Study on economic impact of equivalence of measurement standards

Dr Takashi Usuda, AIST/NMIJ, Japan,

Visiting Scientist, Director's Office, BIPM
September 2010 to December 2011

The economic importance of being able to demonstrate the equivalence of measurement standards maintained by different States is a subject of interest to governments world-wide. The subject has formed the basis of a study conducted at the BIPM from September 2010 to December 2011, using a new methodology. This study models the financial losses resulting from deviations between two sets of measurement standards, allowing a quantitative calculation of the economic benefits of demonstrated equivalence in measurement standards for any industry, any market, and for users at any level of the calibration hierarchy. The same methodology can be used to illustrate the economic impacts or risks in international trade resulting from deviations in measurement standards.

Figure 1 overleaf illustrates the generic application of this methodology to international trade.

All industrial products exhibit a distribution in terms of quality, designated here $D(x)$, where x is a measurand of the product quality (see Fig. 1(a)). The products that fit within the testing limits ($\pm\Delta$) are selected as suitable by the manufacturer/exporter (Fig. 1(a)), and delivered to the user/importer (Fig. 1(b)). The user/importer in turn verifies the quality of the products against its own measurement standards (Fig. 1(c)). If there are no deviations between the metrology standards of the exporter and the importer, all is well and no additional losses arise. However, if there is a deviation ε between the measurement standards of the exporter and those of the importer, additional losses will arise.

These financial losses are caused by "false positive" results, meaning those exported products that will nonetheless be rejected by the importer, and "false negative" results, caused by the products previously rejected by the exporter that would in fact have been accepted by the importer (see Fig. 1(c)). Mathematically, the number of products recognized as "false positive" is given by $\int_{-\Delta}^{-\Delta+\varepsilon} D(x)\mathrm{d}x$, and as "false negative" by $\int_{\Delta}^{\Delta+\varepsilon} D(x)\mathrm{d}x$. The financial losses resulting from these false positive and false negative results can then be calculated given the unit price of the product.

Needless to say, the false positive fraction causes more significant economic loss and could also damage the exporting company's reputation. So this evaluation of false positive results represents a minimum estimate of the economic consequence of a difference between the measurement standards.

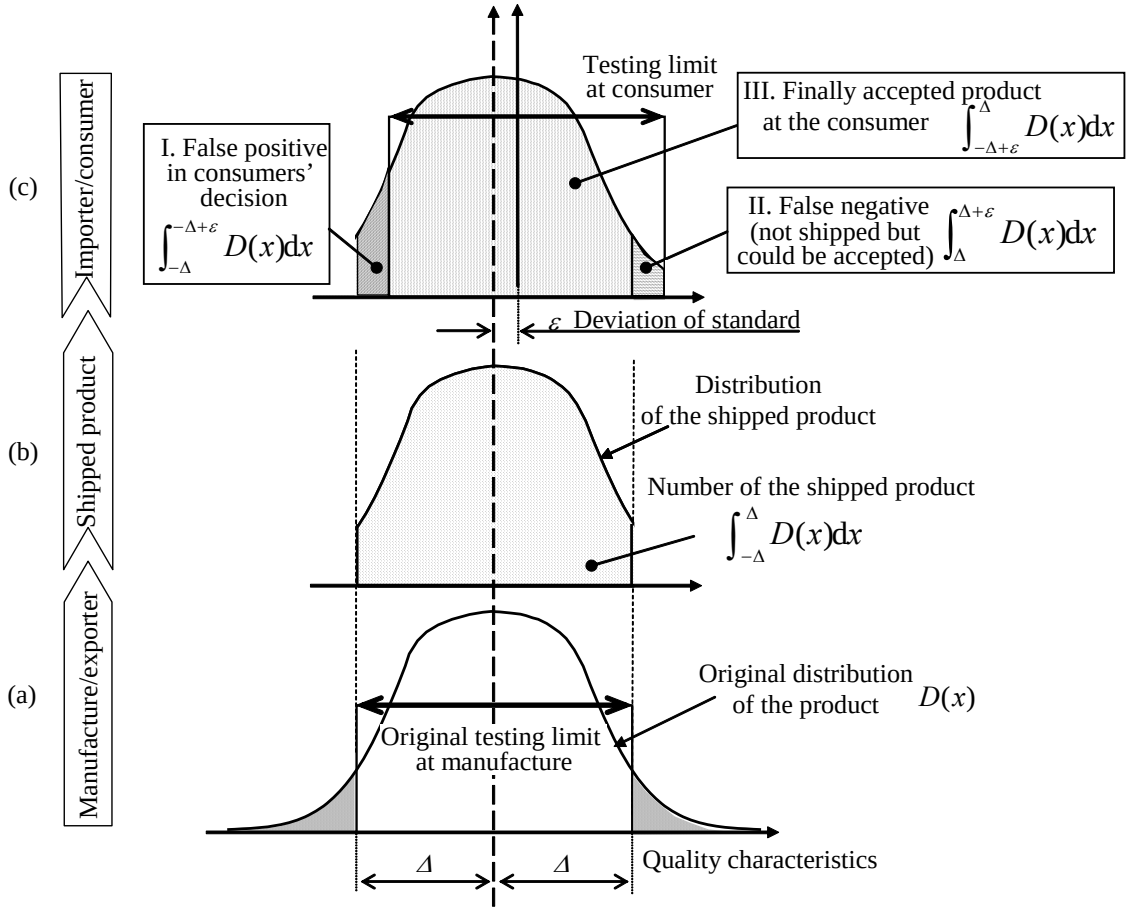

Figure 1. Economic losses due to a deviation between the metrology standards maintained by two trading partners

Since the implementation of the CIPM MRA, peer-reviewed results of comparisons of measurement standards have been collated in the BIPM key comparison database (KCDB). Using the equivalence demonstrated in this database together with data on the quality distribution of products (information usually held confidential by production companies), the proposed method allows us to estimate the economic loss caused by deviations between measurement standards. The KCDB provides an essential input for this quantitative assessment of the economic impact associated with the distribution of the products and the deviation of measurement standards, which was not possible before. The proposed methodology provides a means of demonstrating the large economic benefits resulting from the CIPM MRA.

The full story of this study including some empirical examples calculated from market statistics, will be reported at a later date. For further information on this subject, please contact Dr Takashi Usuda at takashi.usuda@aist.go.jp.

November 2011