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Non-tariff measures, preferential trade agreements, and prices: new evidence

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Abstract Combining for the first time a new dataset of non-tariff measures (NTMs) in 65 countries with the CEPII's unit values database, we estimate average ad-valorem equivalents (AVEs) for sanitary and phytosanitary, technical-barriers-to trade and other measures by section of the Harmonized System of product classification. While most existing AVEs are obtained from indirect quantity-based estimation, ours are obtained from direct price-gap estimation. They lie in a single-digit range, i.e. substantially lower than previous estimates based on older data. Our results may reflect the progressive phasing out of command-and-control instruments such as quantitative restrictions in many countries; they also suggest that sanitary and technical regulations have not substituted for them as trade-restrictive interventions. Most interestingly, we show that deep-integration clauses in regional trade agreements, in particular the mutual recognition of conformity-assessment procedures, substantially reduce the price-raising effect of NTMs, possibly reflecting lower compliance costs.

Keywords Non-tariff measures · Price gaps · Regional trade agreements · Deep integration · Harmonization · Unit values

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1 Introduction

Since Trefler's "mystery of the Missing Trade" (Trefler 1995), a number of studies have investigated why world trade is not as large as economic models predict. Obstfeld and Rogoff (2000) suggested that large unobserved trade costs might explain most of the discrepancy between model estimates and trade statistics, a conjecture confirmed by Anderson and Van Wincoop (2004) who showed that the costs associated with cross-border trade even between well-integrated countries were well above those that could be explained by geographic distance and traditional trade policies. Since then, work attempting to capture and quantify the impact of hidden trade costs has focused on trade-facilitation issues (Maskus et al. 2005; Djankov et al. 2010; Hoekman and Nicita 2011) and non-tariff measures (NTMs; Feenstra 1984; Deardorff and Stern 1997; Baldwin 1989; Leamer 1990; Anderson and Neary 1994; Kee et al. 2009; Disdier et al. 2015; Carrère and de Melo 2011; Cadot and Gourdon 2014).

This paper revisits the effect of NTMs on trade by estimating how they affect the price of imported goods. In doing this, we are agnostic as to whether price rises reflect compliance costs, demand increases due to quality signaling, or any combination of the two. This is important because NTMs have changed in nature over time. For many years, the term "NTMs" designated measures that consisted largely of quantitative restrictions (QR) in the form of quotas, voluntary export restraints and non-automatic licensing. Such measures unambiguously lowered import volumes while having ambiguous effects on trade unit values, depending on the mode of distribution of import licenses (if licenses were sold to exporters, their value would be embodied in trade unit values; if they were given free of charge or sold to domestic importers, trade unit values would be unaffected under a small-country assumption and only domestic wholesale prices would be affected). However, over the last two decades, these measures have largely been phased out.

By contrast, technical and sanitary and phytosanitary (SPS) regulations have proliferated. Focusing on measures that were the object of concerns at the WTO, (Fontagné et al. 2015) show, on the basis of firm-level evidence, that such measures entail compliance costs, raising unit values and inhibiting entry. Interestingly, they show that these effects are not neutral on the distribution of firms, as smaller ones seem to react more strongly. However, SPS measures can also signal quality and improve access to the supply chains of large retailers for imported products; they can also be instrumental in overcoming market failures (see Beghin et al. 2015 for a theoretical and empirical exploration; see Maur and Shepherd 2011 on product standards). Thus, their effects are quite different from those of QRs and can be understood only in a differentiated-products framework. While they unambiguously raise trade unit values (either through compliance costs or through quality signaling/upgrading), their effect on volume and overall value is indeterminate, depending on the relative shifts of the supply and demand curves and on their respective elasticities.

While our approach differs from most of the existing literature (except Beghin et al. 2012) in that it does not assume that NTMs reduce trade, our use of prices instead of volumes or values to measure the impact of NTMs is not new. Price-based approaches consist of estimating the ad-valorem equivalent (AVE) of an NTM by comparing directly the price of products in the NTM's presence with that of similar products on markets without it. It can be applied by simple comparison of averages on a case-by-case basis after correction for transport costs and other observables (see Ferrantino 2006 for examples), or econometrically, as in Andriamanjara et al. (2004). There are several well-known issues with the price-gap approach, discussed in Ferrantino (2006). One key issue is the availability and comparability of price data.

Our approach takes advantage of two recent databases that have not yet been used to estimate the effect of NTMs. For trade unit values, we use the database of the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII) which contains unit values (in US dollars per ton) over 2000–2008 for 173 reporters, 255 partners, and over 5000 six-digit product categories. The unit values are provided in Harmonized System 1996 and 2002 revisions, both free on board (FOB) and including cost of insurance and freight (CIF). The CIF unit values rely on importers' declarations, and include all trade costs except tariffs and domestic taxes after the border. The data is based on comtrade unit values but has undergone a number of consistency checks to reduce the incidence of aberrant and arbitrary values (Berthou and Emlinger 2011).

As for NTMs, over the last 2 years, a major effort has been undertaken to replenish the UNCTAD trade analysis information system (TRAINS) database. The effort, which has led to the collection of data in 65 countries with broader coverage of measures than in TRAINS under a common, consistent nomenclature, is underway. The data is based on double-entry coding of regulatory measures, by type of measure (following a new, detailed nomenclature) and by product (following the HS classification at six digits). However, there is only 1 year of data collection so there is no variation in the time dimension, as would be typically the case for a border-effect approach. From TRAINS, CEPII has built the NTM-Map database which contains indicators measuring the incidence of NTMs and we construct dummies capturing the presence of different types of NTMs at the country product level. The present paper is the first attempt to use this data. Combining the two datasets (NTMs from TRAINS and unit values from CEPII), we construct a product-origin–destination panel of 2.311.774 observations.

Beyond direct price effects, we explore how regional trade agreements (RTAs) affect the impact of NTMs on prices. Many RTAs encourage their members to coordinate technical and SPS regulations through a variety of approaches that include, inter alia, harmonization or mutual recognition (RTAs may also involve technical consultations between members prior to the issuance of new regulations). Harmonization and mutual recognition can also take place on conformity-assessment procedures, in which case measures can differ but compliance verification can be performed in the exporting country, reducing compliance costs.[1]

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[1] These compliance costs can be substantial. Without the recognition of conformity assessment, exporters are sometimes required to have their products tested by accredited laboratories separately for each

Until recently, the literature on technical regulations and standards paid little attention to how they interact with RTAs (see Bourgeois et al. 2007), focusing instead on their direct effects (see e.g. Czubala et al. 2009; Moenius 2004; Henry de Frahan and Vancauteren 2006). Exceptions include (Chen and Mattoo 2008), who showed that mutual recognition and, to a lesser extent, harmonization raised intra-regional trade between industrial countries. As for North–South trade, the detrimental effect of the North–South "standards divide" on Southern exports was discussed in Otsuki et al. (2001) and Wilson and Abiola (2003). Disdier et al. (2015) showed that premature harmonization on stiff Northern standards in North–South RTAs with harmonization clauses could "price out" the Southern partner from third markets in the South, while failing to improve market access within the bloc. By contrast, (Maertens and Swinnen 2009) documented on the basis of an example from Senegalese agriculture how compliance with Northern standards in an RTA could confer benefits to the Southern partner's exporters by raising the quality of exported products, encouraging improved management and production processes, and signaling better quality. Lejarraga and Shepherd (2013) find that RTAs with deeper mechanisms for enhancing transparency appear to be more strongly trade-promoting than those with shallower commitments on transparency. Specifically, in their study each additional transparency commitment negotiated in an RTA is associated with an increase in bilateral trade flows of more than 1 %. Thus, the combined effect of regulations and harmonization/mutual recognition is an empirical question.

This paper explores whether RTAs with NTM harmonization clauses reduce the price-raising effect of NTMs based on Piermartini and Budetta's classification of 70 RTAs (Piermartini and Budetta 2009). Empirically, we use two distinct approaches. First, we run within-product regressions with destination and product fixed effects on the whole dataset. Then, we run product-by-product regressions as in Kee et al. (2009). We find substantial price-raising effects. We also find that RTAs with provisions related to standards (harmonization or mutual recognition) dampen the price-raising effect of NTMs, suggesting, indirectly, that some of the price-raising effect is due to compliance costs that harmonization and mutual recognition reduce. Mutual recognition of conformity assessment, the easiest step toward coordination of standard-related measures, seems to have the strongest dampening effect. One reason for this may be that, in the absence of such recognition, exporters must obtain foreign certification from accredited private laboratories charging high fees.

The paper is organized as follows. Section 2 describes the data and some stylized facts. Section 3 discusses estimation issues and results for AVE estimations, Sect. 4 shows effects of different integration approach on those AVEs and Sect. 5 concludes.

Footnote 1 continued

destination country. In developing countries, these laboratories are typically owned and operated by private companies in quasi-monopoly situations with very stiff fees. For instance, rice exporters in Myanmar incur testing fees between $500 and $1000 per sample at private laboratories in the region. As samples have to be tested for every two 20' containers, testing costs can reach up to 9 % of the FOB price. By comparison, the government export tax is slightly over 2 %.

2 Data

2.1 Prices

The basic issue with price-based estimation is that domestic price data are not published systematically. National statistical institutes collect detailed price data for the calculation of consumer price indices, but the classification varies across countries and true price data, considered sensitive, is typically not made available: only price *indices*, normalized by a base year, are made public. Those indices are comparable over time but not across countries; thus they cannot be used for our purposes since we have only 1 year of NTM data and can infer their effect only through cross-country comparisons.

The only type of prices observable in absolute form and at a disaggregated level is trade unit values, obtained by dividing trade values by quantities. There are several problems with using trade unit values to assess the price-raising effect of NTMs. One is that the data is noisy, as customs typically monitor imperfectly import quantities (border taxes are assessed on values, not quantities). However, this is not a problem for econometric estimation as long as measurement errors are uncorrelated with other regressors on the right-hand side. The second problem is that trade unit values do not include intermediation margins (from CIF border price to wholesale and retail prices). This is problematic in the presence of quantitative restrictions, if licenses are given to domestic distributors; in that case, trade unit values will not reflect the shadow value of the licenses. For our purposes, however, this is not a major problem as most quantitative restrictions have been eliminated after the termination of the Agreement on Textiles and Clothing in December 2004. For SPS and technical regulations whose effect is to raise production costs, compliance costs will be reflected, partly or fully (depending on market structure) in producer prices and therefore in trade unit values.

2.2 Non-tariff measures

This section discusses the NTM data we use. Several points should be kept in mind. First, contrary to tariffs, depending on their type, NTMs may apply either to imported goods only, or to both imported and domestically produced goods. For instance, whereas a quantitative restriction (QR) will apply only to imported goods, a technical regulation will typically apply to both imported and locally produced goods, since otherwise it would be inconsistent with GATT Article III (national treatment). Second, NTMs apply to products rather than production processes (although they can affect technology choices when they apply to intermediate products). Thus, some regulations may be trade-relevant while not being counted as NTMs. For instance, an environmental regulation prohibiting domestic producers from dumping toxic effluents in a river would not be an NTM, even though it could affect trade flows indirectly by raising the domestic producers' costs and thus their ability to export and compete with imports.[2] The reason for this exclusion is that the inclusion of domestic regulations on

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[2] There is thus a logical inconsistency in the MAST classification's treatment of domestic subsidies and regulations, since subsidies to domestic producers are included on account of their potential effect on

production in the list of NTMs would make its scope too wide to be manageable.[3] Thus, regulations may be trade-relevant but nevertheless not included in NTM inventories.

As mentioned in the introduction, data on NTMs is available through a recent data collection effort undertaken jointly by the World Bank, UNCTAD, ITC and the African Development Bank. The data consists of tables with HS6 products in rows and NTMs, coded according to the 2009 MAST nomenclature, in columns. It also contains references to the relevant legal texts as well as indications on the issuing and/or enforcing agency. The data has been collected either by national governments under the coordination of regional secretariats, as in Latin America, or by local consultants hired by the World Bank or the African Development Bank in SSA. In the latter case, it has been endorsed by governments through validation workshops held at the end of the data collection process. All of the data that was collected by the World Bank and the AfDB has been forwarded to UNCTAD for posting on WITS, the World Bank's portal for trade data, and is freely accessible. Some of it was, at the time of writing, still under verification by UNCTAD trade specialists.

Given the complexities involved in the definition of NTMs, in order to ensure consistency in data collection across countries, UNCTAD adopted in July 2009 an exhaustive list known as the multi-agency support team (MAST) classification. The classification was revised in January 2012 by the WTO's legal department which made it the mandatory format for the notification of trade-relevant regulations by member states. Figure 1 shows its broad structure.

Categories A and B (SPS and TBT measures) are often referred to as "technical" ones. Categories C to O are non-technical ones and cover a mixture of command-and-control types of measures (price controls, quantitative restrictions and prohibitions) and a disparate set of measures. Some, like pre-shipment inspection (category C), are easy to track and affect all products. Some, like taxes and para-tariff measures (category F) are more difficult to track as they are sometimes administered in a non-transparent way.

NTM data has been collected for 65 countries (including 27 EU countries) and they cover consistently categories A to E. This is the reason why the NTM-Map database from CEPII covers only those five categories (Gourdon 2014). In Appendix Table 7 shows the availability of data by region, together with the year in which the data were collected.

We now turn to analyze the impact of NTMs across economic sectors using NTM-Map. The use of NTMs greatly varies across economic sectors both for technical and economic reasons. While some products, such as agriculture or chemicals, are highly regulated because of consumers and environmental protection and technical standards, some other goods are by their nature less subject to laws

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Footnote 2 continued

competition with imported products, whereas cost-raising domestic regulations are not, even though they may also distort competition, this time by penalizing domestic producers.

[3] NTMs could conceptually affect *products* based on their production *processes*—say, restrictions on imported products based on differences in labor regulations between the importing and exporting country—but they would then be in violation of (inter alia) GATT Article III (national treatment).

Imports	**Technical measures**	A	SANITARY AND PHYTOSANITARY MEASURES
		B	TECHNICAL BARRIERS TO TRADE
		C	PRE-SHIPMENT INSPECTION AND OTHER FORMALITIES
	Non technical measures	D	CONTINGENT TRADE-PROTECTIVE MEASURES
		E	NON-AUTOMATIC LICENSING, QUOTAS, PROHIBITIONS AND QUANTITY-CONTROL MEASURES OTHER THAN FOR SPS OR TBT REASONS
		F	PRICE-CONTROL MEASURES, INCLUDING ADDITIONAL TAXES AND CHARGES
		G	FINANCE MEASURES
		H	MEASURES AFFECTING COMPETITION
		I	TRADE-RELATED INVESTMENT MEASURES
		J	DISTRIBUTION RESTRICTIONS
		K	RESTRICTIONS ON POST-SALES SERVICES
		L	SUBSIDIES (EXCLUDING EXPORT SUBSIDIES UNDER P7)
		M	GOVERNMENT PROCUREMENT RESTRICTIONS
		N	INTELLECTUAL PROPERTY
		O	RULES OF ORIGIN
	Exports	P	EXPORT-RELATED MEASURES

Fig. 1 The MAST classification of NTMs. *Source*: MAST report

and regulation. Table 1 reports frequencies indices (as calculated in the CEPII NTM-Map) of five broad categories of NTMs for 20 economic sectors.

The use of SPS measures is largely limited to agricultural sectors and products from animal origin, as their control is essential for ensuring the health and well-being of consumers and the protection of the environment. As a result, more than 60 % of food related products are found to be affected by at least one form of SPS. By contrast, TBT can suit a much wider set of products and indeed are found to be more uniformly applied across economic sectors with peaks in textiles, footwear, processed food, and chemicals.

Customs procedural measures subsumed in category C, which include pre-shipment inspection (PSI), are widely distributed across economic sectors, being particularly frequent for agricultural products, wooden products, textiles and footwear. Price control measures such as administrative pricing, anti-dumping and countervailing duties are trade-defense instruments which, by their nature, are applied only to very specific products and thus result in low frequency indices. Price-control measures are more concentrated in agricultural products, textiles and footwear. Finally, quantity control measures are applied more or less uniformly across economic sectors with peaks on agricultural goods, animal products, motor vehicles, and chemical products. These are sectors where particularly sensitive

Table 1 Frequency indices across economic sectors (share of products with at least 1 NTM)

	SPS	TBT	C: pre-shipment	D: contingent	E: quantity control
Live animals	67.9	29.7	6.1	1.4	6.7
Vegetable products	68.9	31.6	6.5	1.0	5.0
Fats and oil	61.0	51.0	10.4	1.6	5.3
Processed food	65.0	56.9	12.1	1.6	8.6
Minerals products	5.5	27.3	3.4	1.3	2.7
Chemical products	8.8	45.6	5.7	1.5	3.0
Rubber and plastics	4.5	49.8	6.4	1.4	2.7
Raw hide and skins	15.7	18.4	3.7	0.6	12.0
Wood	14.9	16.5	3.9	0.6	0.7
Paper	3.4	27.6	6.0	1.4	3.1
Textile	3.6	47.1	13.4	1.0	14.8
Footwear	2.2	44.4	7.5	1.1	3.0
Stone and cement	4.3	29.3	5.4	1.1	1.5
Base metals	4.2	35.3	11.1	1.5	8.8
Machinery electrical equipment	5.7	36.5	6.3	1.2	4.8
Motor vehicles	2.4	42.5	6.3	1.7	8.7
Optical and medicals instruments	2.2	35.6	9.7	1.2	2.6
Miscellaneous goods	4.1	31.6	5.7	2.1	2.0

Source: Gourdon (2014) from CEPII NTM-Map

products are often regulated by non-automatic licenses, quotas, and sometimes outright prohibitions.

2.3 "Deep-integration" clauses in RTAs

Mutual recognition implies that two countries agree to mutually recognize each other's standards as equivalent, thus granting products that meet any of the two countries' standards unrestricted access to both markets. Mutual recognition is commonly considered as a step toward freer trade because it allows firms to choose to conform to one among several standards in force in the area and have the product automatically recognized in all member countries. So, unless consumer preferences are biased toward their domestic specification, a firm located in the region can freely access the whole regional market without additional costs to comply with a specific standard. A well-known downside of mutual recognition is that the stiffer standards become de facto redundant, potentially aligning the whole area's regulatory stand on that of its weakest regulator. With endogenous location of production, mutual recognition could even trigger a race to the bottom as each country undercuts the others' regulations in order to attract production for the whole market. The problem is magnified if initial regulatory stands are heterogeneous in the area; in that case, policy makers may opt instead for the harmonization of minimum standards.

When differences in standards are too large to make mutual recognition desirable, countries may require a certain degree of harmonization of product

standards as a precondition to allow entry into their markets. Harmonization can be full or limited to essential requirements. Full harmonization requires that countries define on a product-by-product basis a common standard, including the design of detailed characteristics of the product. Harmonization of minimal standards consists of defining common essential requirements among countries that liberalize their trade, while leaving each country (or firm) free to design the specific characteristics of the product in the way they most like.

Like mutual recognition of product standards, harmonization is commonly believed to be a step toward freer trade. The advantage of harmonization relative to mutual recognition in terms of its effects on trade is that with harmonization, products produced in different countries are more similar (more homogeneous) and therefore better substitutes from the point of view of producers and consumers. This, in turn, may facilitate trade by improving consumers' confidence in the importing country about quality of the imported good. Also, harmonization will enhance compatibility between imported and domestically produced goods. This would make it easier for consumers to match components, would increase competition, reduce prices and increase trade.

However, harmonization may also have a negative effect on trade. Harmonization of product standards may reduce the scope of varieties available in the presence of vertical differentiation, for instance by excluding low-price, low-safety varieties, which may hamper trade. In addition, harmonization to a specific standard or to essential requirement may imply a higher cost of compliance for firms in certain countries than mutual recognition (and this cost is higher in case of full harmonization), thus effectively erecting a barrier to trade. This is a particular concern for developing countries whose level of technology may not be sufficient to meet certain standards.

Neither mutual recognition nor harmonization may be desirable when differences in product standards reflect fundamental differences in policy or societal choices, say about the appropriate level of tolerance for hazards or externalities. In such cases, countries can still minimize the trade reducing effect of different standards by increasing the transparency of their national standards and technical regulations. Notification of standards and technical regulations and the setting up of enquiry points for standards may in fact facilitate trade by reducing the searching costs required for acquiring information about the standards adopted in another country. The theoretical argument is that different national standards may not be detrimental to trade if they provide easy access to information about the preferences of consumers in a country. In addition, transparency at the stage of preparation of standards may provide an effective mechanism to avoid unintentional protectionist outcomes.

Another way to partially remove technical barriers to trade is through the recognition of conformity-assessment procedures. This implies that the importing country recognizes the competence of the exporting country's conformity-assessment bodies to test and certify that a product complies with the laws of the country where it is sold. Mutual recognition of conformity assessment requires a certain degree of trust between countries and confidence in the quality of the methodologies employed in their conformity tests. While it requires neither recognition nor harmonization of product standards, it is a natural step in deep integration once standards have been harmonized.

Table 2 Incidence of deep-integration clauses, by RTA

	Technical regulation	Conformity assesment
Mutual recognition	15	39
Harmonization	29	25
Transparency requirements	17	

Source: Piermartini and Budetta (2009)

Table 3 Incidence of deep-integration clauses in the sample

	Technical regulation	Conformity assesment
Mutual recognition	667	1285
Harmonization	612	635
Transparency requirements	926	

Source: Author's sample

The impact of mutual recognition agreements (MRAs) of conformity assessment on the trade of participating countries is clearly positive. MRAs will help reduce exporting firms' overall costs of testing and certification of conformity. They will eliminate the need of duplicative tests in each destination market and they will help reduce handling time and uncertainty of delivery.

To sum up, harmonization, mutual recognition of standards and of conformity assessment and enhanced transparency may all represent viable options to help reducing trade costs generated by different national standards.

What is the evidence on the incidence of harmonization and mutual recognition? Table 2 shows the number of RTAs by provision. The table refers to the total of fifty-eight RTAs that include provisions on TBTs out of the over seventy RTAs surveyed. Overall, there appears to be a tendency for regional agreements to favor harmonization of technical regulations over their mutual recognition, while the opposite is true for conformity assessment procedures. However, the two are not completely independent, as the harmonization of certification standards is often a precondition for considering the mutual recognition of conformity assessments.

Out of 10,308 product-dyad cells in our sample (origin–destination-product triplets for which we have both NTM and price data), 1493 are connected through an RTA with TBT clauses. We break down these cells by type of provision in Table 3. The breakdown suggests a high incidence of mutual recognition of conformity-assessment procedures (1285 cells) and transparency requirements (926) compared to other clauses.

3 Estimation and results

We now turn to estimating the relationship between the number or presence of NTMs and trade unit values at the product level, controlling for heterogeneity between products, importing and exporting countries, and country pairs.

3.1 Trade unit values under monopolistic competition

In order to derive a pricing equation that could guide the empirical exploration, let us assume a standard monopolistic-competition framework with heterogeneous firms where each firm draws a random productivity level φ. Let o, d and k index respectively origins, destinations and products. Let Q_{dk} be destination d's demand for product k, P_{dk} its price index on market d (a CES aggregator of the prices of firm-level varieties), σ the elasticity of substitution between varieties, w_o a marginal cost reflecting supply conditions in origin o (e.g. the wage rate) before productivity adjustment (so productivity-adjusted marginal cost is w_o/φ), and τ_{odk} an iceberg-type (ad valorem) trade cost, reflecting a combination of traditional trade costs (distance, etc.) and the cost of complying with any NTM imposed by country d on product k.[4] Finally, let e_{od} be the bilateral exchange rate between the origin and destination countries.

Let $q_d(\varphi)$ and $p_d(\varphi)$ be respectively the quantity sold by a firm with productivity φ in destination d and its FOB price; under constant marginal cost, optimization decisions are separable across destinations. As is well known (see Melitz 2003), for an exporting firm with productivity φ higher than the minimum exporting productivity cutoff $\varphi*$, profits on destination d are given by

$$
\begin{aligned}
\pi_d(\varphi) &= \left[e_{od}p_d(\varphi) - \frac{w_o}{\varphi} \right] q_d(\varphi) \\
&= \left[e_{od}p_d(\varphi) - \frac{w_o}{\varphi} \right] Q_{dk}P_{dk}^{1-\sigma}[\tau_{od}p_d(\varphi)]^{-\sigma}
\end{aligned}
\tag{1}
$$

which yields a standard FOB pricing rule known as "mill pricing" (same FOB price across all destinations):

$$
p_{ok}^{\text{FOB}}(\varphi) = \left(\frac{\sigma}{\sigma - 1} \right) \frac{w_o}{\varphi}.
\tag{2}
$$

The corresponding CIF price, which is destination-specific because it includes trade costs, is then

$$
p_{odk}^{\text{CIF}}(\varphi) = \tau_{od} \left(\frac{\sigma}{\sigma - 1} \right) \frac{w_o}{\varphi}
\tag{3}
$$

Let M_o be the mass of firms producing product k with productivity above $\varphi*$ in origin country o, and let $\mu_o(\varphi)$ be the unconditional distribution of firm productivities. Aggregating over varieties using the standard CES aggregator gives

$$
P_{odk}^{\text{CIF}} = \left\{ \int_0^\infty \left[p_{odk}^{\text{CIF}}(\varphi) \right]^{1-\sigma} M_o\mu_o(\varphi)d\varphi \right\}^{\frac{1}{1-\sigma}}
\tag{4}
$$

which is the trade unit value observed in the data. As shown by Melitz [2003, Eq. (7)] this can be rewritten in terms of a productivity aggregator $\tilde{\varphi}_o$:

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[4] We assume that NTMs are imposed on all origins (including the destination country itself), while other trade costs are bilateral.

$$P_{odk}^{\text{CIF}} = M_o^{\frac{1}{1-\sigma}} p(\tilde{\varphi}_o) = M_o^{\frac{1}{1-\sigma}}\, \tau_{odk}\left(\frac{\sigma}{\sigma-1}\right)\frac{w_o}{\tilde{\varphi}_o}, \qquad (5)$$

with $\tilde{\varphi}_o = \left[\int\limits_0^\infty \varphi^{1-\sigma}\mu_o(\varphi)d\varphi\right]^{\frac{1}{\sigma-1}}$.

Finally, letting n_{dk} be a binary indicator of the presence of an NTM on product k in destination market d (see below), t_{odk} be the ad-valorem tariff faced by product k from origin o on destination market d, and

$$\tau_{odk} = \exp[\beta_1 n_{dk} + \beta_2 \ln(1 + t_{odk}) + \mathbf{x}_{od}\gamma] \qquad (6)$$

we have an expression that, after log-linearization, is amenable to estimation using origin and destination fixed effects. This expression is given in full in the next section. Note that under mill pricing, firms pass through the entire compliance cost (captured here by $e^{\beta_1} - 1$) to CIF unit values.[5]

3.2 Estimation issues

The estimation strategy we propose can be thought of as a simple treatment-effect approach where the prices of some goods in some countries are "treated" by NTMs. Let v_{odk} be the unit value of product p imported from o to d (the empirical counterpart of P_{odk}^{CIF}) and $\mathbf{x}_{od}$ a vector of bilateral determinants of trade including distance, common language, common border, and so on. Let superscript "A" designate type-A measures (SPS) in the MAST classification, "B" type-B measures (TBT), and "other" all the rest (essentially quantitative restrictions). Let also

$$n_{dk}^A = \begin{cases} 1 & \text{if country } d \text{ applies a type-A NTM to product } k \\ 0 & \text{otherwise.} \end{cases} \qquad (7)$$

Controlling for importer characteristics with factor endowments (capital per labor, land per labor and human capital) and income levels (GDP per capita) subsumed in a control vector $\mathbf{z}_d$, the baseline estimation equation corresponding to (5)–(6) is

$$\ln v_{odk} = \delta_o + \beta_1^A n_{dk}^A + \beta_1^B n_{dk}^B + \beta_1^{other} n_{dk}^{other} + \beta_2 \ln(1 + t_{odk}) + \mathbf{x}_{od}\gamma_1 + \mathbf{z}_d\gamma_2 + u_{odk} \qquad (8)$$

Observe that if Eq. (8) is run on a destination-product panel, it would estimate only three average NTM coefficients (one per NTM type): β_1^A for SPS measures, β_1^B for TBT measures, and β_1^{other} for all other measures (QRs and price measures). In order to obtain product-specific estimates, we would need to amend (8) by interacting the NTM dummies with product dummies. However, with over 4575 HS6 products for which at least one country in the sample has an NTM (in all, there are over 5000 products at HS6) and three different types of NTMs, this would

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[5] For an alternative approach with incomplete pass-through, see e.g. Berman et al. (2012).

involve the estimation of up to $3 \times 4575 = 14{,}375$ coefficients, which would be intractable if we tried to estimate them in a single panel regression. Instead, we estimate (8) separately product by product, like Kee et al. (2009). Dropping the product subscript, for a representative product, the estimation equation thus becomes

$$\ln v_{od} = \delta_o + \beta_1^A n_d^A + \beta_1^B n_d^B + \beta_1^{other} n_{dp}^{other} + \beta_2 \ln(1 + t_{od}) + \mathbf{x}_{od}\boldsymbol{\gamma}_1 + \mathbf{z}_d\boldsymbol{\gamma}_2 + u_{od} \tag{9}$$

Several issues arise in the calculation of section averages. First, some destination-product pairs have no NTM; AVEs are undefined for those. We set the AVE arbitrarily at zero for those; an alternative would be to code them as missing values, which would result in higher average AVEs. Second, some coefficients are not statistically significant; we keep only those which are statistically different from zero at the 10 % level (about 40 % of all). Third, some destination-product pairs have negative estimated AVEs. As NTMs can, in some cases, facilitate trade by mitigating information asymmetries (see our earlier discussion), positive estimates, equivalent to negative AVEs, are conceivable in quantity estimation. By contrast, in the context of price-based estimation, negative coefficients, i.e. negative AVEs, would imply that the presence of NTMs reduces trade unit values. The only case where such a price-reducing effect could possibly make sense economically is when a large country imposes a quantitative restriction (QR) on a product (thus depressing its demand) and grants import licenses to domestic operators, leading to a lower before-quota unit values because of the large-country effect on the world price. However, unless special assumptions were made on preferences, the large-country effect would be felt on the product's unit values for all country pairs, not just when imported by the country imposing the QR. It would then be picked up by the product fixed effect rather than the NTM coefficient. It is difficult to think of any alternative case where NTMs would depress trade unit values. Accordingly, we treat negative AVEs in our sample (15 % of observations) as aberrations and replace them by missing values in the calculation of averages.

Finally, the exponentiation involved in the transformation of coefficients into AVEs leads in some cases to implausibly large AVEs. Twenty percent of our estimates are above 100 % or below -100 % and 1 % are well above 500 % or below -500 %. Such large numbers exert a disproportionate influence on section averages. One obvious solution to reduce their influence would be to consider section medians instead of averages, but the large number of zero values drives the median to zero in many cases. Instead, we deal with the issue by using a "squashing" function, the hyperbolic tangent, which forces values asymptotically to 100 % while keeping them roughly unchanged up to 70–80 %. The shape of the hyperbolic tangent function is illustrated in Fig. 2.
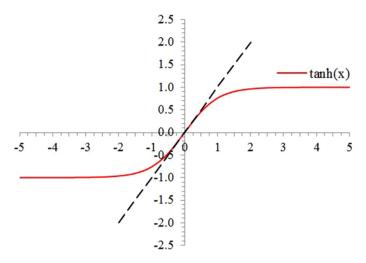
Fig. 2 The hyperbolic tangent function

4 Results

4.1 Baseline

Table 4 shows section averages of estimated AVEs for 20 HS sections, based on Eq. (9). Overall, they are moderate, with an average of 2.8 % for SPS regulations and 5 % for technical (TBT) ones. SPS and TBT measures tend to have the highest AVEs. In accordance with intuition, SPS have particularly high AVEs for food and agricultural products. This is consistent with three conjectures: (i) that SPS regulations are particularly stringent for food products, raising production costs; (ii) that compliance with SPS regulations have strong quality and signaling effects, raising demand; or (iii) that SPS measures are designed to hurt foreign producers, acting as surrogates for agricultural protection. The price-raising effects observed in Table 4 may reflect any combination of these underlying forces, and we leave for further research the combination of price and quantity estimation that could potentially discriminate between them.

TBT measures have high AVEs in the automobile sector. Although all three conjectures discussed in the case of food products are notionally possible, tailor-made technical regulations designed to hurt foreign producers are not to be excluded given that the automobile sector is considered sensitive in many countries and has been affected by numerous grey-zone quantitative restrictions such as voluntary export restraints.

Interestingly, textile and clothing does not stand out with heavily price-raising NTMs in spite of its sensitivity in terms of employment, suggesting that looking at NTMs predominantly through a "hidden-protectionism" lens may be misleading.[6]

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[6] In an alternative specification, we followed Kee et al. (2009) and interacted NTM dummies with country covariates in order to generate predicted effects conditional on destination characteristics.

Table 4 Average NTM AVEs by HS section

	SPS (A)	TBT (B)	Other (CDE)	Total
Animals	12.9	10.1	3.2	26.2
Vegetables	10.3	8.1	1.3	19.6
Fats and oils	6.9	7.8	0.5	15.2
Beverages and tobacco	8.0	7.5	1.8	17.3
Minerals	1.6	6.6	0.8	9.0
Chemicals	1.1	5.6	0.7	7.3
Plastics	1.3	4.7	0.4	6.4
Leather	2.8	2.2	2.6	7.6
Wood products	4.7	1.4	0.4	6.5
Paper	0.8	1.7	0.7	3.2
Textile and clothing	0.8	4.2	1.4	6.4
Footwear	0.7	3.2	0.9	4.8
Stone and glass	1.8	4.9	0.6	7.3
Pearls	1.0	4.3	0.7	6.0
Metals	1.4	3.4	0.8	5.6
Machinery	1.6	4.6	1.0	7.1
Vehicles	0.4	9.3	1.2	10.9
Optical and med. instr.	0.7	7.5	1.6	9.9
Arms	0.0	0.5	0.3	0.8
Miscellaneous	0.7	4.4	0.3	5.3
Work of arts	0.0	2.6	0.0	2.6
Average	2.8	5.0	1.0	8.8

Estimation carried out by OLS, product by product at HS6

We now turn to the impact of harmonization and mutual recognition on such AVEs. To do so we will use the approach with country characteristics and add interaction terms with the presence of provisions in trade agreements on TBT or SPS measures.

4.2 Does deep integration dampen the price-raising effect of NTMs?

Our approach is simply to re-estimate (9) with interaction terms between NTM dummies and dummies marking deep-integration clauses. We focus on SPS (type-A) and TBT (type-B) measures as deep-integration clauses concern essentially those. Let h stand for standards harmonization, m for mutual recognition, and c for mutual recognition of conformity-assessment procedures. We define a set of dummy variables marking type of RTAs based on their deep-integration clauses $\ell = \{h, m, c\}$ as coded by Piermartini and Budetta (2009):

Footnote 6 continued

Mapping back those characteristics into « real » importing countries makes it possible to retrieve predicted effects corresponding to the particulars of each importing country.

$$a_{od}^{\ell} = \begin{cases} 1 & \text{if } o \text{ and } d \text{ have an RTA with deep-integration clause } \ell \\ 0 & \text{otherwise} \end{cases} \quad (10)$$

and rewrite our product-level estimation equation as

$$\ln v_{od} = \delta_o + \delta_d + \sum_{j=A,B,\text{other}} \alpha_1^j n_d^j + \sum_{j=A,B,\text{other}} \beta_1^j \left(n_d^j \times a_{od} \right) + \beta_2 \ln(1 + t_{od})$$
$$+ \mathbf{x}_{od}\gamma_1 + \mathbf{z}_d\gamma_2 + u_{od}$$

$$(11)$$

Table 5 AVE-reducing effect of deep-integration clauses, by HS section

| | AVE without RTA | | | AVE with RTA | | | AVE change | | | | |
| | SPS (A) | TBT (B) | Total | SPS (A) | TBT (B) | Total | Absolute (%. points) | | Proportional (% of baseline) | | |
							SPS (A)	TBT (B)	SPS (A)	TBT (B)	Total
Animals	11.6	9.2	20.8	8.5	7.8	16.4	−3.1	−1.3	−26.7	−14.5	−21.3
Vegetables	9.9	10.3	20.3	9.3	6.6	15.8	−0.7	−3.8	−6.7	−36.4	−21.9
Fats and oils	8.9	8.4	17.3	4.9	7.8	12.6	−4.0	−0.6	−45.4	−7.6	−27.0
Beverages and tobacco	8.1	8.4	16.5	6.6	5.3	11.9	−1.5	−3.1	−18.4	−37.3	−28.1
Minerals	1.6	7.8	9.4	1.6	5.2	6.8	0.0	−2.6	0.2	−33.4	−27.6
Chemicals	1.0	7.0	7.9	0.8	4.6	5.4	−0.1	−2.4	−13.6	−34.2	−31.7
Plastics	1.2	5.8	7.0	1.1	3.9	5.0	−0.1	−1.9	−9.1	−33.1	−29.0
Leather	2.7	3.7	6.5	1.6	2.5	4.2	−1.1	−1.2	−40.7	−31.9	−35.7
Wood products	4.5	2.1	6.5	4.1	1.5	5.7	−0.4	−0.5	−8.0	−24.7	−13.3
Paper	0.7	2.5	3.3	0.5	1.6	2.1	−0.2	−0.9	−24.3	−37.3	−34.5
Textile and clothing	0.9	4.8	5.6	0.7	3.6	4.3	−0.2	−1.2	−18.0	−24.5	−23.5
Footwear	0.7	4.3	5.0	0.6	2.6	3.2	0.0	−1.7	−6.7	−40.4	−35.9
Stone and glass	1.5	4.9	6.4	1.4	3.7	5.1	−0.1	−1.2	−8.2	−23.9	−20.2
Pearls	1.0	4.3	5.3	0.8	4.2	5.0	−0.2	−0.1	−21.3	−2.1	−5.6
Metals	1.2	4.6	5.8	1.0	2.9	3.9	−0.2	−1.6	−18.5	−35.8	−32.2
Machinery	1.5	5.2	6.7	1.2	3.6	4.8	−0.3	−1.6	−19.2	−30.6	−28.0
Vehicles	0.4	8.9	9.3	0.4	7.5	7.9	−0.1	−1.4	−15.5	−15.4	−15.4
Optical and med. instr.	0.8	7.5	8.3	0.7	6.0	6.6	−0.1	−1.6	−10.6	−20.8	−19.9
Arms	0.0	0.5	0.6	0.0	0.5	0.6	0.0	0.0	0.0	0.0	0.0
Miscellaneous	0.6	4.9	5.5	0.5	3.4	3.9	−0.1	−1.5	−17.7	−30.6	−29.2
Work of arts	0.0	2.7	2.7	0.0	1.7	1.7	0.0	−1.0	0.0	−37.8	−37.8
Average	2.8	5.6	8.4	2.2	4.1	6.3	−0.6	−1.5	−21.2	−26.5	−24.8

Estimation carried out by OLS, product by product at HS6, with destination covariates

Table 6 AVE-reducing effect of deep-integration clauses, by HS section and instrument

Proportional change (percent of baseline)

	Mutual Recognition of technical regulation			Harmonization of technical regulation			Mutual recognition of conformity assessment			Harmonization of conformity assessment			Transparency requirement		
	SPS (A)	TBT (B)	Total	SPS (A)	TBT (B)	Total	SPS (A)	TBT (B)	Total	SPS (A)	TBT (B)	Total	SPS (A)	TBT (B)	Total
Animals	−0.6	−10.8	−5.3	−14.7	−14.2	−14.5	−19.3	−20.2	−19.7	−14.1	−14.9	−14.5	−21.6	−13.9	−17.7
Vegetables	0.5	−8.7	−3.1	−15.8	−15.1	−15.5	−12.7	−38.3	−26.1	−15.6	−26.5	−20.6	−2.9	−33.5	−15.4
Fats and oils	−16.0	−23.1	−20.5	−28.6	13.2	−1.6	−16.3	−11.3	−13.4	−26.7	11.2	−2.5	−43.0	−24.6	−33.3
Beverages and tobacco	−3.6	0.8	−1.6	−24.0	−44.3	−32.8	−25.2	−46.0	−36.4	−16.9	−36.8	−25.9	−26.5	−18.7	−22.9
Minerals	0.0	−4.9	−4.1	0.0	−22.8	−19.4	0.2	−26.4	−22.0	2.8	−21.3	−17.2	5.3	−10.5	−8.0
Chemicals	4.6	−13.3	−10.9	−8.6	−30.7	−27.3	−12.6	−33.5	−31.0	−4.7	−23.5	−20.2	−6.2	−26.1	−23.6
Plastics	−4.8	−22.7	−18.8	−5.6	−21.4	−18.1	−12.2	−40.5	−36.0	−6.4	−27.8	−23.5	−2.7	−24.3	−19.9
Leather	−17.7	−15.0	−16.4	0.0	6.1	3.2	−19.6	−31.5	−26.4	2.3	−0.1	1.0	−20.4	−16.1	−18.4
Wood products	−6.8	78.7	1.8	−9.2	0.0	−6.6	4.0	−25.4	−5.3	−9.2	0.0	−6.8	−5.3	−59.5	−17.8
Paper	1.6	13.1	9.4	4.0	3.7	3.8	−18.4	−41.5	−36.1	5.0	−30.1	−19.9	4.4	−16.8	−10.5
Textile and clothing	−0.5	−18.3	−15.1	−1.8	−31.7	−26.8	−14.9	−21.7	−20.7	−2.3	−30.1	−25.2	−2.0	−20.9	−17.5
Footwear	0.0	−21.8	−18.7	0.0	−64.9	−56.3	−2.8	−35.9	−31.8	0.0	−78.7	−67.7	0.0	−50.3	−43.6
Stone and glass	−1.3	−0.6	−0.8	0.0	−15.7	−11.7	−3.6	−16.8	−13.3	0.4	−8.7	−6.2	2.1	−19.2	−13.7
Pearls	0.0	−7.4	−5.9	−16.1	−18.1	−17.7	−22.9	−9.3	−12.0	−16.3	−15.6	−15.7	0.0	−8.8	−7.2
Metals	−1.7	−11.0	−8.8	−3.9	−17.1	−13.5	−15.5	−26.2	−24.0	−3.3	−15.3	−11.7	−3.9	−31.4	−25.6
Machinery	−2.5	−7.6	−6.3	−6.5	−29.0	−24.2	−19.1	−29.1	−26.7	−5.1	−24.4	−19.6	−4.1	−22.1	−17.8
Vehicles	−1.1	−6.8	−6.6	−10.5	−29.9	−29.1	−14.8	−18.0	−17.9	−1.9	−29.1	−27.7	0.6	−14.1	−13.6
Optical and med. instr.	0.0	−10.6	−9.8	0.4	−24.4	−22.0	−10.1	−21.4	−20.4	0.4	−6.4	−5.7	0.6	−15.0	−13.7
Arms	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 6 continued

	Proportional change (percent of baseline)														
	Mutual Recognition of technical regulation			Harmonization of technical regulation			Mutual recognition of conformity assessment			Harmonization of conformity assessment			Transparency requirement		
	SPS (A)	TBT (B)	Total	SPS (A)	TBT (B)	Total	SPS (A)	TBT (B)	Total	SPS (A)	TBT (B)	Total	SPS (A)	TBT (B)	Total
Miscellaneous	0.1	-12.9	-11.5	0.4	-16.2	-13.8	-21.6	-30.5	-29.6	-1.1	-21.8	-18.7	6.8	-6.0	-4.6
Work of arts	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-40.3	-40.3	0.0	0.0	0.0	0.0	-40.0	-40.0
Average	-3.6	-9.9	-7.7	-13.6	-20.3	-18.0	-15.1	-27.6	-23.6	-11.8	-20.0	-17.2	-15.4	-21.1	-19.1

Estimation carried out by OLS, product by product at HS6, with destination covariates

Results are shown in Table 5. The first three columns show estimates of α_1^A, α_1^B and α_1^{other}, the linear (non-interacted) terms in (11), which can be thought of as the counterfactual AVEs of NTMs in the absence of a PTA. They are not identical to those reported in Table 5 because, in Table 6, they are affected by the simultaneous inclusion of interacted terms. The second block of three columns shows estimates of $\alpha_1^A + \beta_1^A$, $\alpha_1^B + \beta_1^B$ and $\alpha_1^{\text{other}} + \beta_1^{\text{other}}$, the sum of linear and interacted terms in (11), which can be thought of as AVEs in the presence of a PTA. The last block reports the absolute and percent difference between the first two blocks.

AVE estimates are lower in the presence of an RTA (second block) than without, suggesting that—as conjectured—RTAs reduce the price-raising effect of NTMs. AVEs of SPS measures are cut by 3 % points for animal products and 4 % points for fats and oils, products for which many developing countries have cumbersome and complex regulations. For instance, AVEs of TBT measures are cut by 3.8 % points for vegetables and by 3.1 % points for beverages and tobacco.

All in all, "deep integration" clauses reduce AVEs of SPS and TBT measures by about a quarter. Returning to the three alternative explanations for the price-raising effect of NTMs, the reduction observed in the presence of deep-integration clauses is consistent with either a reduction in compliance costs directly attributable to harmonization or mutual recognition, a reduction in the signaling effect due to better consumer information and/or reduced home bias within a regional trade bloc, or a reduction in protectionist-motivated distortions in the design of technical regulations. Whatever the underlying force, the effect is substantial, suggesting that deep-integration clauses may be the way to go in order to reduce NTM-induced market fragmentation.

Table 6 decomposes the overall effect of deep-integration clauses by instrument. That is, we re-estimate (11) replacing summary deep-integration dummies by specific ones: (i) harmonization of technical regulation; (ii) mutual recognition of technical regulation; (iii) harmonization of conformity assessment; (iv) mutual recognition of conformity assessment; or (v) transparency requirements.

Somewhat surprisingly, mutual recognition of technical regulations appears to be the least effective in reducing the compliance cost of NTMs, and by a substantial margin. As for conformity assessment, mutual recognition has a stronger cost-reducing effect than harmonization, an intuitive result. Our results suggest that transparency provisions reduce the price-raising effect of NTMs by 19.1 %, a result consistent with Lejagarra and Shepherd (2013).

5 Concluding remarks

The objective of this paper was to provide a rough, first-cut approach to measuring how deep-integration clauses reduce the cost-raising effect of NTMs. In a first step, we estimate NTM AVEs by measuring how their presence (marked in binary form) raises trade unit values. Positive effects may reflect either compliance costs or quality/signaling effects, and we do not attempt to disentangle those, leaving this important issue for future research. Taking these AVEs as a starting point, we then

ask whether the presence of deep-integration clauses, also marked in binary form, seems to reduce them.

The answer seems to be yes to both: NTMs do raise trade unit values for half of the HS6 products in the analysis, with an average price-raising effect of about 8 % (3 % for SPS measures and 5 % for TBT ones). However, this price-raising effect is dampened by a factor of about a quarter in the presence of deep-integration clauses, the strongest effect coming from the mutual recognition of conformity-assessment procedures.

The issue and results are potentially important for regulatory policy. Many countries struggle to reduce the regulatory burden on their companies in order to make them more cost-competitive. The prevalent "doing-business" approach pushed by many development consultancies is simply to cut regulations and red tape. However, in many developing countries, there is a glaring need for more consumer protection against counterfeits and hazardous or adulterated products. Policy advice predicated on the notion that high-AVE measures should be prioritized for elimination irrespective of their non-trade objectives would not just be wrong-headed: It could have disastrous implications for public health and the environment. Our results suggest an alternative and more sensible route to improved regulations; namely, to encourage regional cooperation through mutual recognition of regulations. Indeed, many of the complaints heard on the ground and in portals open to private-sector complaints have to do with non-recognition of basic paperwork like origin or SPS certificates by the customs or health authorities of importing countries, even within FTAs. Our results suggest that donors should continue providing technical assistance geared toward better cooperation in regulatory policy at the regional level.

Our findings also suggest that countries can expect to gain from transparency provisions in RTAs. Such provisions are more likely to be extended more widely among trading partners that have sufficient institutional and governance capacity.

Appendix

See Table 7.

Table 7 NTM data coverage and collection year

Region	Country name	Year of collection
Latin America	Argentina	2012
	Bolivia	2012
	Brazil	2012
	Chile	2012
	Colombia	2012
	Costa Rica	2012
	Ecuador	2012
	Guatemala	2012
	Mexico	2012
	Peru	2012
	Paraguay	2012
	Venezuela	2012
	Uruguay	2012
Middle East and North Africa	Egypt	2011
	Lebanon	2011
	Morocco	2011
	Syria	2011
	Tunisia	2011
Developed	European Union	2011
	Japan	2011
Africa	Burundi	2012
	Burkina Faso	2012
	Cote d'Ivoire	2012
	Guinea	2012
	Kenya	2011
	Madagascar	2011
	Mauritius	2011
	Senegal	2011
	Tanzania	2011
	Uganda	2011
	SouthAfrica	2011
Asia	Bangladesh	2012
	India	2012
	Sri Lanka	2012
	Nepal	2012
	Pakistan	2012
	China	2012
	Indonesia	2009
	Cambodia	2011
	Laos	2011
	Philippines	2010

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