstanding the very considerable contribution the Perinorm database makes to information in this complex area, a number of problems limit the usefulness of this type of information. The primary problem is that not all countries report information about their shared standards. There is no information on the degree of accuracy either over time nor across sectors. Therefore, using Perinorm to obtain information on the count of bilateral shared standards can sometimes give misleading results. The Table below reports the number of total and shared (defined as equivalent of identical) standards for countries covered in the Perinorm database. The recorded number of zero internationally shared standards for some countries, such as Australia, Italy and Norway clearly suggests that the information is not a reliable count of the actual number of standards that these countries share at the international level.

Other problems include the risk of double counting due to the fact that a standard may be relevant to more than one sector, the fact that many standards have different classification codes across countries, and that frequently international links are not symmetric.

Moreover, even if steps were taken to solve these problems, the count of shared standards would still remain a very imprecise proxy of the extent to which technical barriers to trade have been removed. The number of harmonized standards is higher in sectors characterized by network effects or where safety requirements are needed the most. Moreover, trade can be higher in a sector when essential requirements are defined by a single standard rather than when many (shared) standards define detailed characteristics in that sector.

Number of standards by country, 1980-2004

Country	Total	Shared
Australia	8469	0
Austria	18063	15721
Belgium	12384	13
Czech Republic	25052	19511
Denmark	19644	19085
France	26309	141
Germany	29794	17087
Italy	12741	0
Japan	13496	1795
Netherlands	24463	6
Norway	12190	0
Poland	24413	15250
Russia	14686	3176
Slovakia	26106	17751
South Africa	4662	2205
Spain	17770	14094
Sweden	15904	12641
Switzerland	14691	14012
Turkey	21569	6411
United Kingdom	23094	18598
United States	32886	8848

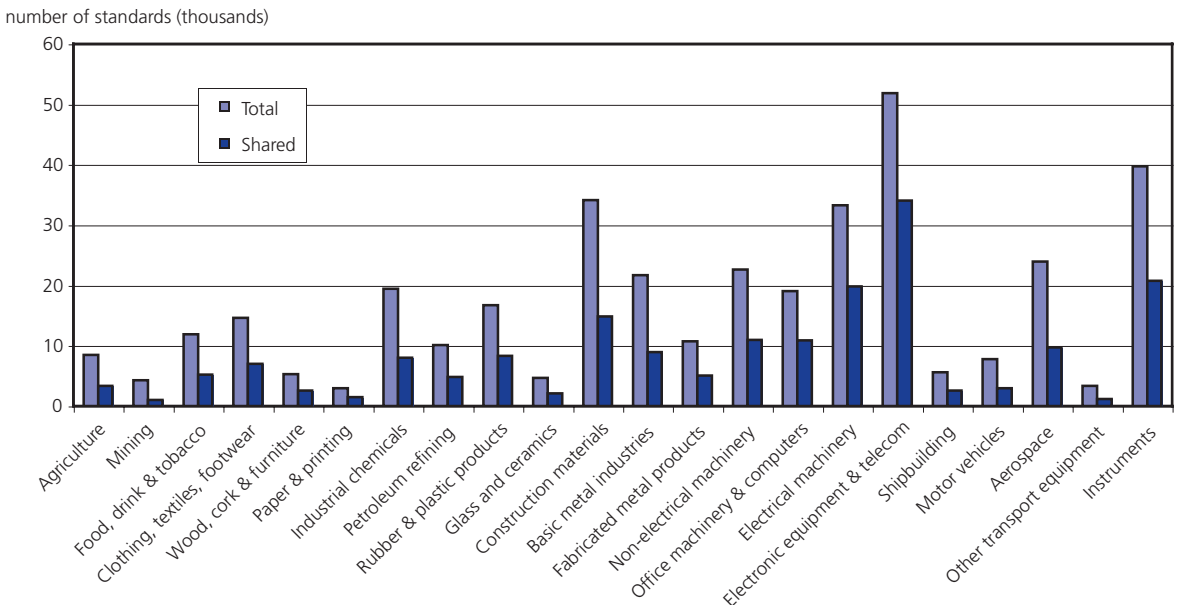
Source: Perinorm.

As expected, the number of standards is highest in industries characterized by network externalities, such as those related to electronic equipment and communication technology. Neither is it surprising to encounter a limited number of standards in the military engineering industry. Standards are a source of information and the defence industry is characterized by a strong concern for secrecy.

It is worth noting that some network industries are also more likely to harmonize their standards internationally. Chart 2 reports the total number of standards published between 1980 and 2004 by sector, and compares them with the number of shared standards – that is, the number of standards that are not country-specific but are "identical" or "equivalent" to international or regional standards or the standards set by one other country. Global network industries, such as electronic equipment and telecommunications, are deeply harmonized across countries (nearly 70 per cent of standards are shared), while strictly local industries such as stone, clay and glass are characterized by relatively more country-specific standards.

A number of salient features emerge from this look at some available sources of information on standards. First, standard-setting activity seems to be pronounced in industries characterized by network externalities. Second, insofar as technical regulations are concerned, the bulk of standards seem to relate to problems associated with information asymmetry (safety and health, consumer protection, etc.). Third, in some major markets these regulations cover a large number of tariff lines and a significant share of imports so the potential exists for these regulations to have an adverse effect on trade.

Chart 2
Number of total and shared standards by sectors (1980-2004)



Note: ICS classification has been converted to ISIC Rev. 2.
Source: Perinorm (2004).

(b) The price and cost effects of standards

One of the biggest complaints against product standards in international trade concerns the costs faced by exporters in complying with the requirements of the importing country. Two tracks have generally been followed to determine how much costs have been raised by product standards – the price-based approach and the cost-based approach. The most popular is the price-based approach, which involves comparing the domestic price of a product to the world market price, on the assumption that the percentage difference reflects the "tariff equivalent" effect of a standard. The cost-based approach examines directly how standards affect the costs of firms who need to adapt products to conform to technical requirements. Each approach presents data and methodological difficulties and neither of them is entirely satisfactory.

Under the price-based or tariff-equivalent approach, which is less data-intensive than the cost-based approach, a number of problems arise in respect of the prices selected for the calculation. Adjustments need to be made if the domestic and imported products are not perfect substitutes, if there are other regulations in place, for marketing and distribution costs, or if producers possess market power. But even with homogeneous products and perfect competition, price comparisons confuse the effect of a standard with other trade policy measures. Finally, the cost-raising effects of standards depend on the interaction with demand in the market – that is, the elasticity of demand. Hence, it is possible for an identical standard to produce different estimates of price wedges in two markets because one market is characterized by more inelastic demand than the other.

Deardorff and Stern (1997) examined evidence on the importance of various types of non-tariff barriers in OECD countries. A substantial part of the information used involved price comparisons. However, their assessment of the extent of NTBs in OECD countries had little to say about technical barriers to trade. This may be partly because, as they admit, it is one of the hardest NTBs to quantify. The authors have stressed the importance of information provided by technical experts who are familiar with the details of standards, regulations, and certification systems applied to particular products or processes. In their view, it may be possible to construct estimates of the added costs involved when: (i) higher standards are applied to imported as compared to domestic goods; (ii) regulations are enforced more stringently on imports; and (iii) imports are subjected to more cumbersome and costly certification procedures. However, the sparseness of evidence on technical barriers may also reflect the fact that these measures are less of a problem than other non-tariff measures which were highlighted in the study, such as quantitative restrictions, anti-dumping duties, and so on.

Because of the ambiguities introduced by price comparisons, the more direct approach of asking producers and traders directly about the effects standards and technical regulations through surveys or case studies have also been tried. This cost-based approach was pursued in a 1999 OECD study, surveys conducted by the European Commission and the United States Trade Representative on European and American exporters respectively and by Henson et al. (1999) and Wilson and Otsuki (2004) for a sample of developing countries. Detailed case studies on the costs faced by developing country exporters of complying with food standards have been undertaken and reported in World Bank (2005) and Unnevehr (2003). The advantage of the cost-based approach is that respondents are able to pinpoint which standards are particularly troublesome. But since a survey or a case study necessarily covers only a small number of producers and there can be some self-selection involved, the results may not be representative of the overall problems faced by a country's exporters.[38]

The OECD (1999) survey collected data from 55 firms on the costs of compliance with technical requirements in export markets and on the extent to which these impede trade. The survey covered telecommunications equipment, dairy products and automotive components in four markets – the United States, the United Kingdom, Germany and Japan. The OECD study was able to supply some information on the estimated percentage increase in production costs incurred as a result of physically adapting products to meet technical specifications. In the case of telecommunication equipment, the additional costs incurred to meet technical requirements ranged between zero and 10 per cent. For dairy products it was between zero and 15 per cent. For automotive products, the additional costs ranged more widely from zero to a high of 30 per cent. The overall conclusion was that while different mandatory technical requirements existed among the surveyed countries for each of the three product categories, meeting them did not significantly increase costs. Some significant problems were reported for a relatively small range of automotive components, such as seat belts and exhaust systems. For dairy products, problems arose due mainly to the export of certain speciality (as opposed to bulk) products.

Even though no major problems were identified, the survey did seem to suggest a different impact on small and large (multinational) firms. These differences existed both in the gathering of information about standards and the design of products. Small firms seemed to face higher costs in ascertaining the nature of the standards with which they must comply. In the area of product design, larger firms incorporate many features demanded by export markets into the initial product design. Although this means larger outlays for research and development expenditure at the start, this strategy allows for quick penetration of target markets when favourable opportunities arise and the costs can be spread over larger production volumes. For smaller firms, the initial design is tailored solely for the domestic market. Only when significant export opportunities arise are further and more costly changes to the product made to meet the standards in the target market.

The costs of conformity assessment varied significantly across the three sectors, reflecting differences in the technical complexity of the products involved. Terminal telecommunications equipment and automotive components require an initial approval of the product before any exporting can begin. Costs of external assessment varied, although it was often the case that significant internal staff costs were incurred in product testing. In the case of dairy, each individual consignment must be tested both prior to export and/or at the port of entry. Thus in the telecommunications equipment and automotive component markets, technical standards and conformity assessment procedures act as a fixed cost of market access that must be borne prior to the commencement of exports, while they act as a variable cost in the case of dairy products.

The study by Wilson and Otsuki (2004) is based on company survey data covering 689 firms in about 25 industries in 17 developing countries. On average, firms perceive that the cost of complying with a foreign regulation is higher than that of complying with domestic regulation. Standards and technical regulations are considered an impediment to exports. In fact, for the majority of firms surveyed (over 65 per cent), the costs of testing and certification are an important reason for not exporting to the Quad countries (Canada, the EU, Japan and the US). However, transportation costs and marketing and other distributional costs appear to be more important. Wilson and Otsuki also study the costs associated with duplication of testing procedures to

[38] In the case of a survey for example, questionnaires are usually mailed to the companies and not all of them respond to the survey. It is not unreasonable to assume that those who already face problems with standards would be the most likely to write back.

meet foreign requirements, even though domestic requirements have been met. The majority of firms surveyed report that they face significant duplication costs. For some countries, a high percentage of firms report that they need two tests. In Senegal, for example, over 60 per cent of firms faced a complete second test.

The conclusions by Wilson and Otsuki (2004) differ quite significantly from those reached in the World Bank (2005) report. That study involved a series of case studies covering a number of low-income countries (Ethiopia, India, Jamaica, Kenya, Morocco, Nicaragua, Senegal, Thailand, etc.) and commodity chains related to fish, horticulture, livestock products, nuts and spices. The report found that compliance costs vary enormously between countries, industries, and firms/farms within the same industry. Countries and industries that have greater foresight or have taken a "pro-active" stance are better able to adapt to the evolution of product standards. Firms and industries vary in their capacities, so a change in standards that may require only minor changes in practice in one firm or industry may require radical changes in another. Industrial structure and the possibility of what they call "collective action" is also a major explanatory variable. There are economies of scale and scope associated with various SPS functions and the ability to exploit these depends on the degree of cooperation that can be established among firms and also the leadership of public institutions. The extent of benefits from compliance varies with the type of market for the product. In some cases, consumers may be willing to pay a premium for safe products but in others there may not be much of a premia.

Why could the survey and case studies produce substantially different results on the costs of compliance? One reason may be that the case studies are able to capture the dynamic aspects of compliance – how firms, industries or even countries adjust to new regulations. Firms faced with a new requirement may experience very high costs in the very short run but adaptation, learning and investments in compliance means that costs will be lower in the medium and long run. The issue of timing may also apply to the benefits from compliance - they only accrue over an extended period of time. Hopefully, continued empirical work in this area – relying on both surveys and case studies – will close the gap.

Both the Deardorff and Stern study and the OECD survey of the same group of countries produce some consistent results regarding the relatively small effects of standards on costs and prices. Technical barriers did not emerge as a major NTB concern in the former case and the survey of OECD firms did not identify major problems in complying with regulations in other OECD markets. However, the same relatively benign results seem not to apply with respect either to smaller firms. With respect to the cost of compliance by firms in developing countries, the evidence is mixed. The survey work suggests that firms in developing countries face very high costs, sometimes almost a doubling of their cost of production, in order to meet technical requirements in major developed country markets. However, the case studies tell a more complex story where the costs of and benefits from compliance vary enormously among firms and countries and depend on a range of factors – industrial structure, possibility of collective action, strength of consumer preference for safety, etc.

(c) Standards and international trade flows

Much more formal econometric work has been undertaken to examine the connection between international trade flows and measures of standardization activity. In attempting to quantify the impact of removing technical barriers to trade on imports and exports, empirical economists have explored two approaches. One approach has tested whether country-specific standards and internationally harmonized standards have different effects on trade. The other approach has compared the impact of harmonization versus mutual recognition of product standards on international trade.

National versus harmonized standards

Theoretical arguments discussed in Subsection 3 suggest that while the impact of standardization on trade could go either way, harmonization of standards in general facilitates trade.[39] Some of the early econometric

[39] Recall, however, that to the extent that trade is driven by love for variety, harmonization could have a negative effect on trade through its variety reduction effect.

studies investigating the role of product standards in international trade include Swann et al. (1996), Moenius (1999) and DIN (2000). A common issue addressed in these studies is whether country-specific standards and internationally harmonized standards have different effects on trade. Interestingly, all studies use information on the number of shared standards provided by the Perinorm data base to proxy for internationally harmonized standards (see Box 7).

Swann et al. (1996) examines three hypotheses about the links between trade and standards. First, standards are a means for firms to upgrade quality or to reap economies of scale, thus obtaining a competitive advantage. Second is the argument that by imposing administrative burdens and increasing costs, national standards create a competitive disadvantage for domestic firms. Finally, international standards, by allowing greater compatibility of components, promote intra-industry trade. The first two propositions imply that adoption of national standards have an ambiguous effect on trade while the third implies that international standards should have an unambiguously positive effect. The authors examine the relationship between a measure of British trade performance in 83 manufacturing sectors and the number of British standards and German standards (which is a proxy for international competition in standards) in these sectors, together with a set of other economic variables. The data they employ are at the 3-digit SIC level over the period 1985-91. For data on standards, they use a count of UK standards and German standards by manufacturing sector. The econometric results they obtain show that the number of British national and international standards increases British exports and imports. Surprisingly, the trade effect is larger for national standards than for international ones. Their conclusion, broadly stated, is that the competitive advantage and intra-industry arguments are supported by the estimation results, while the competitive disadvantage argument is not. Thus, on the whole, the adoption of product standards results in greater trade between the United Kingdom and its partners. A methodological difficulty with their work is the rather ad hoc nature of the econometric specifications. Without an underlying structural model informing the regressions, there are bound to be some questions about their interpretation.

The DIN study re-examined the same three propositions as in Swann et al., but this time focusing on Germany, Austria and Switzerland, although only results for Germany will be described here. Like Swann et al., the econometric specifications are ad hoc. The study performs both cross-section and time-series regressions.[40] The cross-section results seem to provide some support for the competitiveness and intra-industry trade arguments. The number of standards in a particular sector had a positive effect on Germany's net exports, although this was true for only a third of the 36 bilateral trade relations examined. The results seem to be the same whether national or international standards were used as explanatory variables. The time-series regressions, however, seemed to support the competitive disadvantage hypothesis. The number of national standards had a negative effect on the German trade surplus. When the number of international standards was used in the regressions, they had a negative effect on imports.

Moenius (1999) used a gravity model[41] to assess the trade impact of product standards. To the extent that the gravity model has better established theoretical roots, it represents an econometric improvement over the Swann et al and DIN studies. Moenius's data cover 471 industries in 12 Western European countries from 1980 to 1995. Like the other studies, he uses standards-related data from the Perinorm database. Regressing sectoral bilateral trade volumes (4-digit SITC) on counts of bilaterally shared (or harmonized) standards using a country-pair-year fixed-effect model, he finds that shared standards have a positive and significant effect on bilateral trade. He estimates that a 10 per cent increase in the number of shared standards enhances bilateral trade by about 3 per cent. When both the count of country-specific standards and that of shared standards

40 The difference between the two is that cross-section data comprise a series of observations made at the same time, while time-series data are a series of observations through time.

41 Gravity models are econometric models of trade which acquire their name from their similarity to Newton's theory of gravitation. The gravity model of trade predicts that the volume of trade between any two countries will be positively related to the size of their economies (usually GDP) and inversely related to the distance between them. The gravity model has proven to be popular among empirical trade economists because of the very high explanatory value obtained, even with the use of cross-section data. For a time, gravity models were linked primarily with trade models of imperfect competition. However, recent work (Deardorff, 1998) has made it clear that the gravity model can also arise from a traditional factor-proportions explanation of trade. Hence, far from being a purely econometric tool without a theoretical basis (an early criticism against the gravity model), it can be derived from a range of trade theories.

are introduced in the regression, harmonization is still found to have a positive and significant effect on trade. Interestingly, importer-specific standards have a negative impact on imports in the non-manufacturing sectors, but have a positive impact on imports in the manufacturing sector. Moenius explains this result in terms of incomplete information. Trading partners face high information costs in the absence of standards. The presence of product standards, even if they are specific to one country, lowers information costs. While there are costs in adapting products to conform to national standards in foreign markets, if these costs are small relative to information costs, the presence of standards increases rather than deters trade. These effects dominate in manufacturing sectors, where products are more differentiated and information about market preferences is, therefore, more valuable.

There are a number of concerns that need to be highlighted about the Moenius study. First, it is not based on the standard version of the gravity model. Instead of using aggregate bilateral trade as the variable to be explained (dependent variable), the study uses bilateral trade at the sectoral level. And it omits measures of distance between countries and tariff barriers, favouring time country-pair fixed effects. Thus, it is difficult to assess the regression on the basis of a comparison of the estimated coefficients with previous studies and some results are likely to suffer from a significant bias arising from omitted explanatory (independent) variables. Second, the study does not distinguish between voluntary and mandatory standards. Empirically, they might have very different impacts on trade. Since traders are not obliged to comply with voluntary standards, the count of voluntary shared standards does not provide an appropriate measure of the number of standards actually shared. Further work in this direction may be of great importance.

The available empirical literature on the effect of standards on international trade flows is still rather limited, reflecting the difficulty of the subject and the nature of the data. The explanatory variable used to represent standards in the regressions is just the number or count of existing standards in a particular industry. Because of this specification, the literature is not able to reflect important features of standards such as their functions, importance, compliance costs, technical complexity and innovativeness. The econometric methods used are often ad hoc or are non-standard applications of models. Nevertheless some interesting results have arisen. Intra-industry trade can be spurred by greater standard-setting activity in industrial sectors, suggesting that standards play an important role in increasing compatibility. Also, the adoption of standards, even purely national ones, can increase trade. One possible explanation for this result is that standards convey information about consumer preferences to exporters.

Harmonization versus mutual recognition

Harmonization and mutual recognition of product standards are commonly believed to be steps towards freer trade. However, economic theory does not provide a clear-cut answer about which approach is more trade enhancing (see Subsection 3). The advantage of harmonization is that products produced in different countries are homogeneous and therefore better substitutes from the point of view of producers and consumers. This, in turn, may facilitate trade by improving confidence in the importing country about product quality, and by enhancing compatibility with domestically produced goods. A higher degree of product homogeneity is also likely to result in more intense competition. On the other hand, harmonization imposes a cost in terms of reduced variety. Insofar as demand for foreign goods is driven by a love of variety, a reduced degree of product differentiation would hamper trade. Unless consumer preferences are biased towards a domestic specification, another potential advantage of mutual recognition is that it allows any firm to pick a standard and still sell in the whole regional market without incurring additional costs. Harmonization to a specific standard, by contrast, may imply a higher cost of compliance for firms in certain countries, thus effectively erecting a barrier to trade.

The empirical literature on the impact of harmonization as against mutual recognition on trade is very limited. A paper by Vancauteren and Weiserbs (2003) provides a somewhat indirect estimate of the impact of harmonization versus mutual recognition on trade by looking at whether those sectors where the EU has sought to remove technical barriers to trade by harmonizing technical regulations or by applying mutual

recognition present a lower "home bias"[42] than the average. The study relies on the hypothesis that the large home bias in Europe is induced by technical barriers to trade, such as different technical regulations. Hence, to the extent that harmonization and mutual recognition of product standards remove trade distortions they should reduce the home bias.

Using a gravity model for intra-EU bilateral trade for the period 1990-98, the authors of the study estimate the home bias effect for five groups of sectors, defined according to whether the new approach, old approach, mutual recognition principal, or a combination of these three approaches applies, and whether technical regulations are significant barriers to trade. Their results show that the home bias remains substantial both for sectors where standards have been harmonized and for those where mutual recognition holds according to national laws. Moreover, a significant home bias is also found for products where no significant barriers were deemed to exist.

In other words, the study by Vancauteren and Weiserbs did not find that measures taken to remove technical barriers to trade had a significant impact on the home bias. Although the smallest home bias is found for those sectors characterized by mutual recognition (the coefficient of the home bias is equal to 2.72 for products where mutual recognition applies, while it is above 3 for sectors whose standards have been harmonized), the analysis does not allow us to say whether this is significantly smaller than for harmonization.

A number of reasons can explain the failure of Vancauteren and Weiserbs to find a significant impact from European measures to remove technical barriers to trade on the home bias. First, factors other than technical barriers to trade can explain the home bias. Second, the study groups sectors on the basis of a sectoral classification set up in a study by Atkins for the Single Market Review in 1998. This study reflected the situation in 1998, while the study by Vancauteren and Weiserbs used data for the period 1990-98. Their data therefore only partially captures the impact of a directive introduced in 1997 to harmonize standards. Finally, since the establishment of the "new approach" in 1985, any good that circulates in one country of the EU can "freely" circulate in another EU country (the burden of the proof of a standard not being equivalent to that of the importing country falls on the importing country). Therefore, given that some time had elapsed between the adoption of the new approach in 1985 and the period considered in their study (1990-98), it is understandable why they find it hard to capture the trade-enhancing impact of mutual recognition.

A recent study (Piermartini, 2005) estimated a standard gravity model[43] for intra-EU sectoral trade[44] over the period 1978-2002. The impact of harmonization on trade is estimated by introducing dummy variables indicating whether, at a certain point in time, the sector was harmonized according to the "old approach" or "new approach". A distinction between the horizontal harmonization (including, for example, compatibility standards) and vertical harmonization (covering health, safety and quality) of standards was also made. Moreover, a mutual recognition dummy was introduced, allowing estimation of the impact of the mutual recognition principle in 1985 for those sectors that have not been harmonized. Mutual recognition of product standards was found to have a positive and significant effect on intra-EU trade. Trade among a randomly chosen country pair and sector was estimated to be 1.2 times higher under mutual recognition. The results regarding the impact of harmonization on trade appeared less robust. Overall, harmonization according to the "old approach" results in enhanced trade more than the "new approach", especially when it concerned horizontal standards.

While it may be too early to draw strong conclusions regarding the relative merits of mutual recognition and harmonization in enhancing trade, given the limited number of studies and their focus on European countries, more robust and significant trade enhancing effects are found in the case of mutual recognition.

42 The term "home bias" determines the preference for consuming domestically produced goods rather than imported goods. In Europe, internal trade (consumption of domestically produced goods) has been estimated to be larger by a factor of ten than trade with other EU partners (Nitsch, 2000).

43 Standard explanatory variables include the GDP values of the trading partners, and five dummy variables which take a value of zero or one to denote whether they share a border, a common language or the same currency, and whether one of the trading partners is an island or a landlocked country.

44 Trade data in ISIC Rev.2 at 4 digit classification from Comtrade are used for the estimation.

(d) SPS measures

The focus here is on SPS measures intended to reduce the dangers posed to animal, plant and human life and health by imports. Two sets of empirical studies are considered – welfare-based analysis of SPS measures and detailed case studies which examine the trade repercussions.

The welfare-based approach to analysing these measures generally adopt a partial equilibrium framework. From the importing country's view, the main costs of imposing SPS measures are the reduction in consumer surplus[45] and expenditures on quarantine controls. The benefits include the increase in producer surplus[46] and the expected reduction in the risk of foreign pests damaging domestic agricultural production. For the importing country, the optimal SPS standard is that which achieves benefits from risk reduction and increase in producer surplus that exceeds the loss in consumer surplus and costs of quarantine controls.

This welfare-based analysis is used in Calvin and Krissoff (1998), James and Anderson (1998) and Paarlberg and Lee (1998). Calvin and Krissoff (1998) looked at the effect of Japanese quarantine measures on imports of US apples.[47] The major concern of Japanese authorities is with fire blight, a bacterial disease which is widespread in the United States. The phytosanitary protocol requires a chlorine dip and an inspection regime with three visits each season by Japanese inspectors who must certify that the apple orchard is free of fire blight. All the costs are to be borne by the exporter. The authors' welfare calculations suggest that it would take the loss of 26 per cent of Japanese apple production to justify the phytosanitary regulations, an occurrence which they characterized as "unprecedented".

James and Anderson (1998) analysed Australia's import ban on bananas. Although an import ban is not a product standard *per se,* for analytical purposes it can be treated as a standard so stringent that no foreign products can meet it. Because of the small size of the Australian banana industry, their study suggests that the consumer gains from removing the ban on Australian imports of bananas even exceeded the cost of losing the whole sector from a foreign pest.

Paarlberg and Lee (1998) examined US beef quarantine rules to guard against foot and mouth disease (FMD). Prior to the adoption of the SPS Agreement, the United States had prohibited imports of cattle, swine, sheep and some forms of meat from countries with FMD. They find that an import prohibition can be justified on welfare grounds only if it is assumed that there is a high risk of FMD from imports (defined as an outbreak of FMD per 215 thousand tons of imports).

One recurring issue in the empirical literature is the difficulty of finding reliable estimates of the risk of pests associated with imports and the size of the damage to domestic production. In the case of FMD for example, Paalsberg and Lee were not able to find US data tracing such outbreaks to imports and had to rely on British data over the 1954-81 period. The data showed nearly a thousand-fold difference in the rate of FMD incidence associated with imports, from 1 for every 215 thousand metric tons of imports during 1954-66 to 1 for every 24.7 million metric tons during the 1967-81 period.

That difficulty raises an important question about the conceptual framework used in these papers to analyse decision-making when there is uncertainty. Knight (1921) had famously distinguished between "risk" and "uncertainty". Risk refers to situations where the decision-maker can assign probabilities to the outcomes that he is faced with. Uncertainty refers to situations when probabilities cannot be assigned to the possible outcomes. The distinction is important because under conditions of risk it is possible to compute mathematical expectations of the welfare gains from removing SPS barriers. But under conditions of uncertainty, this would not be possible. The question is which of these two concepts better describes the situation faced by policymakers when confronted with dangers to the health and life of animals, plants and humans. If decision

[45] Consumer surplus measures the amount that a consumer has to pay for a product against what he would be willing to pay. A loss in consumer surplus obviously means consumers are worse off.

[46] Producer surplus measures what a producer manages to sell his product for compared to what he would be willing to sell it for. In less technical terms, producer surplus is sometimes equated to profits.

[47] This case became the subject of a WTO dispute between Japan and the United States and is discussed in Section IID.

makers are confronted by situations characterized by risk, the studies above provide important evidence that SPS measures are too restrictive. If on the other hand, they are confronted by uncertainty (in Knight's sense) then the studies have overestimated the gains from relaxing SPS measures.

MacLaren (2001) argues that a number of factors make it difficult for decision makers to assign subjective probabilities to outcomes. If there has been an embargo on imports, then governments may not be in a good position to assess the probabilities of pest entry since there is no (or little) data to go by. Scientific evidence may be incomplete or experts may disagree in their interpretation of the evidence. The decision-maker may recognize the existence of unforeseen contingencies which can significantly affect benefits and costs but which he does not think about or recognize at the time when he makes the decision. There may also be an element of irreversibility in some of the consequences of imports (e.g. a pest enters and becomes endemic) which may make decision-makers more risk averse.

There are conflicting conclusions too about the trade impact of SPS measures on developing countries. The Unnevehr (2003) study documents four cases of developing countries whose access to export markets was denied due to sanitary or phytosanitary issues, resulting in substantial costs in terms of lost sales, market share, and investments required to re-enter export trade. They included fish from Kenya, raspberries from Guatemala, shrimp from Bangladesh and horticultural crops from Guatemala, Jamaica and Mali. The paper by Otsuki et al. (2001) dealing with regulations that safeguard human health investigated the effect of aflatoxin standards in the EU on Africa-EU trade flows and health risks. They examined three regulatory scenarios: standards set at pre-EU harmonized levels (status quo), the standard set by Codex, and the new harmonized EU standard. The human health implications of strengthening aflatoxin standards come from risk assessments conducted by the Joint FAO/WHO Expert Committee on Food Additives. They then use a gravity model, which includes aflatoxin standards as one of the explanatory variables, to predict the effect on trade flows between Africa and Europe of changes in the aflatoxin standard. They conclude that compared to Codex standards, the implementation of the new harmonized aflatoxin standard in the EU would reduce health risk by approximately 1.4 deaths per billion a year, but would simultaneously decrease African exports to the EU by about $670 million.

A different picture is provided by Jaffee and Henson (2004) who argue that standards are not necessarily barriers for developing countries. They estimate the value of developing country agro-food border rejections because of SPS measures to be about $1.8 billion, 74 per cent of which is accounted for by middle-income countries. The estimated value of low-income country agricultural and food product trade rejected at the importing country border is $275 million, representing just less than 1 per cent of the agricultural and food exports of these countries.

Part of the reason why these regulations can pose barriers for individual countries but not cut significantly the total volume of trade is that where there are losers there are often winners. For example, in the case of the Guatemalan raspberries which ceased exporting to the US because of the outbreak of cyclospora (documented in Unnevehr (2003)), several of the leading firms in the industry (including both Guatemalan and international firms) shifted their operations to Mexico. Mexico's exports of raspberries now account for the majority of an expanding import trade into the United States (Calvin, 2003).

They also take issue with the Otsuki et al. (2001) study believing that it severely exaggerates the predicted effect of the new EU aflatoxin standard. The simulation proceeded from an inflated baseline. Only a small number of consignments of groundnuts were rejected by EU Member States because of aflatoxin. They suggest that the near-term "loss" of African trade due to the more stringent European Union standards has actually been in the hundreds of thousands rather than the hundreds of millions of dollars.

Rising standards serve to accentuate underlying supply chain strengths and weaknesses and thus impact differently on the competitive position of individual countries. Some countries are able to use high quality and safety standards to reposition themselves in global markets. The analysis in Jaffee and Henson suggests the importance of considering the impacts of food safety and agricultural health measures within the context of wider capacity constraints in developing countries and underlying supply chain trends.

The welfare-based literature finds that SPS measures are generally restrictive and involve a welfare loss in the importing country. The presumed health risks or losses from the introduction of pests through imports need to be extraordinarily high in order to justify some regulatory regimes in place. But questions have been raised about the appropriateness of the analytical framework employed since there may be circumstances when regulatory authorities are not able to assign credible probabilities to the outcomes and therefore are more risk averse than assumed in the papers.

There are conflicting conclusions too about the trade impact of SPS measures on developing countries. There have been cases where access to export markets was denied due to sanitary or phytosanitary issues, resulting in substantial costs in terms of lost sales and market share. But rising standards also serve to accentuate underlying supply chain strengths so some countries are able to use high quality and safety standards to reposition themselves in global markets.

(e) Environmental standards

The relationship between environmental standards and trade flows has usually focused on the pollution haven and race to the bottom stories.

The pollution haven hypothesis starts with a world where countries differ in the stringency of their environmental regulations and industries differ in their pollution intensities. The hypothesis is that these differences in regulations will induce pollution-intensive firms to locate production to less regulated countries. It also predicts that as a result of this flow of investment, exports of pollution-intensive products will increasingly come from these locations while more regulated countries will progressively become net importers of these products.

The regulatory chill or race to the bottom story focuses more on the effect of increasing economic integration on regulators' incentives to stick to, strengthen or relax environmental standards. With increased competition for footloose investments and trade, countries may be reluctant to adopt new regulations or to strengthen existing ones, for fear of scaring off investors. Worse, they may even move to weaken existing regulations to attract investments. If other countries respond in a similar fashion, a race to the bottom in environmental standards may occur.

Pollution haven

In their survey article ten years ago on the effect of environmental regulations on US manufacturing, Jaffe et al. (1995) concluded that while these regulations imposed significant costs on polluting industries, they have not affected patterns of international trade. The paper summed up what numerous studies had up to then shown – that there was little empirical evidence that differences in environmental regulations affected international trade and investment flows.

However, the pollution haven hypothesis continues to draw a large amount of research interest and this part of the empirical survey examines a number of recent investigations. Much of this recent literature subjects the available data to greater scrutiny, prefers the use of more disaggregated data and is more careful in handling heterogeneity within samples.

Smarzynska and Wei (2001) examined the investment decisions of 534 multinational firms in 24 countries in Central and Eastern Europe and the former Soviet Republics. They refined their data in several ways. Instead of using country or industry level FDI data, they used firm-level data. They also tried to account for other variables that could be correlated with laxity in environmental regulations and which may have influenced previous studies. In particular, poor quality of government institutions (i.e. corruption) will discourage FDI even as it will also be positively correlated with weak environmental regulations. With all these refinements, they found some support for the pollution haven hypothesis. Investment from pollution-intensive multinational firms is smaller for host countries with more stringent environmental regulations. But they judged the evidence to be weak, as it did

not survive various extensions and robustness checks (for example, using alternative measures of environmental regulations). The authors therefore cautioned against drawing any strong conclusions from their study.

Eskeland and Harrison (2002) examined foreign direct investment by US firms in four countries: Côte d'Ivoire, Mexico, Morocco and Venezuela. They considered whether environmental regulations in the United States were driving FDI into more pollution-intensive sectors abroad and whether US firms were more or less environmentally friendly than domestic firms. Although they found some evidence that US investors abroad located in sectors with high levels of air pollution, they conclude that the evidence was weak. They also found that foreign plants were significantly greener – using cleaner types of energy and more energy efficient – than domestic firms in the host country. Third, outbound FDI from the United States turned out to be highest from those industries where environmental regulations were low, contrary to the usual expectation.

Ederington et al. (2003) provide some explanations for the absence of the pollution haven effect in previous studies. They argue that international trade is dominated by trade among developed countries which tend to have relatively similar regulations. But if only trade between industrialized and developing economies is examined, environmental regulations have stronger effects on the pattern of trade. Increasing the stringency of environmental regulations in the United States will decrease imports from developing countries. Second, they find that polluting industries also happen to be the least geographically mobile (as measured by transport costs, the cost of setting up a new plant and agglomeration benefits from its current location). Thus, these industries find it more costly to move to jurisdictions with less stringent regulations.

Race to the bottom or regulatory chill

Esty and Geradin (1998) pointed to mainly anecdotal evidence of a race to the bottom or the chilling effects of trade on environmental regulation. Among the evidence cited were the reluctance of some countries to sign up for the Kyoto Protocol, changes in German conservation laws, the UK coating industry's 1995 victory over legislation that would have forced them to reduce their emissions of volatile organic compounds which are a major contributor to city smog and respiratory health problems.

But there is little systematic or formal empirical work to buttress these observations. In fact, the formal empirical work either shows that regulatory chill or race to the bottom effects cannot be detected, or if they exist, they are not a substantial factor preventing continual improvement in environmental indicators. Frankel's (2003) survey reveals little statistical evidence that openness to trade undermines environmental regulation through a race to the bottom. If anything, he cites favourable gains from trade in measures of air pollution such as sulphur dioxide SO_2 concentrations.

Fredriksson and Millimet (2002) test the regulatory chill effect in the case of NAFTA. They compared trends in Levinson's index of relative state compliance costs (a measure of the stringency of environmental regulations) in US states bordering Canada and Mexico and in other US states. The rationale for this stratification is that if there is a race to the bottom, then US states that border either of these countries would have acted differently than interior states during the time surrounding the ratification of NAFTA. They found that states on either border had been less responsive to changes in neighbouring states than interior US states, suggesting a mild regulatory chill. But this did not stop environmental indicators from improving for all US states during the period leading up to the ratification of NAFTA, and improvements beyond ratification for some indicators as well.

Overall, recent studies find more of a pollution haven effect than the older literature, although there is some question about the robustness of these results. Less work has been done to examine empirically the race to the bottom story, but the available study point to little or no effects. While the presumption is still that environmental standards do not have significant effects on trade and on investment flows, these new studies will likely spur further research along these lines.

5. SUMMARY AND CONCLUSIONS

The effects of standards on the direction and size of trade flows tend to be complex and need to be analysed on a case by case basis. Standards typically have an effect on both consumers and producers. They may affect the willingness of consumers to pay for product varieties meeting the standard, because they change consumers' perception or appreciation of these varieties. Standards may affect producers' costs in a number of ways. First, they may imply a fixed cost when producers switch from producing one product variety to producing another, higher quality variety. Second, they may involve a change in variable costs, for instance if it is more expensive to produce a good meeting the standard than one not meeting the standard. Third, the introduction of a standard affects production costs if it causes producers to run additional product lines. And fourth, standards will typically also generate costs related to conformity assessment procedures. Overall, the introduction of a standard is likely to affect the prices that consumers are willing to pay for certain product varieties and the prices at which producers are willing to supply those varieties. Standards will affect trade flows if they have a different effect on the demand for and supply of varieties produced abroad and varieties produced domestically. This may, for instance, be the case if foreign and domestic producers supply different varieties of the relevant good, or if standards affect their production costs differently.

The trade effects of standards will affect countries' welfare, including the welfare of the country introducing the standard. If a standard is purely designed to raise the costs of foreign producers in order to protect the domestic industry, it is very likely to reduce both trade flows and domestic welfare. But standards that reduce trade flows are not necessarily welfare reducing, in particular if they are designed in order to reduce the negative welfare effects of a market imperfection. Standards that improve consumers' information, that increase consumers' safety or that reduce the negative effects of environmental externalities, for instance, may well increase domestic welfare even if they have a negative effect on trade. As a consequence it may be in the interest of individual countries to set standards in order to raise their own welfare but which, as a by-product, reduces trade flows. Tensions with trading partners may then arise, if such a standard that is welfare-increasing from the domestic point of view decreases trading partners' welfare.

The discussion in previous Subsections has illustrated the importance of distinguishing among different types of standards. For the sake of this Report, standards have been distinguished according to their function – that is according to the policy objectives they intend to address. The cases of standards related to network externalities, imperfect information and negative production or consumption externalities have been discussed. These types of standards differ in a number of aspects that will play a role when evaluating the following three statements often used in the public debate.

Do standards decrease trade flows?

Standards are likely to increase trade flows in the case of standards targeting network externalities. Voluntary standards targeting information asymmetries (e.g. safety standards) or negative production externalities may also have a positive impact on trade, as they are likely to increase the variety of products supplied in the market. Mandatory safety standards and environmental product standards have ambiguous effects on the size of trade flows, but are likely to decrease trade if they create cost disadvantage (in relative terms) for producers exporting to the countries imposing the standard. The impact of mandatory process standards related to the environment depends on whether they are applied to foreign producers or not. If they are applied to foreign producers, trade flows may decrease. Yet such standards raise important questions concerning control and enforcement, given that production takes place abroad.

Is harmonization at the international level the best solution?

The case in favour of international standards is likely to be much stronger in the context of compatibility standards (network externalities) than in the context of the other two types of standards examined. In the case of network externalities, markets will tend to oversupply varieties when left alone. Compatibility standards therefore reduce the number of varieties in markets. This argument also holds with respect to global markets. In other words, harmonization is likely to be desirable in the case of compatibility standards.

However, it should be emphasized that in this case, market forces are likely to generate the desirable outcome, without the need for government intervention.

The case in favour of harmonization of standards is weaker when it comes to standards addressing information asymmetries (e.g. safety standards) and local environmental externalities. To the extent that countries differ, it may be preferable to have separate policy instruments for each country rather than one single policy instrument in these cases.

When standards addressing global production or consumption externalities are set at the national level they are likely to be inefficient. This is, for instance, the case for global environmental externalities. International collaboration is necessary in order to correct for such externalities. The optimal solution, however, does not necessarily involve harmonized standards, as production technologies and consumer behaviour differ across countries.

Should standard-setting be left to the private sector?

Producers will set standards in a profit maximizing way. As a consequence they automatically take consumer interests into account, but only to the extent that consumer preferences are reflected in prices. This is unlikely to be the case in the presence of production externalities and/or information asymmetries. Consumer and producer interests will diverge in these cases. Government intervention is necessary to ensure that consumer interests are taken into account. Consumer and producer interests are likely to coincide when it comes to network externalities and it therefore makes sense for compatibility standards to be set by the private sector.

Producer and consumer interests may also differ in another important domain – that of international trade. While producers may have an incentive to set standards so as to provide them with an artificial competitive advantage, this is not in the interest of consumers. It should be the aim of governments to take both producer and consumer interests into account and to ensure that standards are not used as protectionist devices.

Two other important issues arise from the discussion above that are of particular importance for the multilateral trading system:

Domestic versus global effects of standards and the role of the WTO

In the presence of market failures such as those discussed here, it is possible that policies which are optimal from a national point of view cause losses to trading partners. It is also possible that these losses outweigh the benefits going to the country introducing the policy. In other words, in integrated markets, regulatory policies that are optimal from a national point of view may not be optimal from a global point of view. The question therefore arises as to whether such policies should be considered consistent with the multilateral trading system. Given the complexity of this issue, questions also arise concerning the precise role of and the interactions between national standard setting bodies, international standard setting bodies and the World Trade Organization. These questions will be alluded to in Section IIC and Section IID.

Control and enforcement of process standards in the international domain

Production processes in one country can exert negative externalities on consumers in other countries. This can be the case because the production process affects global aspects of the environment (e.g. air pollution, maritime pollution). Whatever the justification or appropriateness of process standards, the issue of control and enforcement will be a thorny one in the international domain. If a country wishes to condition imports on compliance with a certain process standard, the question arises as to who controls and enforces this standard, given that production takes place abroad. Section IIC will discuss how international standard-setting bodies and other non-governmental organizations have dealt with this issue. Section IID illustrates that this question has also played a role in WTO jurisprudence.

The empirical evidence

Ideally, the empirical survey of standards and trade would have examined whether certain types of standards are trade creating, while other types are not. But with the exception of environmental standards and SPS-related measures, a large part of the empirical literature on standards and trade has tended not to distinguish the nature of the standards being studied. The number of empirical studies has also been limited. These limitations have to be taken into account in the recapitulation of some of the results of the empirical survey.

Standard-setting activity seems to be pronounced in industries characterized by network externalities. Insofar as technical regulations are concerned, the bulk of this activity seems to deal with various types of problems associated with information asymmetries. In some major markets these regulations cover a large number of tariff lines and a significant share of imports, so there is potential for these regulations to have an adverse effect on trade.

The cost or price-raising effects of standards do not emerge as an important NTB concern in OECD countries. OECD firms did not identify major problems in complying with regulations in other OECD markets. However, the same relatively benign results seem not to apply with respect to smaller firms. With respect to the cost of compliance by firms in developing countries, the evidence is mixed with the survey work suggesting that firms in developing countries face very high costs, while the case studies tell a more complex story where the costs of and benefits from compliance vary enormously among firms and countries and depend on a range of factors.

The available empirical literature on the effect of standards on international trade flows is still rather limited, reflecting the difficulty of the subject and the nature of the data. But some interesting results have arisen. Intra-industry trade can be spurred by greater standard-setting activity in industrial sectors, suggesting that standards play an important role in increasing compatibility. Also, the adoption of standards, even purely national ones, can increase trade. One possible explanation for this result is that standards convey information about consumer preferences to exporters.

On the relative merits of harmonization or mutual recognition of standards to facilitate trade, it is not possible to draw strong conclusions given the very limited empirical studies available, most of which are focused on EU members. But early evidence suggests that more robust and significant trade-enhancing effects are found in the case of mutual recognition.

The welfare-based literature finds that SPS measures are generally restrictive and involve a welfare loss in the importing country. The presumed health risks or losses from the introduction of pests through imports need to be extraordinarily high in order to justify some regulatory regimes in place. But questions have been raised about the appropriateness of the analytical framework employed since there may be circumstances when regulatory authorities are not able to assign credible probabilities to the outcomes and therefore are more risk averse than assumed in the papers. There are conflicting conclusions too about the trade impact of SPS measures on developing countries. There have been cases where access to export markets was denied due to sanitary or phytosanitary issues, resulting in substantial costs in terms of lost sales and market share. But there have been other cases as well where, by adopting higher standards, countries are able to find an important niche and improve their position in the global marketplace.

On environmental standards, recent studies find more of a pollution haven effect than the older literature, although there is some question about the robustness of these results. Less work has been done to examine empirically the race to the bottom story, but available studies point to little or no effects on the behaviour of regulators. So the presumption is still that environmental standards do not, in general, have significant effects on trade and on investment flows.